

Moderation of the Relation of County-Level Cost of Living to Nutrition by the Supplemental Nutrition Assistance Program


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Objectives. To examine the association of county-level cost of living with nutrition among low-income Americans.

Methods. We used the National Household Food Acquisition and Purchase Survey (2012–2013; $n=14\,313$; including 5414 persons in households participating in the Supplemental Nutrition Assistance Program [SNAP]) to examine associations between county-level cost-of-living metrics and both food acquisitions and the Healthy Eating Index, with control for individual-, household-, and county-level covariates and accounting for unmeasured confounders influencing both area of living and food acquisition.

Results. Living in a higher-cost county—particularly one with high rent costs—was associated with significantly lower volume of acquired vegetables, fruits, and whole grains; greater volume of acquired refined grains, fats and oils, and added sugars; and an 11% lower Healthy Eating Index score. Participation in SNAP was associated with nutritional improvements among persons living in higher-cost counties.

Conclusions. Living in a higher-cost county (particularly with high rent costs) is associated with poorer nutrition among low-income Americans, and SNAP may mitigate the negative nutritional impact of high cost of living. (*Am J Public Health.* 2016;106:2064–2070. doi:10.2105/AJPH.2016.303439)

 See also Galea and Vaughan, p. 1901.

Limited or uncertain access to adequate food—known as “food insecurity”—among low-income Americans is associated with poor nutrition, an increased risk of major nutrition-related chronic diseases, and poor clinical control of hypertension and type 2 diabetes.^{1–5} Low-income Americans faced with food insecurity often engage in economic trade-offs—for example, sacrificing their food budgets to pay for major living expenditures, such as rent or medical bills.^{6,7} High area-level cost of living may have a substantial impact on household budgets and, therefore, force such economic trade-offs. As a consequence, purchased foods may be of lower nutritional value, in part because perceived or real prices of healthier foods, such as fruits and vegetables, are often higher than those of calorie-dense, nutrient-poor food items.⁸

To support nutrition among the food insecure, the nation’s largest nutritional assistance program—the Supplemental Nutrition Assistance Program (SNAP)—currently provides assistance to nearly 1 in 7 Americans.⁹ Some research suggests that SNAP is associated with poorer nutrition and a higher risk of obesity^{10,11}; however, these associations generally are not observed in rigorous analyses accounting for unobserved confounders (e.g., the propensity for low-income households to live in areas with limited healthy food availability).^{12,13} Furthermore, there are

selection biases in comparing persons who enter into SNAP and those who do not.

To our knowledge, the relationships between area-level cost of living, SNAP participation, and the healthfulness of food acquisitions have not been studied. Cost of living is of particular interest because SNAP benefits are currently based on a national average cost estimate of a basket of lower-cost foods. Previous studies suggest that the national estimate drastically underestimates food cost in some urban areas.¹⁴ Hence, in 2013, an Institute of Medicine panel was called to assess strategies to ensure the adequacy of SNAP benefits. The panel recommended investigation into whether a smaller-area (e.g., county- or metro-level) cost-of-living adjustment could be applied to SNAP benefits, but noted the absence of sufficient local area-level cost data to perform this research.

Since the panel report, comprehensive local area-level cost indices have been made available by the Bureau of Economic Analysis and the US Census. Using these newly available metrics, we sought to test 3 key hypotheses that attempt to decipher whether and under what contexts cost of living relates to the healthfulness of food acquisitions, and whether SNAP enrollment affects these associations. Our first hypothesis was that high area-level cost of living would be associated with less-healthy food acquisitions, because people would sacrifice their food budgets to pay for other costs, such as

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rent. Our second hypothesis was that SNAP participation would be associated with living in a lower-cost area, both because lower-income populations tend to live in lower-cost areas and because a SNAP dollar would be able to purchase more food in such areas, potentially making benefits “stretch” farther in such areas. Our third hypothesis was that SNAP participation would have a different impact on the healthfulness of food acquisitions in high- and low-cost areas, because area-level costs such as rent may affect how much SNAP users are able to stretch their SNAP allotments to cover not just less-healthy, cheaper foods but also healthier, potentially more-expensive foods.

METHODS

We tested our hypotheses by performing secondary data analyses on the National Household Food Acquisition and Purchase Survey (FoodAPS, 2012–2013) released in 2015 by the US Department of Agriculture (USDA). FoodAPS is a representative national survey of noninstitutionalized households, including subpopulations of SNAP participants, eligible nonparticipants (household incomes < 185% of the federal poverty threshold¹⁵), and higher-income ineligible nonparticipants.¹⁶ The FoodAPS survey provides a novel source of detailed geocoded data on households’ food acquisitions, unavailable in other major surveys, allowing us to examine the relationships among cost of living, SNAP participation, and food choices in a comprehensive manner for the first time. Compared with other surveys, it has the advantage of reducing measurement error of SNAP participation by including administrative confirmation of SNAP participation by the USDA.

Surveyors from the USDA identified a primary respondent in each household as the main food shopper or meal planner and asked them to complete 2 in-person interviews and 3 brief telephone interviews regarding food acquisition events over the course of 1 week. The surveyors asked each household member aged at least 11 years to track and report all food acquisitions during the week (at home and away from home, including donated or gifted food).

Households scanned barcodes on packaged foods and submitted receipts from stores and restaurants. For variable-weight items (e.g., fruit) and items without barcodes, respondents scanned barcodes from a standardized book or listed nonscannable foods. Postcollection processing included resolution of inconsistencies against receipts and imputation where possible.¹⁷ To enable nutritional analyses, individual food items were matched to items in the Food and Nutrient Database for Dietary Studies or the National Nutrient Database for Standard Reference.^{18,19} FoodAPS surveyors also collected demographic, socioeconomic, and nutrition-related information about each household (Table 1 and Table A, available as a supplement to the online version of this article at <http://www.ajph.org>).

We supplemented FoodAPS data with 2 metrics of area-level cost of living. The first metric—the regional price parity (RPP) from the Bureau of Economic Analysis (2012)—provides the average price of goods or services in an area divided by the national average price across all such areas.^{20,21} The national average is set to a value of 100 so that an area’s RPP can be interpreted as a percentage of the national average (e.g., an area with 14.1% higher costs than the national average has an RPP of 114.1). We focused on the overall, rent, and food RPPs. We specifically included the rent RPP as rent expenditures account for the largest weighted share of expenditures (approximately 43% of total expenditures). The second metric was the US Census Bureau’s geographic adjustment to the Supplemental Poverty Measure, which is based on geographic differences in rent costs in the American Community Survey (Appendix available as a supplement to the online version of this article at <http://www.ajph.org>).²² We evaluated both metrics at the county level, because this was the smallest area that (1) contained the primary food store for most FoodAPS participants (i.e., most populations travel outside of areas smaller than the county to reach their primary food store),²³ (2) had routinely updated cost metrics (for policy relevance to benefit adjusters), and (3) had control variables of interest (Table 1).

Dependent Outcome Metrics

Our dependent variables of interest included average daily person-level food acquisitions, expressed in kilocalories and food pattern equivalents units (e.g., ounce-equivalents or cup-equivalents), based on the Food Patterns Equivalents Database and Food Patterns Ingredients Database, and the School Nutrition Dietary Assessment Study for foods obtained from reimbursable school meals (2011–2012).^{24,25} We grouped analyses into 8 food categories per the National Food and Nutrient Database for Dietary Studies:

1. vegetables (total dark green, red and orange, starchy vegetables, and legumes counted as vegetables);
2. whole fruits and 100% fruit juices;
3. whole grains;
4. refined grains;
5. dairy products (milk, yogurt, cheese, and whey);
6. proteins (meat, poultry, seafood, eggs, soy, nuts, seeds, and legumes counted as proteins);
7. solid fats and oils; and
8. added sugars.

We computed each respondent’s Healthy Eating Index (HEI, version 2010, the most recent available)—a widely used metric of overall dietary quality—to permit comparability to other studies examining SNAP impact.²⁶ The HEI can be applied to any level of the food system (from production to market availability to acquisition to consumption) because it relies on universal standards and a density approach (e.g., nutrients per 1000 calories).²⁷ The HEI-2010 is a composite score (0=worst to 100=best) indicating the concordance of food acquisitions per person per day to the 2010 Dietary Guidelines for Americans; newer guidelines recommend less meat and added sugars, so we analyzed these food groups in additional detail.²⁸ The score is constructed by adding points for acquiring foods or nutrients considered health-promoting (e.g., whole grains), and for low acquisition of foods or nutrients considered potentially harmful (e.g., refined grains).

TABLE 1—Key Characteristics of Survey Respondents, Including Participants and Nonparticipants in the Supplemental Nutrition Assistance Program: National Household Food Acquisition and Purchase Survey, United States, 2012–2013

Characteristic	SNAP Participants	SNAP Nonparticipants < 185% FPT	SNAP Nonparticipants ≥ 185% FPT
Sample size, no.			
Individuals	5414	3863	5036
Households	1581	1391	1852
Age, y, mean (95% CI)	30.0 (2.0, 67.0)	37.5 (4.0, 78.0)	38.9 (4.0, 72.0)
Female, %	53.6	53.7	51.3
Race/ethnicity, %			
White	63.0	75.4	83.3
Black	26.7	15.3	9.8
Hispanic ^a	31.2	27.8	12.2
High school or more education, %	47.5	58.9	73.3
Full- or part-time employment, %	28.9	34.3	55.9
Household income as % of federal poverty threshold (95% CI)	138.6 (0.0, 357.0)	100.8 (0.0, 180.0)	503.9 (206.0, 1048.0)
Household's monthly rent or mortgage, \$, mean (95% CI)	577.1 (0.0, 1500.0)	720.6 (0.0, 2000.0)	1014 (0.0, 2400.0)
Straight-line distance to primary food store, miles, mean (95% CI)	3.1 (0.2, 13.3)	3.5 (0.2, 14.3)	3.9 (0.4, 14.1)
Living in a rural residential area, %	22.7	27.5	35.4
Low or very-low food security on USDA 30-d scale, %	42.7	31.9	6.9
WIC participation, %	22.4	14.1	3.0
Supermarkets per 1000 people, in county of residence, mean (95% CI)	12.0 (6.1, 21.4)	11.8 (6.4, 21.4)	12.1 (6.7, 21.7)
People in county below federal poverty threshold, % (95% CI)	16.2 (9.6, 25.8)	15.6 (7.7, 23.6)	13.8 (6.6, 21.8)
Regional price parity, relative to national average ^b (95% CI)			
Overall cost of living	97.6 (89.6, 121.0)	100.4 (89.6, 122.2)	99.3 (89.6, 121.4)
Rent or mortgage costs	95.8 (65.4, 156.7)	103.8 (70.6, 181.3)	102.4 (70.6, 181.3)
Food costs	98.7 (94.9, 112.3)	100.1 (94.9, 112.3)	100.0 (84.8, 112.3)

Note. CI = confidence interval; FPT = federal poverty threshold; SNAP = Supplemental Nutrition Assistance Program; USDA = US Department of Agriculture; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children. See Table A, available as a supplement to the online version of this article at <http://www.ajph.org>, for a more comprehensive descriptive statistics table. All individuals were participants in the National Household Food Acquisition and Purchase Survey (2012–2013). The Stata commands SVY and SUBPOP were applied to data from each subpopulation to adjust estimates for stratification and clustering, and to apply sample weights.

^aNot mutually exclusive with White or Black race.

^b100 = average.

Analytic Approach

Because many unmeasured covariates could influence individuals to live in a higher- or lower-cost county, as well as affect SNAP participation and food acquisitions (the problem of endogeneity), we performed all regressions by using endogenous treatment effects models. These models attempt to control for the endogeneity of treatment assignment (e.g., whether one lives in a high- or low-cost area) by using a control function approach (see full equations in the Appendix text).²⁹ Specifically, the models attempt to control for unmeasured confounders, and thereby produce unbiased regression

coefficients, by first modeling the probability of living in a high-cost area based on observed covariates, then including the residual error from the probability model in a second regression of cost of living on the dependent variables. In short, the residual errors from the first model (predicting endogenous variables) capture the unmeasured confounders, such that when they are controlled in the second model, the unmeasured confounders are also controlled.

We tested our first hypothesis by regressing metrics of cost of living against food acquisition and HEI scores, with control for the individual-, household-, and area-level covariates. We defined an area with “higher”

cost of living as 1 standard deviation above the national mean.^{20–22} Our second hypothesis was restricted to only low-income potentially eligible SNAP populations (< 185% of the federal poverty threshold, either SNAP participants or nonparticipants), among whom we regressed SNAP participation against cost of living, with control for the factors in Table 1 and additional variables capturing geographic variations in SNAP enrollment policies (instrumental variables; see the Appendix text). We estimated our third hypothesis, also restricted to the same low-income potentially eligible SNAP population, by regressing SNAP against food acquisitions and HEI scores, then adding an interaction term

between SNAP participation and area cost of living.

We used survey weights to adjust estimates for differential sampling and nonresponse. We did not impute missing data, as food acquisition data cannot be determined to be missing (i.e., failure to report a food cannot be identified), and minimal data were missing for covariates in the regressions (<7% missing for any single variable). We performed all estimates with Stata version MP/14 (StataCorp LP, College Station, TX).

RESULTS

Table 1 provides key summary statistics on the analytical sample, which are further detailed in Table A. The study sample included 1581 SNAP participant households, 1391 nonparticipant households below 185% of the federal poverty threshold (eligible nonparticipants), and 1852 nonparticipant households greater than or equal to 185% of the federal poverty threshold (including the value of benefits as income). The SNAP participants were younger than nonparticipants, and were more likely to be Black or Hispanic, have lower education, have a lower probability of employment, and have a larger household (Table 1). The SNAP participants were also notably less poor than eligible nonparticipants (on average, 138.6% of the federal poverty threshold for household size, vs 100.8%), faced lower housing costs (\$577 vs \$721 per month), were closer to their primary food store (3.1 vs 3.6 miles), and were less rural (23% vs 28% in a rural residence).

The SNAP participants had a similar density of supermarkets and fast-food restaurants in their county as either eligible or ineligible nonparticipants, and lived in similarly impoverished counties. However, the ratio of fast-food restaurant density to supermarket density was significantly higher in lower-cost than higher-cost counties (7.0 vs 6.4; $P < .001$). Cost-of-living metrics overlapped between SNAP participants and eligible or ineligible nonparticipants, although they varied widely across counties. Housing costs varied widely in particular; the 5th and 95th percentiles of the overall RPP were 85.9 and 108.5, of the food RPP were 92.1 and 105.5, and of the rent RPP were 58.5 and 140.0.

Both SNAP participants and nonparticipants showed similar food acquisitions, except for higher acquisitions of added sugars among SNAP participants than nonparticipants. Tables B and C (available as supplements to the online version of this article at <http://www.ajph.org>) reveal that the estimated daily food acquisitions in all groups of our analytical sample are very similar to the reported food consumption among participants in the National Health and Nutrition Examination Survey,³⁰ and similarly distant from National Dietary Guidelines.³¹

As shown in Table 2, no matter which cost of living metric we used, living in a higher-cost county was associated with significantly lower volume of acquired vegetables, fruits, and whole grains and significantly greater acquisitions of refined grains, dairy products, protein, fats and oils, and added sugars. Even after we controlled for individual-, household- and county-level factors, living in a higher-cost county (as measured by the overall RPP) was associated with a decline in vegetable acquisition by about 0.65 cup-equivalents per person per day ($SE = 0.04$; $P < .001$), which is approximately 37% less than the estimated mean of vegetable acquisition among persons with equivalent covariates living in a lower-cost county. Living in a higher-cost county was also associated with 0.14 cup-equivalents (16%) lower fruit acquisitions, 0.11 ounce-equivalents (11%) lower whole grain acquisitions, 2.35 ounce-equivalents (34%) higher refined grain acquisitions, 36.63 gram (52%) increase in fat and oil acquisitions, 9.40 teaspoon-equivalent (35%) increase in added sugar acquisitions, 550 kilocalories per person per day (23%) higher caloric intake, and a 6.0 point (11%) lower HEI score (all $P < .01$).

The rent RPP was more strongly associated with acquisitions of vegetables, whole grains, protein, fats and oils, and overall HEI score than the food RPP. The geographic adjustment to the Supplemental Poverty Measure, which is based on rent prices, was more associated with acquisitions of any food than any other cost-of-living metric (Table 2). In subgroup analyses (Figure A, available as a supplement to the online version of this article at <http://www.ajph.org>), SNAP nonparticipants below 185% of the federal poverty threshold (SNAP-eligible

nonparticipants) were most vulnerable to having a lower HEI score given an increase in cost of living. Living in a higher-cost county measured by the overall RPP was associated with 5.8-point lower HEI scores among SNAP participants ($SE = 0.9$; $P < .001$), 7.0-point lower HEI scores among SNAP-eligible nonparticipants ($SE = 1.0$; $P < .001$), and 4.0-point lower HEI scores among higher-income SNAP-ineligible nonparticipants ($SE = 0.6$; $P < .001$).

As shown in Table 3, SNAP participation was correlated with living in a higher-cost county (for all cost-of-living metrics) after we controlled for relevant individual-, household-, and county-level confounding variables. The finding was consistent across all measures of cost of living (Table 3). For example, the probability of living in a higher-cost county as defined by the overall RPP was 0.2 for SNAP nonparticipants, but increased to 0.6 for SNAP participants.

Participation in SNAP was only associated with healthier food acquisition in higher-cost counties (HEI scores of 41 if not participating in SNAP vs 61 if participating in SNAP, based on an endogenous treatment effects model that controls for selection). By contrast, in lower-cost counties, SNAP participation was not significantly associated with HEI score (Figure B, available as a supplement to the online version of this article at <http://www.ajph.org>). In lower-cost counties, SNAP participation was associated with increased fruit and vegetable acquisition, but also with increased acquisition of fats and oils and added sugars, which offset the HEI improvements that would have been observed from the increased fruit and vegetable acquisition (Table D, available as a supplement to the online version of this article at <http://www.ajph.org>).

DISCUSSION

We analyzed new nationally representative data to understand how cost of living relates to the healthfulness of food acquisitions, how SNAP participation relates to cost of living, and the degree to which the relationship between SNAP benefits and nutritional quality varies in geographic areas with differing costs of living. We specifically measured cost of living by using indices that

TABLE 2—Cost of Living and Nutrition Among Participants: National Household Food Acquisition and Purchase Survey, United States, 2012–2013

Cost-of-Living Metric	Change in Food Acquisitions in Each Food Category (per Person per Day) With a 1-SD Increase in the Cost-of-Living Metric (SE)								Change in Calories Acquired, Kcal/Person/Day (SE)	Change in HEI Score ^a (SE)
	Vegetables, Cup-Eq	Fruits, Cup-Eq	Whole Grains, Oz-Eq	Refined Grains, Oz-Eq	Dairy, Cup-Eq	Protein, Oz-Eq	Fats and Oils, Grams	Added Sugars, Tsp-Eq		
Overall cost of living, RPP	−0.65 (0.04)	−0.14 (0.02)	−0.11 (0.03)	2.35 (0.12)	0.28 (0.04)	0.86 (0.11)	36.63 (1.89)	9.40 (0.84)	542.92 (45.60)	−6.0 (0.9)
Rent cost, RPP	−0.65 (0.04)	−0.14 (0.02)	−0.11 (0.03)	2.35 (0.12)	0.28 (0.04)	0.86 (0.11)	36.63 (1.89)	9.40 (0.84)	542.92 (45.60)	−6.0 (0.9)
Food cost, RPP	−0.41 (0.04)	−0.17 (0.02)	−0.06 (0.04)	2.68 (0.13)	0.33 (0.04)	0.64 (0.12)	31.74 (1.40)	9.63 (0.66)	471.50 (40.91)	−1.4 (1.0)
All goods, RPP	−0.34 (0.03)	−0.10 (0.01)	0.38 (0.04)	2.67 (0.11)	0.24 (0.03)	1.38 (0.10)	43.45 (1.97)	11.54 (0.82)	884.54 (66.84)	−4.5 (0.8)
All services, RPP	−0.35 (0.03)	−0.11 (0.02)	0.36 (0.04)	2.80 (0.12)	0.34 (0.04)	1.10 (0.10)	45.07 (2.46)	16.15 (1.05)	869.22 (73.18)	−4.1 (0.8)
Geographic adjustment to Supplemental Poverty Measure	−0.67 (0.04)	−0.18 (0.02)	−0.05 (0.04)	3.05 (0.13)	0.36 (0.04)	1.35 (0.11)	47.71 (2.11)	12.57 (0.92)	766.35 (52.10)	−2.1 (0.9)

Note. Eq = equivalent; HEI = Healthy Eating Index; RPP = regional price parity; Tsp = teaspoon. Living in a higher-cost county (1 SD above mean national cost) was associated with less healthy food acquisitions and lower HEI scores. All coefficients were statistically significant at $P < .01$ except for the association between the geographic adjustment to the Supplemental Poverty Measure and HEI score, which was significant at $P < .05$. Estimates are from an endogenous treatment effects model controlling for individual-, household-, and county-level factors, detailed in Table A (available as a supplement to the online version of this article at <http://www.ajph.org>). The sample size was $n = 14\,313$.

^aScore from 0 (worst) to 100 (best).

might be used in the future to adjust SNAP benefits for county-level food and living costs.

Our study makes several important contributions to the existing literature on nutritional intake and cost of living. First, we found that living in a higher-cost county was associated with a significantly lower volume of vegetable, fruit, and whole grain acquisitions and a significantly higher volume of refined grains, dairy products, protein, fats and oils, and added sugars acquisitions. Living in a higher-cost county was also associated with

an 11% reduction in the HEI—a decrease in HEI larger than that associated with a significant rise in cardiovascular disease, type 2 diabetes, and all-cause mortality.^{32,33}

In addition, we observed that the food cost metric was less associated with changes in the healthfulness of food acquisitions than the rent cost metric, perhaps because variations in expenditures such as rent are larger and have a more substantial impact on overall household and food budgets. This is an important finding for policymakers who may need to choose which metric of cost of living would

be utilized if SNAP or related benefits were adjusted for subnational cost of living. An increasing literature suggests that when rent prices are high, low-income households have limited funds available to augment their SNAP budget, leaving them reliant on emergency food aid.³⁴ Hence, food prices may be less useful as an indicator of food purchasing power than rent prices, which constitute the largest expenditure away from the food budget among vulnerable low-income households.

Further analyses revealed that SNAP participation appears to moderate the relationship between cost of living and healthy food acquisition, with SNAP being associated with healthier acquisitions in higher-cost counties. One potential explanation for this finding is that SNAP participation may be effectively buffering participants from some negative impacts of high living costs. Increasing SNAP enrollment may improve the food acquisitions of eligible nonparticipants, who constitute about 15% of the eligible population.³⁵ Participation in SNAP was also associated with living in a higher-cost county. One potential explanation is that higher-cost counties more quickly drain monthly budgets, increasing the need for SNAP participation.

TABLE 3—Supplemental Nutrition Assistance Program Participation and Area Cost of Living: National Household Food Acquisition and Purchase Survey, United States, 2012–2013

If Higher-Cost County Is Defined by:	The Probability (SE) of Living in Higher-Cost County, if Not Participating in SNAP, Is:	The Change in Probability (SE) of Living in Higher-Cost County, if Participating in SNAP, Is:
Overall regional price parity	0.2 (0.0)	+0.4 (0.0)
Rent regional price parity	0.2 (0.0)	+0.4 (0.0)
Food regional price parity	0.3 (0.0)	+0.4 (0.0)
Geographic adjustment to the Supplemental Poverty Measure	0.3 (0.0)	+0.4 (0.0)

Note. SNAP = Supplemental Nutrition Assistance Program. SNAP participation was associated with living in a higher-cost county (1 SD above mean national cost). All coefficients were statistically significant at $P < .01$. Estimates are from an endogenous treatment effects model controlling for individual-, household-, and county-level factors, detailed in Table A (available as a supplement to the online version of this article at <http://www.ajph.org>). The sample size was $n = 14\,313$.

Finally, when we used endogenous treatment effects models that controlled for selection, we observed that SNAP had a neutral association with the healthfulness of food acquisitions in lower-cost counties, because increased fruit and vegetable acquisitions and lower refined grain acquisitions attributable to SNAP participation were counterbalanced by increased acquisitions of fats and oils as well as added sugars. Although individuals had a worse dietary profile in higher-cost counties when not participating in SNAP, SNAP participation was associated with more healthy food acquisitions in higher-cost counties. One explanation may be that in a higher-cost county, SNAP dollars are used disproportionately to acquire foods that are considered most out of reach because of high prices.

The finding may alternatively be a commentary on the nature of the food acquisition environment; that is, if lower-cost counties indeed have environments saturated with less-healthy foods (and, indeed, our data suggest that the density of fast-food establishments to supermarkets is significantly higher in such counties),³⁶ the additional money for food from SNAP benefits may be less able to counteract the strong effect of a poor food environment. Unlike previous analyses that lacked neighborhood covariates, our analyses included controls for area-level covariates including metrics of the food environment and built environment. Hence, our finding brings further context to recent literature demonstrating associations between SNAP enrollment and changes in HEI scores.^{37,38}

Whereas previous literature has documented trade-offs between energy costs, housing costs, medical care costs, and food security,^{6,7,39,40} our study provides evidence for the additional dimension of how cost of living among low-income Americans is associated with the healthfulness of food acquisitions, among both SNAP participants and nonparticipants. To our knowledge, this is the first assessment to use nationally representative survey data to understand how broad costs of living across the nation relate to the healthfulness of food acquisitions. We used the new FoodAPS data set, which offers the opportunity to administratively confirm SNAP participation. Other surveys (e.g., National Health and Nutrition Examination

Survey) are known to substantially misidentify SNAP participation,¹³ preventing accurate assessments of program impact.

Limitations

Several notable limitations in our analysis are important to highlight. First, our data are from cataloged food acquisitions, not 24-hour dietary recalls. Hence, we do not observe actual food consumption and associated information such as variations in portion size or food waste. The data are also subject to observational effects (e.g., participating individuals may have changed their food acquisition patterns during study participation). A further limitation is that we utilized data on costs geocoded to the county level, not smaller levels. Because even low-income Americans typically travel significant distances (beyond areas defined by census block or tract, for example) to their primary food store,²³ our analysis was intended to capture the price distribution for key food items purchased by households. We also controlled for county-level covariates because this was the smallest area level for which data on cost-of-living metrics are available for adjustment of benefits (i.e., to render our analysis policy-relevant), and the smallest area with neighborhood environment and population demography consistently available, to control for key confounders. Finally, we were not able to explore why eligible nonparticipant households do not enroll in SNAP, or how much adjustment for cost of living among SNAP benefits may alter geographic, racial/ethnic, and income-related disparities in nutrition, which should be the subject of future research.

Public Health Implications

Lower-income populations may be particularly vulnerable to less-healthy food acquisitions when they face high costs of living, at least when they are not enrolled in SNAP. Costs of food are not the only—or even the best—metric of which costs of living are associated with less-healthy food acquisitions. Rent costs appear to be strongly associated with the healthfulness of food acquisitions, suggesting that housing costs are a major source of stress and financial constraint among low-income households. These findings suggest a need for further investigation into

the impact of including cost-of-living adjustments in benefit calculations for SNAP, the nation's largest nutrition assistance program. **AJPH**

CONTRIBUTORS

All authors conceptualized the study. S. Basu conducted the analysis and drafted the first version of the article. C. Wimer and H. Seligman critically analyzed the data and contributed to revision of the article.

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HUMAN PARTICIPANT PROTECTION

This study was approved by the Stanford University institutional review board, eProtocol 30708.

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