RESEARCH ARTICLE

Impact of the supplemental nutritional assistance program on diet-related disease morbidity among older adults

Layla G. Booshehri PhD ⬤ | Jerome Dugan PhD ⬤

Department of Health Services, School of Public Health, Hans Rosling Center for Population Health, University of Washington, Seattle, Washington, USA

Correspondence
Jerome Dugan, PhD, Department of Health Services, School of Public Health, Hans Rosling Center for Population Health, University of Washington, Seattle, Washington 98195-1616, USA.

Abstract

Objectives: To examine the health effects of the Supplemental Nutritional Assistance Program (SNAP) and the differential impact of SNAP across race/ethnicity among older adults.

Data Source/Study Setting: 2008-2013 Medical Expenditure Panel Survey, a nationally representative population-based complex sample survey.

Study Design: A difference-in-regression-discontinuity (DRD) design is used to assess the impacts of SNAP on diet-related disease morbidity. The primary outcomes were the prevalence rate of hypertension, coronary heart disease, stroke, diabetes, and cancer. We also conducted supplemental analysis to examine potential co-occurring trends in medical utilization.

Data Collection/Extraction Methods: Data are publicly available.

Principal Findings: In the full sample, SNAP eligibility was associated with a significant decline in diabetes (−3.71 percentage points [pp]; $P < .05$). Non-Hispanic (NH) White respondents reported trends similar to the full sample; however, NH Black respondents reported large declines in hypertension (−13.95 pp; $P < .01$) and Hispanic respondents reported declines in the prevalence of angina (−6.94 pp; $P < .05$) and stroke (−4.48 pp; $P < .05$).

Conclusions: Supplemental Nutritional Assistance Program eligibility was associated with the reduced prevalence of diet-related disease among older adults. These observed declines in the prevalence of diet-related disease do not appear to be attributable to increased medical visits or spending on medical services and prescriptions.

KEYWORDS
diet-related disease, older adults, Supplemental Nutritional Assistance Program

1 | INTRODUCTION

The Supplemental Nutritional Assistance Program (SNAP), the largest federal nutritional program, provides nutritional assistance to over 22.7 million American households (45 million individuals) and guaranteed eligibility to the program as long as a few asset and income-based means tests are met.[1] A large prior empirical literature has generated mixed results on the impact of the SNAP program's economic and health outcomes. On one hand, researchers have shown that SNAP participation is associated with reduced food insecurity, higher self-assessed health, fewer illness days, and less visits to the doctor or hospital relative to other income eligible persons not receiving SNAP.[2-12]

On the other hand, researchers have also documented that SNAP recipients have lower nutritional quality in food purchases, lower dietary intake, and higher diet-related disease morbidity than persons not receiving SNAP.[13-17] A major reason for these contradictory results is that the classification approach used to construct treatment groups (eg, comparing income eligible persons that enrolled in SNAP to income eligible nonparticipants) in most cross-sectional and longitudinal studies do not account for the voluntary, self-enrolling nature of SNAP enrollment. This self-selection bias is a major threat to the internal and external validity of study results throughout the literature, and it is crucial to identify sources of exogenous variation in program participation where participation is uncorrelated with participant outcomes.

The lack of exogenous variation to guide the construction of treatment groups introduces the possibility that the reported estimates in these studies are potentially biased and inconsistent, meaning they cannot be used to draw causal inferences regarding the program health effects of the SNAP program. To overcome self-selection bias issues, we use a change in the rules governing SNAP eligibility that occurs when a member of a household reaches age 60 as a natural experiment to estimate a quasi-experimental difference-in-regression-discontinuity (DRD) design that models the effects of the SNAP program on the prevalence of diet-related disease.[18-20] We hypothesize that SNAP expansions would decrease diet-related disease, as it provides access to a finance mechanism for more nutritionally adequate food sources.

2 | METHODS

2.1 | Data source

Data are collected from the full year consolidated data file component of the Medical Expenditure Panel Survey (MEPS), administered by the Agency of Health Care Research and Quality within the US Department of Health and Human Services. The MEPS is a stratified and clustered random sample of the US noninstitutionalized civilian population used to construct nationally representative estimates for health status, prevalence of disease, insurance coverage, medical expenditures, and a range of health-related and socioeconomic factors.[21,22] We examine survey years 2008-2013, the most current years with comprehensive data for the main study variables that are available. More current years of the MEPS cannot be incorporated into this analysis because the MEPS stopped tracking tax filing information after survey year 2013. In the final repeated cross-sectional dataset, we refine the study sample to individuals over 130% of the federal poverty level, as our identification strategy is designed to address potential selection issues for persons residing in households greater than 130% of the federal poverty level.

2.2 | Outcome measures

The primary outcomes in this study are individual and composites of individual diet-related diseases. Diet-related disease, a host of

What is known on this topic?

- The Supplemental Nutritional Assistance Program (SNAP)—the largest federal nutritional assistance program in the United States—provides nutritional assistance to households if they can pass a series of income-based tests tied to the federal poverty level.
- Empirical studies have found mixed results on the effect of SNAP on health outcomes due in part to research designs that do not fully control for biases introduced when comparing SNAP eligible participant populations to SNAP eligible nonparticipant populations.

What this study adds?

- This study presents a quasi-experimental approach to examine the effects of the SNAP program on health using a change in SNAP program eligibility rules at age 60.
- This analysis finds that SNAP is associated with reduced diet-related disease morbidity, with minorities reporting significant reductions in cardiovascular-related conditions.
- This study adds to the growing evidence that the SNAP program can be used as a policy tool to improve population health and reduce disparities. Policy makers should consider adopting strategies to increase constituent knowledge of their eligibility for SNAP.

diet-related conditions and diseases that can cause illness in humans, is assessed within the study population through examining how persons responded to survey questions concerning their health status. We focus on hypertension, coronary heart disease and stroke (CHDS), diabetes, and cancer, as the presentation of these diseases is highest among low-income populations suffering from food insecurity.[23-25] A hypertension, diabetes, and cancer diagnosis is determined if the respondent was ever told by a doctor or other health professional that they had hypertension, diabetes, or cancer. Similarly, respondents are identified as having a CHDS diagnosis if they were ever told by a doctor or other health professional that they had angina, coronary heart disease, a heart attack, any other kind of heart condition, or stroke. In the main analysis, CHDS will be examined as individual diseases, but will also be examined as a single diagnosis group because these diseases all share the same pathophysiology.[26-28]

2.3 | Statistical analysis

Most individuals become eligible for SNAP if their household passes both a gross income means test, where gross income must fall below

130% of the federal poverty line (FPL), and a net income test, where net income after allowable deductions must fall below 100% FPL; however, when a member of a household turns age 60, households are only subject to the net income test.[29] Regression discontinuity (RD) analyses use age-based rule changes like this to exogenously assign individuals to treatment groups, where individuals below an a priori cutoff point do not receive the treatment and individuals above the cutoff point receive the treatment (or vice versa). The empirical RD design model for repeated cross-sectional datasets is written as follows:

$$Y_{i,t} = \beta_0 + \beta_1 RD_{it} + \gamma X_{i,t} + \varepsilon_{i,t}$$

where β_0 is a constant term, RD is an indicator of eligibility for SNAP under the net income means test only—equal to one if a respondent is aged 60 or older, X is a set of individual covariates, and ε is an unobserved error component. The coefficient β_1 captures the effect of the SNAP program.

While the coefficient β_1 potentially captures the effect of a SNAP eligibility expansion, this is predicated on observing an exogenous change in SNAP enrollment at age 60. Figure 1 presents a graph of population-weighted trends in average SNAP enrollment between ages 56-64 and demonstrates that SNAP enrollment declines across the age distribution, with no discrete changes in SNAP enrollment observed at age 60. This lack of a discontinuity in the overall sample means that the RD model in its current form cannot consistently estimate the average treatment effect of SNAP on diet-related

diseases. Moreover, β_1 would be positive, only capturing the trend of increased morbidity with aging.

One reason a discrete change in SNAP enrollment is not observed in Figure 1 is that the enrollment mechanism for SNAP at age 60 is not as simple as other government programs for older adults with age-based enrollment criteria. For example, the Medicare program allows nearly every American to enroll in the program once they reach age 65 with an application that does not include any income-based means tests. Americans are also well informed about their eligibility for Medicare through regular communications from the government and private sector firms that offer Medicare insurance products. On the other hand, far less knowledge exists regarding changes in the income-based means tests for SNAP at age 60 due to less extensive advertising activities by the government. In order to overcome the lack of knowledge regarding the rule change at age 60, we identify an additional source of variation that directly addresses the information asymmetry. For this study, we focus our attention to the net income rule itself.

The enrollment rule change for the SNAP program at age 60 requires household net income after allowable deductions to fall below 100% FPL. Allowable deductions for any applicant household's gross income (regardless of state of residence) include a standard deduction—an earned income deduction equal to 20% of earnings, a medical expense deduction for out-of-pocket medical expenses, a dependent care deduction for out-of-pocket expenses for dependents (eg, children, elderly parent, elderly spouse), an excess shelter deduction for a household's housing costs that exceeds half
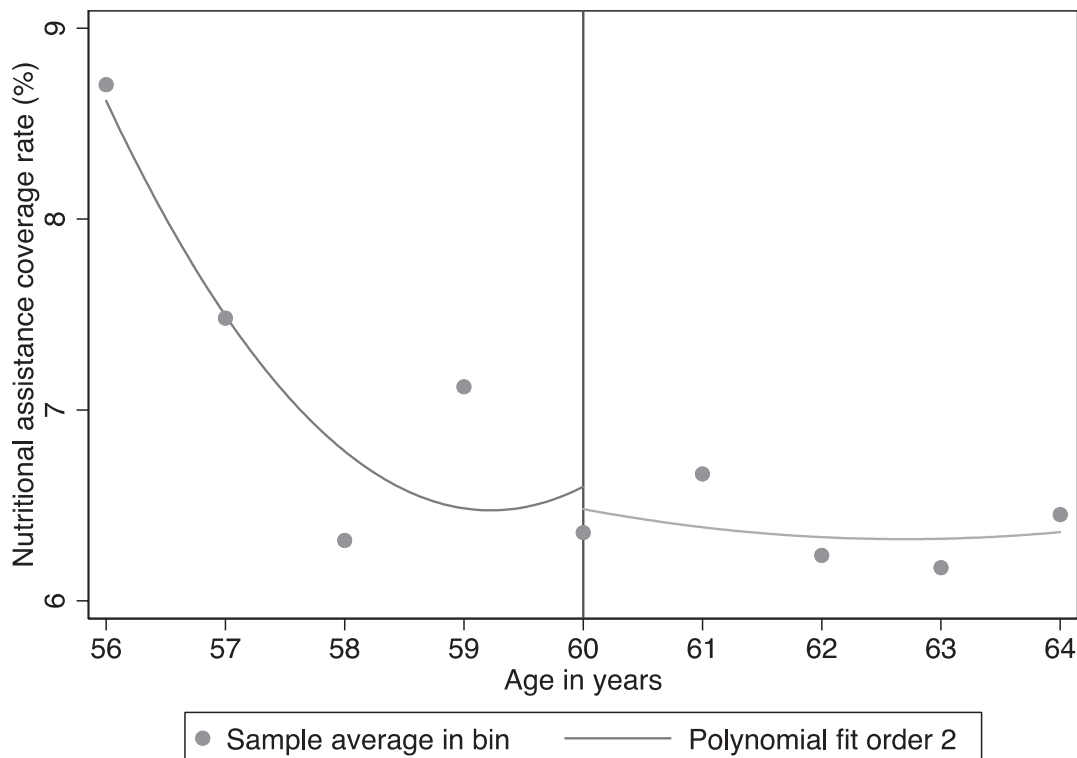
FIGURE 1 Supplemental Nutritional Assistance Program (SNAP) enrollment rates. Source: Medical Expenditure Panel Survey respondents residing in households >130% FPL, 2008-2013

of a household's net income after all other deductions, and a homeless shelter deduction. While all households qualify for the SNAP

(a) Standard deduction

(b) Itemized deduction

(c) Standard deduction

(d) Itemized deduction

FIGURE 2 Supplemental Nutritional Assistance Program (SNAP) enrollment rates and annual nutritional assistance received by federal tax filing status. Source: Medical Expenditure Panel Survey respondents residing in households >130% FPL, 2008-2013

standard deduction, households must itemize SNAP specific deductions to qualify before enrolling in SNAP. It should also be acknowledged that broad-based categorical eligibility (BBCE) policies, which allow states to relax the eligibility requirements for SNAP, represent another potential avenue to qualify for SNAP benefits. However, since BBCE policies only allow states to align asset and gross income limits with other state administered programs that have less restrictive limits, BBCE policies would have no effects on the net income rule change at age 60 and would still require each household applying for SNAP benefits to pass the net income test before receiving benefits.

A critical observation made from the examination of the net income rule is that the process and schedule of allowable deductions used to determine net income for the SNAP program looks similar to the process and schedule of allowable deductions used by persons that itemize deductions on their federal tax returns. From this observation, we hypothesize that households that itemize deductions on their federal tax returns are more likely to recognize and take advantage of the rule change at age 60 over individuals that take a standard deduction on their tax returns. This hypothesis is corroborated by our graphical analysis (Figure 2) that demonstrates an increase in SNAP benefits on both the extensive and intensive margin following the rule change at age 60.

Figure 2 presents graphs of population-weighted trends in average SNAP enrollment and total annual dollar amount of SNAP benefits between the ages of 56-64 for households by federal tax filing status. On the extensive margin, the enrollment rate steadily declined between ages 56-60 for both tax filing groups (Figure 2A,B); however, only respondents who itemize deductions experienced a discrete increase and change in trend in SNAP enrollment after age 60 (Figure 2B). On the intensive margin, respondents taking a standard deduction on tax returns experienced a declining trend in the dollar amount of nutritional assistance received after age 60 (Figure 2C). On the other hand, respondents who itemize deductions experienced a discrete increase in the dollar amount of nutritional assistance received after age 60 (Figure 2D). The findings of this graphical analysis demonstrate that only respondents who itemize deductions are responsive to the rule change at age 60. This suggests they more easily overcome knowledge gaps related to changes in eligibility rules at age 60 (as measured by enrollment on the extensive margin and dollar amount of benefits received on the intensive margin) due to their knowledge of their net (taxable) income calculated using a complex schedule of allowable deductions. Therefore, this graphical empirical analysis reveals that the variation in tax filing status is suitable to identify a change in enrollment and this variation will facilitate the measurement of the effects of SNAP.

Using both the rule change at age 60 and the variation in tax filing status, we estimate a difference-in-regression-discontinuity (DRD) model.[18-20] The DRD model is an improvement over the standard RD model because it goes beyond relying on just a comparison of outcomes before/after the rule change to estimate the effects of SNAP. Instead, the DRD model compares the before/after rule change differences in outcomes for itemizers with the before/after
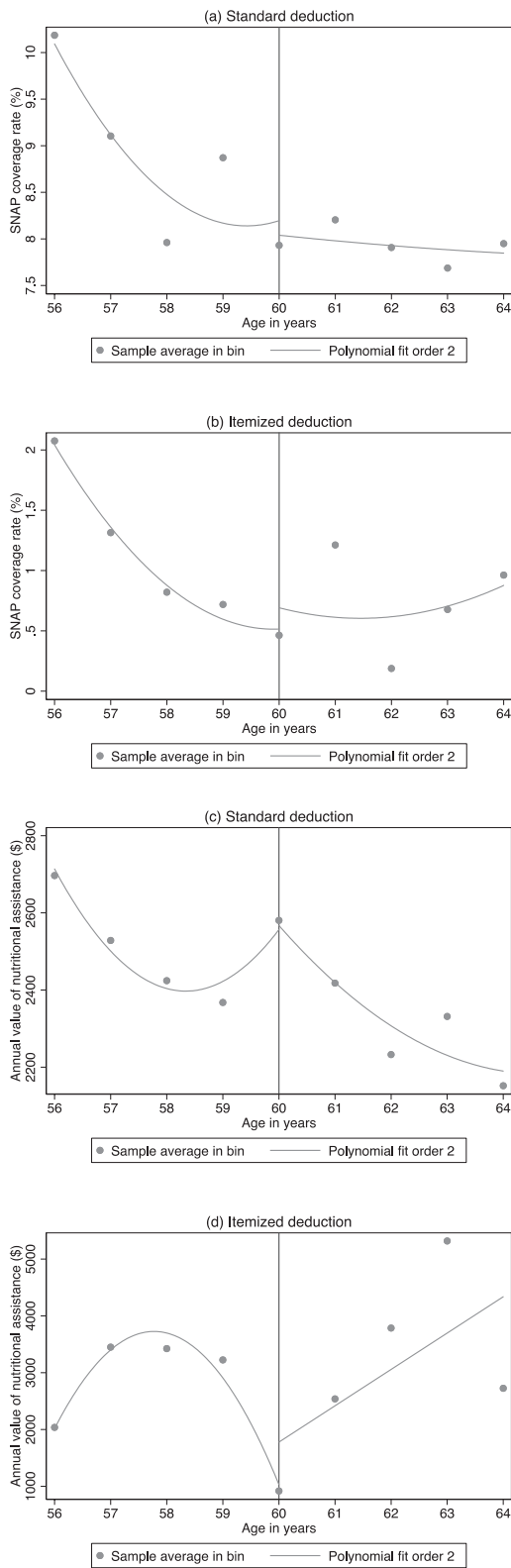
rule change differences in outcomes for standard deductors—and it is this difference in the regression discontinuities that allows the DRD model to measure the average treatment effect of the SNAP program. The empirical DRD model for repeated cross-sectional datasets is written as follows:

$$Y_{i,t} = \beta_0 + \beta_1 RD + \beta_1 TAXSTATUS + \beta_3 (RD \times TAXSTATUS) + \gamma X_{i,t} + \varepsilon_{i,t}$$

where β_0 is a constant term, RD is an indicator for respondents aged 60 and older, $TAXSTATUS$ is an indicator for respondents who itemized deductions on their federal return (versus taking the standard deduction), X is a set of individual covariates, and ε is an unobserved error component. The coefficient β_3 is the DRD term—the tax filing status indicator interacted with the RD term—that captures the average treatment effect of the SNAP program on diet-related disease.

It is important to note that the DRD model uses tax filing status on the intensive margin (itemized deductions vs. standard deduction), not tax filing status on the extensive margin (filing vs. nonfiling). Since tax filing is generally optional for persons making under the standard deduction, we limit our analysis to persons with income above the standard deduction and traditional eligibility threshold (above 130% FPL) to address potential selection bias due to nonfiling. Furthermore, in addition to the presence of a discrete change in SNAP enrollment near age 60, it is also necessary that there are no systematic differences in tax filing status for individuals before/after age 60 in order to measure the effect of the SNAP program. That is to say, households are not manipulating their tax filing status assignment. Both the empirical and theoretical literature on taxation finds that individuals may be less sensitive to changes in the price of health spending (which increases the demand to itemize tax deductions) due to irrationality, the complexity of both the tax and health care system, or that short-term liquidity constraints do not induce individuals to seek tax relief months after the fact.[30-32] Therefore, we do not expect to observe endogenous selection into tax filing status, which allows us to consistently estimate the DRD model. We provide evidence of this identifying assumption for our study sample by demonstrating that no statistically significant changes in itemizing deductions occurs after the eligibility rule change.

The DRD models are estimated using multivariate linear probability models and use sampling weights to adjust for oversampling. We restrict our analysis to individuals age 56-64 years of age to avoid capturing the health effects of Medicare.[33,34] The main independent variable is an interaction variable between age (≥60) and tax deduction status indicators. When this interaction variable is included in our DRD, the interaction variable becomes a DRD estimator that captures the effect of SNAP on the prevalence of disease. In addition to the DRD term, we control for other socioeconomic covariates that include gender, educational attainment, geographical region, and survey year to account for any changes in national trends during the study period. All statistical analyses are performed using Stata MP version 15 (Stata Corp).

According to the United States Department of Agriculture, 11.1% or 14.3 million households in the United States face limited or uncertain access to adequate food due to economic reasons; however, minority headed households report significantly higher food insecurity rates than the national average.[35] In particular, 21.2% of Black non-Hispanic and 16.2% of Hispanic headed households are food insecure, while only 8.1% of White non-Hispanic headed households are food insecure.[35] As these racial disparities have persisted for decades, researchers have increasingly sought to go beyond controlling for race/ethnicity in analyses and instead identify exposures (ie, poverty, income inequality, discrimination, structural racism) and the interactions between exposures that may differentially impact racial/ethnic groups.[36-38] Although the primary mandate of the SNAP program is to improve nutritional access for financially vulnerable households, the structure of financial transfers for SNAP benefits potentially impact households in ways that can reduce (or enhance) the program efficacy based on the exposures that different groups face.

In order to gain a stronger understanding of the extent to which the SNAP program can be used as a policy mechanism to help address diet-related disease disparities in a way that overcomes structural and societal barriers, respondents are stratified into four racial/ethnic categories based on how respondents self-identified. People who identified as either Hispanic or Latino are aggregated into a single Hispanic ethnic group and Whites and Blacks with no Hispanic ancestry are defined as non-Hispanic (NH) White and NH Black, respectively. All other respondents (eg, NH Asians, NH Others) are assigned to NH Other race/ethnicity. NH Other are included as a covariate in the overall group analysis along with NH Black and Hispanic respondents, with NH White respondents serving as a comparison group; however, race/ethnicity controls are excluded from models in the racial/ethnicity stratified analysis because they are controlled through sample refinement. All statistical analyses are performed using Stata MP, version 15.

We conduct several sensitivity analyses to determine whether alternative explanations can explain any effects of SNAP that we observe at the age threshold. First, we construct descriptive statistics and statistically test the socioeconomic compositions of the study population before and after age 60 to verify the identifying assumption and determine whether there are systematic differences between the two study populations. Second, we determine the effects of physician utilization by examining the frequency of routine office-based and emergency department physician visits over the survey period. Last, we examine the role of household medical cash investments on the prevalence of diet-related disease at the threshold by examining changes in total out-of-pocket spending and total expenditures and prescription drugs.

3 | RESULTS

3.1 | Descriptive statistics

The overall study sample contained 15 980 MEPS respondents between 2008 and 2013 (Table 1). Women comprised half the sample at

51.24% and NH White respondents made up the majority of respondents (77.33%), with NH Black and Hispanic respondents representing the second and third largest racial/ethnic groups at 8.78% and 8.07%, respectively. Most respondents reported household income above 400% of the federal poverty level (60.33%) and were high school graduates (43.53%) or had at least some college experience (47.95%).

Table 1 also presents summary statistics for outcome variables decomposed by treatment groups and federal tax filing status. Of the 15 980 MEPS respondents, 7812 and 8168 respondents belong to the control (age < 60) and treatment groups (age ≥ 60), respectively. Aside from race/ethnicity, the sociodemographic composition did not vary significantly between the treatment groups; therefore,

TABLE 1 Characteristics of study population

| | | By tax federal filing status | | | |
| | | Standard deduction | | Itemized deductions | |
Characteristics	Overall sample	Control (Age <60)	Treatment (Age ≥60)	Control (Age <60)	Treatment (Age ≥60)
Female	51.24 (0.50)	52.60 (0.72)	54.03 (0.77)	45.15 (1.37)	43.74 (1.43)
Race/Ethnicity					
Non-Hispanic White	77.33 (0.33)	73.83 (0.58)	76.56*** (0.53)	83.00 (0.91)	85.15* (0.81)
Non-Hispanic Black	8.78 (0.20)	9.82 (0.34)	8.63*** (0.30)	7.61 (0.58)	7.21 (0.57)
Hispanic	8.07 (0.19)	9.62 (0.33)	8.87* (0.31)	5.20 (0.52)	3.40*** (0.40)
Non-Hispanic Other	5.82 (0.18)	6.72 (0.31)	5.94* (0.31)	4.20 (0.46)	4.24 (0.42)
Family income					
130%-330% of poverty	30.57 (0.43)	33.89 (0.73)	35.55 (0.71)	16.68 (1.04)	17.01 (1.03)
330%-400% of poverty	9.10 (0.27)	9.68 (0.45)	9.01 (0.41)	7.94 (0.78)	8.70 (0.71)
400+ of poverty	60.33 (0.47)	56.43 (0.79)	55.43 (0.76)	75.37 (1.24)	74.29 (1.20)
Educational attainment					
Less than high school diploma	8.52 (0.25)	10.16 (0.44)	10.56 (0.42)	2.69 (0.44)	2.06 (0.39)
High school graduate	43.53 (0.51)	45.84 (0.84)	45.19 (0.81)	38.18 (1.58)	35.91 (1.45)
At least some college	47.95 (0.52)	44.00 (0.85)	44.25 (0.82)	59.14 (1.59)	62.03 (1.47)
Medical conditions					
Diabetes	15.17 (0.35)	12.91 (0.54)	18.75*** (0.60)	10.55 (0.92)	14.41*** (0.99)
Hypertension	50.04 (0.50)	47.02 (0.81)	53.87*** (0.78)	43.36 (1.54)	52.62*** (1.45)
CHDS	12.10 (0.32)	10.31 (0.48)	14.51*** (0.55)	8.84 (0.85)	12.55*** (0.92)
Cancer	16.12 (0.38)	12.66 (0.58)	17.68*** (0.62)	16.47 (1.20)	21.01*** (1.22)
Medical utilization					
2+ routine visits	63.89 (0.47)	57.45 (0.80)	66.70*** (0.71)	66.62 (1.45)	71.54*** (1.27)
2+ emergency visits	2.66 (0.16)	2.46 (0.25)	3.02 (0.27)	2.44 (0.51)	2.31 (0.48)
Out-of-pocket (total)	$1245.98 (30.41)	$1090.09 (48.67)	$1271.46*** (49.62)	$1425.41 (101.86)	$1532.80 (70.94)
Out-of-pocket (prescription)	$405.88 (10.67)	$357.81 (19.15)	$420.09** (14.41)	$405.88 (33.55)	$519.19*** (34.78)
N	15 980	6295	6513	1517	1655

Note: This table presents mean values for the diet-related disease and medical utilization outcomes examined in this study. The sample contains respondents from the Medical Expenditure Panel Survey aged 56-64 from years 2008-2013 residing in households over 130% of the federal poverty level. All estimates are weighted to be representative of the general noninstitutionalized population.

Tax filing by control group (Age < 60) and treatment group (Age ≥ 60): The mean of households itemizing deductions on their federal tax return for age groups 56-59 and 60-64 were 23.08% and 23.71%, respectively. The statistical difference between the two means is $P = .46$.

Abbreviation: CHDS, coronary heart disease and stroke.

*$P < .10$, **$P < .05$, ***$P < .01$.

TABLE 2 The effects of SNAP on diet-related diseases and medical utilization

	A. Major diet-related disease			
	Diabetes	Hypertension	CHDS	Cancer
Overall population (N = 14 052)	−3.71** (1.48)	1.59 (2.16)	−0.92 (0.89)	−0.22 (0.99)
By Race/Ethnicity				
Non-Hispanic White (N = 8037)	−3.73* (1.92)	2.60 (2.45)	−1.55 (1.00)	−0.64 (1.24)
Non-Hispanic Black (N = 2380)	−4.94 (3.37)	−13.95*** (3.46)	3.28 (3.69)	2.39 (2.98)
Hispanic (N = 2347)	−2.82 (3.40)	10.60 (7.83)	−7.25* (3.31)	6.24 (6.09)
	B. Coronary heart disease and stroke			
	Angina	Stroke	Heart attack	Heart disease
Overall population (N = 14 052)	0.79 (0.68)	−0.01 (0.83)	−1.21 (0.90)	−1.40* (0.72)
By race/Ethnicity				
Non-Hispanic White (N = 8037)	−1.30 (0.99)	0.002 (0.84)	−1.98 (1.12)	−2.07** (0.76)
Non-Hispanic Black (N = 2380)	5.51* (2.83)	1.99 (2.32)	2.44 (1.86)	1.24 (2.13)
Hispanic (N = 2347)	−6.94** (2.38)	−4.48** (1.74)	−1.57 (3.13)	−3.19 (2.75)

Note: This table presents difference-in-regression-discontinuity model results of the effect of SNAP on the incidence of diet-related disease for the overall population. The sample contains respondents from the Medical Expenditure Panel Survey aged 56-64 from years 2008-2013 residing in households over 130 percent of the federal poverty level. All estimates are weighted to adjust for oversampling and cluster-robust standard errors are utilized.

CHDS, coronary heart disease and stroke.

*$P < .10$, **$P < .05$, ***$P < .01$.

the treatment groups are comparable in the years just before and after SNAP eligibility rules are altered to exclude the gross income test at age 60. Moreover, before age 60, the rate of itemizing deductions in the population is 23.08%, while after age 60, the rate is 23.71%; however, this difference of 0.63% is not statistically significant (See notes in Table 1). Therefore, no systematic differences in itemizing deductions on federal tax returns are observed across the age-based policy threshold used in our main analysis. Finally, the prevalence of diet-related diseases in the study sample increased across the two age groups, which is consistent with the degenerative effects of age and subsequent increased susceptibility to chronic disease diagnoses.

For both tax status groups, respondents aged 60 and older (treatment group) reported higher morbidity (diabetes, hypertension, CHDS, and cancer) and medical utilization (routine visits, emergency visits, and out-of-pocket medical costs overall) than respondents less than age 60 (control group). These results are consistent with the degenerative effects of age and subsequent increased susceptibility to chronic disease diagnoses. Respondent households that took a standard deduction on their federal tax returns reported higher rates of mortality and medical utilization than respondents residing in households that itemized deductions.

3.2 | Changes in the prevalence of diet-related disease

In the full sample, the DRD analysis reported a statistically significant decline in the prevalence of diabetes (−3.71 percentage

point [pp]; $P < .05$) in association with the change in SNAP eligibility rules at age 60 (Table 2, Panel A). No statistically significant impacts were observed for hypertension, CHDS, or cancer in the full sample.

Trends in diet-related disease prevalence for NH White respondents followed the overall sample, with NH White respondents reporting a statistically significant decline in the prevalence of diabetes (−3.73 pp; $P < .10$), but saw no changes in the prevalence of any other individual diet-related diseases. The results for NH Black respondents and Hispanic respondents varied from NH White respondents. NH Black respondents saw no declines in the prevalence of diabetes, but NH Black respondents experienced significant declines in hypertension (−13.95 pp; $P < .01$) in association with the change in SNAP eligibility rules at age 60. On the other hand, Hispanic respondents experienced significant declines in CHDS (−7.25 pp; $P < .10$).

In the main analysis, we assumed that CHDS has overlapping atherosclerotic disease mechanisms, although it may be the case that underlying diet-related risk factors that are altered by SNAP alter the emergence of the individual diseases that make up CHDS. A separate DRD analysis focused on the individual disease components of the CHDS indicator (eg, angina pectoris, coronary heart disease, heart attacks, stroke) and revealed wide variability of the impacts across race/ethnicity and individual disease groups (Table 2, Panel B). In the full sample, the DRD analysis revealed a decline in the prevalence of coronary heart disease (−1.40 pp; $P < .10$). Results varied substantially across racial/ethnic subgroups. Among NH White respondents, prevalence declined for coronary heart disease (−2.07 pp; $P < .05$). Hispanic respondents reported significant declines in angina

(−6.94 pp; *P* < .05) and stroke (−4.48 pp; *P* < .05). Unlike NH White and Hispanic respondents, NH Black respondents saw no declines in the prevalence CHDS. Moreover, this group saw an increase in angina (5.51 pp; *P* < .10).

3.3 | Robustness checks

We evaluated whether the results are robust to alternative explanations and specifications in two ways. First, it could be the case that the findings of the reduced prevalence of disease identified following changes to the eligibility rules for SNAP were attributable to increased investments in health, which led to overall improvements in health outcomes. To test this hypothesis, we estimated four alternative DRD models that look at whether increased utilization of physician services (eg, routine office-based visits, emergency department visits) or out-of-pocket medical spending (eg, total, prescription drug) were associated with improvements in health outcomes (Table 3, Panel A). Across all groups, there were no statistically significant increases in routine medical visits. However, Hispanic respondents did report a significant increase in utilization of emergency department (7.66 pp; *P* < .01), but such emergency department use is not generally considered a mechanism of health

utilization that can adequately mitigate the development of chronic disease. Moreover, the overall sample reported declines in total hospital expenses (−12.30 pp; *P* < .10). Last, no groups reported increases in out-of-pocket expenses.

Second, to examine whether the results are attributable to random chance or uncontrolled policy changes that may have occurred within the original four-year analysis window around age 60 (such as the effects of persons claiming early, reduced social security retirement benefits at age 62), we restricted the DRD analysis window to one year around age 60. The results of the DRD analysis restricted to a 1-year window (Table 3, Panel B) are consistent with the main study results presented in Table 2. Moreover, although an income subgroup analysis did not reveal any statistically significant results using a 4-year window around age 60 (not shown), the income subgroup analysis revealed important policy relevant results using the 1-year window. In particular, respondents residing in households between 130%-330% FPL experienced declines in diabetes (−5.29 pp; *P* < .05) and CHDS (−9.19 pp; *P* < .05), while respondents residing in households 400% FPL or higher reported trends similar to the main results. Respondents residing in households between 330% and 400% FPL did report an increase in CHDS (4.69 pp; *P* < .10) and a decline in cancer (−9.46 pp; *P* < .10); however, these results are likely attributable to the small sample size of this income group (N = 497).

TABLE 3 Robustness checks

	A. Medical utilization and out-of-pocket spending			
	Two or more routine visits[a]	Two or more emergency visits[b]	Out-of-pocket Total expenditures[c]	Out-of-pocket Prescription drugs[d]
Overall population (N = 14 052)	−4.29 (2.62)	−0.88 (1.00)	−12.30* (6.28)	−11.28 (12.32)
By race/Ethnicity				
Non-Hispanic White (N = 8037)	−3.80 (2.41)	−1.64 (1.01)	−16.66* (9.09)	−13.98 (15.85)
Non-Hispanic Black (N = 2380)	−9.61 (5.40)	1.83 (2.94)	9.79 (15.02)	20.97 (17.59)
Hispanic (N = 14 052)	−6.48 (6.77)	7.66*** (2.00)	0.31 (33.05)	−43.39 (32.95)
	B. Restricted analysis window to ages 59-61			
	Diabetes	Hypertension	CHDS[a]	Cancer
Overall population (N = 4685)	−3.75* (1.22)	−1.35* (0.40)	−0.16 (0.77)	−0.77 (0.43)
Family income				
130%-330% FPL (N = 1783)	−5.29** (0.90)	0.33 (2.76)	−9.19** (1.94)	−2.93 (1.64)
330%-400% FPL (N = 497)	0.72 (4.57)	−3.46 (5.81)	4.69* (1.57)	−9.46* (2.45)
400% or more FPL (N = 2405)	−3.15** (0.70)	0.01 (0.08)	2.59 (1.11)	0.17 (2.29)

Note: This table presents difference-in-regression-discontinuity (DRD) results of the effect of SNAP on the utilization of medical services using a 4-y DRD window and incidence of diet-related disease morbidity using a 1-y DRD window. An income subgroup analysis is also conducted using the 1-y window. The sample contains respondents from the Medical Expenditure Panel Survey aged 56-64 from years 2008-2013 residing in households over 130 percent of the federal poverty level. All estimates are weighted to adjust for oversampling and cluster-robust standard errors are utilized.

[a]Two or more routine visits indicate whether a respondent made two or more routine office-based visits within the survey year.

[b]Two or more emergency visits indicate whether a respondent made two or more emergency department visits within the 12-mo survey year.

[c]Out-of-pocket total expenditures and prescription drugs indicate the log of out-of-pocket total expenditures.

[d]Out-of-pocket prescription drugs indicate the log of out-of-pocket prescription drug expenditures.

*P < .10, **P < .05, ***P < .01.

4 | DISCUSSION

The SNAP eligibility analysis yielded four important results. First, the main analysis demonstrated that SNAP eligibility was associated with a decline in the prevalence of diet-related diseases, which is consistent with the findings of other nutritional assistance studies involving older Americans.[39-41] Second, the racial/ethnic subgroup analysis revealed that NH Blacks and Hispanics reported wide variations in the type and magnitude of morbidity combinations and prevalence of individual diseases as compared to NH white respondents. These results in particular highlight the potential role of the SNAP program in reducing structural and societal barriers that drive disparities across racial/ethnic groups. Third, the income subgroup analysis revealed that respondents in our lowest income group (130%-330% FPL) experienced the largest effects from the change in SNAP eligibility rules at age 60 as compared to the other income groups. This finding not only highlights the presence of food insecurity issues within this population, but also the potential of the SNAP program to function as a tool to address structural and societal barriers, as minority households tend to be at the lower end of the income distribution. Last, the differences in the prevalence of diet-related disease in the main results were not associated with changes in the number of physician visits or in spending on medical services and prescription drugs.

This study builds on previous literature investigating the impacts of safety net programs in several ways. First, while several studies have utilized aged-based eligibility thresholds to examine the impact of public programs on health outcomes,[42-47] these studies are focused on examining the health impacts of health insurance-based safety net programs. To date, few studies have examined the impact of nonhealth insurance safety net programs like SNAP on health outcomes utilizing aged-based eligibility thresholds.[11] Second, the recent literature on SNAP largely focuses on the utilization of safety net programs through business cycles and recessions to overcome the selection biases introduced in observational studies that compare individuals participating in SNAP to SNAP eligible non-participants.[34,48-52] Our current study does not rely on temporary expansions to SNAP that occurred during the recent Great Recession for identification. Last, our results not only inform policy makers on the role nonhealth safety net programs play in improving population health, but also can help guide health care professionals with nonmedical interventions that may help lower the prevalence of diet-related diseases that manifest over a short time horizon among older patient populations.

This analysis has several potential limitations. First, disease diagnosis and medical expenses rely on a respondent's recall, which could lead to reporting errors in the outcomes utilized in this study. However, unlike surveys such as the Health Retirement Survey or the National Health Interview Survey, the MEPS uses multiple rounds of interviewing throughout the survey period and asks respondents to maintain a diary of medical bills, insurance statements, and changes in health status to ensure the accuracy of reporting.[53,54] Second, our analysis focused on the prevalence of diet-related disease, but does not focus on severity of illness or nutritional adequacy due to the lack of data within the MEPS. Last, the DRD analysis revealed that SNAP impacted the prevalence of every diet-related disease, except for cancer. This could be attributable to the broad measure of cancer utilized in this study, and the DRD modeling is designed to capture the impacts of SNAP within a short-term window around age 60, which may not be able to capture the long-run impact of changes to nutrition attributable to SNAP on the metabolic factors associated with cancer.[55]

5 | CONCLUSIONS

In summary, the results of this study contribute to understanding the efficacy of nationally administered food insecurity interventions and the subsequent effect of SNAP on individual health disparities across demographic groups. Moving forward, policy makers and researchers should re-examine the enrollment requirements for the SNAP program, increase outreach to improve awareness of changes in SNAP enrollment requirements, evaluate alternative income cut-offs for the SNAP program, and evaluate the structure of transfers under the SNAP program to enhance the program's ability to overcome structural and societal barriers and improve population health among older adults across a broader set of conditions.

ORCID

Layla G. Booshehri https://orcid.org/0000-0001-6881-8034
Jerome Dugan https://orcid.org/0000-0002-7716-8317

REFERENCES

1. Kochhar S, Gray K. *Characteristics of Supplemental Nutrition Assistance Program Households. Fiscal Year 2014*. Alexandria, VA: U.S. Department of Agriculture; 2015.
2. Hernandez DC, Jacknowitz A. Transient, but not persistent, adult food insecurity influences toddler development. *J Nutr*. 2009;139(8):1517-1524.
3. Bhattacharya J, Currie J, Haider S. Poverty, food insecurity, and nutritional outcomes in children and adults. *J Health Econ*. 2004;23(4):839-862.
4. Ziliak JP, Gundersen C, Haist M. *The Causes, Consequences, and Future of Senior Hunger in America*. Alexandria, VA: The National Foundation to End Senior Hunger and Feeding America; 2008.
5. Van Hook J, Balistreri KS. Ineligible parents, eligible children: food stamps receipt, allotments, and food insecurity among children of immigrants. *Soc Sci Res*. 2006;35(1):228-251.
6. Borjas GJ. Food insecurity and public assistance. *J Public Econ*. 2004;88(7–8):1421-1443.
7. Nord M, Golla AM. Does SNAP decrease food insecurity? Untangling the self-selection effect. *Am J Clin Nutr*. 2009;99:1006-1114.
8. Hoynes H, Schanzenbach DW. U.S. Food and nutrition programs. *NBER Working Paper Series*. 2015 (Working Paper No. 21057):1-94.
9. Mabli J. *SNAP Participation, Food Security, and Geographic Access to Food*. Alexandria, VA: U.S. Department of Agriculture; 2014.
10. Mabli J, Ohls J. Supplemental Nutrition Assistance Program participation is associated with an increase in household food security in a national evaluation. *J Nutr*. 2015;145(2):344-351.
11. Hoynes H, Schanzenbach DW, Almond D. Long-run impacts of childhood access to the safety net. *Am Econ Rev*. 2016;106(4):903-934.
12. Gregory CA, Deb P. Does SNAP improve your health? *Food Policy*. 2015;50:11-19.

13. Taillie LS, Grummon AH, Miles DR. Nutritional profile of purchases by store type: disparities by income and food program participation. *Am J Prev Med*. 2018;55(2):167-177.

14. Andreyeva T, Luedicke J, Henderson KE, Tripp AS. Grocery store beverage choices by participants in federal food assistance and nutrition programs. *Am J Prev Med*. 2012;43(4):411-418.

15. Grummon AH, Taillie LS. Nutritional profile of Supplemental Nutrition Assistance Program household food and beverage purchases. *Am J Clin Nutr*. 2017;105(6):1433-1442.

16. Franckle RL, Moran A, Hou T, et al. Transactions at a Northeastern supermarket chain: differences by Supplemental Nutrition Assistance Program use. *Am J Prev Med*. 2017;53(4):e131-e138.

17. Hastings J, Shapiro JM. How are SNAP benefits spent? Evidence from a retail panel. *Am Econ Rev*. 2018;108(12):3493-3540.

18. Asfaw AA. The effect of prescription drug insurance on health behavior: evidence from medicare part D. *Health Econ*. 2019;28(3):403-418.

19. Carneiro P, Løken KV, Salvanes KG. A flying start? Maternity leave benefits and long-run outcomes of children. *J Polit Econ*. 2015;123(2):365-412.

20. Navarro-Palau P. Effects of differentiated school vouchers: evidence from a policy change and date of birth cutoffs. *Econ Educ Rev*. 2017;58:86-107.

21. Abdus S, Selden TM. Adherence with recommended well-child visits has grown, but large gaps persist among various socioeconomic groups. *Health Aff (Millwood)*. 2013;32(3):508–515.

22. Cohen JW, Monheit AC, Beauregard KM, et al. The Medical Expenditure Panel Survey: a National Health Information Resource. *Inquiry*. 1996;33:373-389.

23. Seligman HK, Bindman AB, Vittinghoff E, Kanaya AM, Kushel MB. Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutrition Examination Survey (NHANES) 1999–2002. *J Gen Intern Med*. 2007;22(7):1018-1023.

24. Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. *J Nutr*. 2010;140(2):304-310.

25. Stuff JE, Casey PH, Szeto KL, et al. Household food insecurity is associated with adult health status. *J Nutr*. 2004;134(9):2330-2335.

26. Lopez H. *SNAP Access Barriers Faced By Low Income 50–59 Year Olds*. Washington, DC: AARP Foundation; 2013.

27. Kim AS, Johnston SC. Global variation in the relative burden of stroke and ischemic heart disease. *Circulation*. 2011;124(3):314-323.

28. D'Agostino RB, Vasan RS, Pencina MJ, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. *Circulation*. 2008;117(6):743-753.

29. Hartline-Grafton H. *The Role of the Supplemental Nutrition Assistance Program in Improving the Health and Well-Being of Americans*. Washington, DC: Food Research and Action Center; 2013.

30. Gouveia M, Strauss RP. Income taxes and medical expenses. *Proc Ann Conf Tax Min Ann Meet Nat Tax Assoc*. 2004;97:232-235.

31. Gouveia M, Strauss R. The US Individual Income Tax and the Medical Expense Deduction Proceedings. *Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association*. 2004;97:232–235.

32. Smart M, Stabile M. Tax credits, insurance, and the use of medical care. *Can J Econ*. 2005;38(2):345-365.

33. Morrisey MA, Jensen GA. The near-elderly, early retirees, and managed care. *Health Aff (Millwood)*. 2001.20(6):197–206.

34. McWilliams JM, Meara E, Zaslavsky AM, Ayanian JZ. Use of health services by previously uninsured medicare beneficiaries. *N Engl J Med*. 2009;357(2):143-153.

35. Coleman-Jensen A, Rabbitt M, Gregory C, Singh A. Household food security in the United States in 2018. *USDA-ERS Econ Res Rep*. 2019;270:1–47.

36. Odoms-Young A, Bruce MA. Examining the impact of structural racism on food insecurity: implications for addressing racial/ethnic disparities. *Fam Community Health*. 2018;41:S3-S6.

37. Bailey ZD, Krieger N, Agénor M, Graves J, Linos N, Bassett MT. Structural racism and health inequities in the USA: evidence and interventions. *Lancet*. 2017;389(10077):1453-1463.

38. Wallace ME, Mendola P, Liu D, Grantz KL. Joint effects of structural racism and income inequality on small-for-gestational-age birth. *Am J Public Health*. 2015;105(8):1681-1688.

39. Sharkey JR, Branch LG, Zohoori N, Giuliani C, Busby-Whitehead J, Haines PS. Inadequate nutrient intakes among homebound elderly and their correlation with individual characteristics and health-related factors. *Am J Clin Nutr*. 2002;76(6):1435-1445.

40. Bartlett S, Klerman J, Olsho L, et al. *Evaluation of the Healthy Incentives Pilot (HIP). Final Report*. Alexandria, VA: United States Department of Agriculture; 2014.

41. Bleich SN, Rimm EB, Brownell KDUS. Nutrition assistance, 2018 - modifying SNAP to promote population health. *N Engl J Med*. 2017;376(13):1205-1207.

42. Dugan J, Virani SS, Ho V. Medicare eligibility and physician utilization among adults with coronary heart disease and stroke. *Med Care*. 2012;50(6):547-553.

43. Card D, Dobkin C, Maestas N. Does medicare save lives? *Q J Econ*. 2009;124(2):597-636.

44. Card D, Dobkin C, Maestas N. The impact of nearly universal insurance coverage on health care utilization: evidence from medicare. *Am Econ Rev*. 2008;98(5):2242-2258.

45. Anderson ML, Dobkin C, Gross T. The effect of health insurance on emergency department visits: evidence from an age-based eligibility threshold. *Rev Econ Stat*. 2014;96(1):189-195.

46. Anderson M, Dobkin C, Gross T. The effect of health insurance coverage on the use of medical services. *Am Econ J Econ Policy*. 2012;4(1):1-27.

47. Currie J, Gruber J. Health insurance eligibility, utilization of medical care, and child health. *Q J Econ*. 1996;111(2):431-466.

48. Moffitt RA. The great recession and the social safety net. *Ann Am Acad Pol Soc Sci*. 2013;650(1):143-166.

49. Anderson PM, Butcher KF, Schanzenbach DW. Changes in safety net use during the great recession. *Am Econ Rev*. 2015;105(5):161-165.

50. O'Leary CJ, Kline KJ. Use of supplemental nutritional assistance program benefits by unemployment insurance applicants in Michigan during the great recession. *Upjohn Institute for Employment Research*. 2014 (Working Paper 14-210):1-44.

51. Ganong P, Liebman JB. The decline, rebound, and further rise in SNAP enrollment: disentangling business cycle fluctuations and policy changes. *NBER Working Paper Series*. 2013 (Working Paper 19363):1-56.

52. Conrad Z, Rehm CD, Wilde P, Mozaffarian D. Cardiometabolic mortality by Supplemental Nutrition Assistance Program participation and eligibility in the United States. *Am J Public Health*. 2017;107(3):466-474.

53. Zuvekas SH, Olin GL. Validating household reports of health care use in the medical expenditure panel survey. *Health Serv Res*. 2009;44(5 Pt 1):1679-1700.

54. Zuvekas SH. The effects of recall length and reporting aids on household reporting of health care events in the medical expenditure panel survey. *J Econ Soc Measure*. 2011;36(4):321-343.

55. Fontana L, Klein S, Holloszy JO. Long-term low-protein, low-calorie diet and endurance exercise modulate metabolic factors associated with cancer risk. *Am J Clin Nutr*. 2006;84(6):1456-1462.