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Food insecurity and chronic diseases in low-income older Americans: The role of SNAP receipt in medication under use

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Abstract

We are interested in exploring how SNAP participation is related to the health of older adults. We used Supplemental Nutritional Assistance Program (SNAP) administrative records, Medicaid medical claims records for diabetes, and hypertension, and Medicaid pharmacy claims records related to treatment plans for these disease conditions for the period 2006 to 2014 for older adults aged 60 and older in one Midwestern State. First, using only the SNAP administrative records, we investigated the characteristics of older adult participants in SNAP who experience administrative churn, a short-term disruption in benefits lasting up to four months and often occurring when participants are required to recertify their eligibility for benefits. Second, using the SNAP records linked to the Medicaid records, we documented rates of hypertension or diabetes diagnoses and rates of medication adherence to antihypertensives and antidiabetics for SNAP participants overall as well as by age group and race/ethnicity. Third, we examined the relationship between concurrent SNAP and Medicaid enrollment, pattern of SNAP participation, and medication non-adherence among low-income Medicaid-insured older adults living with hypertension. Finally, we estimated the causal effects of small changes in SNAP benefit size on chronic disease medical claims, Emergency Room (ER) claims, and medication adherence.

Executive Summary

This project has two main aims: (1) to investigate demographic characteristics of the older adult SNAP population by risk of churn, and frequency and duration of churn spells, and (2) to examine how SNAP benefits are related to medication non-adherence and health care utilization for diabetes and hypertension among older Americans. To address the aims we used a unique linked state administrative dataset that contains Medicaid claims and SNAP participation data for adults ages 60 and older from 2006 to 2014. We examined four research questions: one related to our first aim and three related to our second aim. First, is administrative churn an issue for the older adult population and what are the characteristics of older SNAP participants who experience administrative churn? Second, what is the prevalence of hypertension and diabetes among older adult SNAP participants and the associated level of medication adherence to antihypertensives and anti-diabetic medications? Third, among low-income Medicaid-insured older adults living with chronic disease (hypertension), is there a relationship between SNAP participation, concurrent SNAP and Medicaid enrollment, pattern of SNAP participation, and medication non-adherence? Fourth, among low-income Medicaid-insured older adults living with chronic disease, did changes in SNAP benefit size due to the American Recovery and Reauthorization Act (ARRA) in April 2009 affect health care utilization in general (hypertension claims), emergency health care utilization (emergency room claims for hypertensive emergencies), or medication adherence to antihypertensives?

Our first manuscript has been accepted for publication at Applied Economic Perspectives and Policy (Heflin et al., 2022) and examined rates of administrative churn for the older adult population and the demographic characteristics of older SNAP participants who experience administrative churn. We found that about one quarter of our study population experienced

administrative churn. For them, about 20% experienced more than one spell of churn and each churn spell lasted for a month on average. We also found that most churn spells occurred at the end of the certification period. Risk of churn, and the frequency and duration of churn spells, varied with individual, household, and geographic characteristics: churn was more common among older adults in larger households, and those living in urban areas. Additionally older adults who experienced churn were more likely to be Hispanic, Black, Asian or have an unknown racial identity and less likely to be White than the general population of older adults on SNAP (Heflin et al., 2022).

Our second manuscript (Heflin et al., 2021) examines the prevalence of hypertension and diabetes among older adult SNAP participants and the associated level of medication adherence to antihypertensives and anti-diabetic medications. Documenting the prevalence of hypertension and diabetes (types I and II) among older adults on SNAP is important because the burden of these diseases for Americans over 60 years of age is profound and because the number of older adults on SNAP is expected to increase as the share of the U.S. population over the age of 60 likely doubles in the next 20 years. We found that about 7 in 10 participants in the study sample were living with hypertension and 4 in 10 were living with diabetes. On average, 1 in 4 of those living with hypertension and 1 in 3 of those living with diabetes were non-adherent to antihypertensives or antidiabetic medications each year, respectively.

Our third manuscript is currently under review at Journal of General Internal Medicine, and it investigates the relationship between SNAP participation, medication adherence, and concurrent Medicaid and SNAP enrollment among Medicaid-insured, low-income adults living with hypertension. We found that Medicaid-insured older adults living with hypertension who had ever been on SNAP were more likely to be adherent to their antihypertensives medications compared to those who had never been on SNAP. We also found that, among SNAP

participants, those who were concurrently on SNAP and Medicaid during a 12-month continuous Medicaid enrollment period were more likely to be adherent to their antihypertensives medications compared to non-SNAP beneficiaries.

In our fourth manuscript we examined if increases in SNAP benefits ($24 for a 1-person household) due to the American Recovery and Reauthorization Act in April 2009 affected our outcomes of interest for older adults (≥60 years) (n=43,269 individuals; 1,038,46 claims). Using a difference-in-difference matching approach, we did not find an effect of changes in SNAP benefit sizes on health care utilization related to hypertension (measured by medical claims for hypertension), emergency care for hypertension (measured by emergency room claims for hypertension), or medication adherence (measured by pharmacy claims for antihypertensives). These results were robust to analytical approaches, samples, and subgroups.

Introduction

In 2017, 7.7% of adults 60 and older were food insecure (Ziliak & Gundersen, 2018). Food insecurity is defined as limited or uncertain access to adequate food because of limited economic resources for food (U.S. Department of Agriculture, 2022). The consequences of older adult food insecurity are far-reaching, affecting their health and well-being (Gundersen & Ziliak, 2015). Food insecurity is correlated with limitations to the skills needed to manage physical needs, including increased limitations in activities of daily living (ADLs), like dressing or functional mobility, and increased limitations in instrumental activities of daily living (IADLs), which are more complex activities required for independent living like preparing meals, cleaning, and housekeeping (Spector & Fleishman, 1998). Food insecurity is also correlated with a host of negative health indicators, including increased work-limiting disabilities, negative self-reported health, reduced cognitive performance, increased depression, increased anxiety, and deterioration of oral health (Gundersen & Ziliak, 2015; Steiner et al., 2018; Vilar-Compte, Gaitán- Rossi, Pérez-Escamilla, 2017; Heflin, Altman & Rodriguez, 2019). Not only food insecurity is correlated with negative health conditions but, among older adults in particular, food insecurity is also correlated with chronic diseases such as diabetes, cardiac disease and poor disease management (Fernandes et al. 2018). The association between food insecurity and poor health among older adults is believed to come from two main sources. First, prior research suggests that food insecurity may worsen diet quality, which in turn may increase poor health among older adults (Zilliak & Gundersen, 2018; Gundersen & Ziliak, 2015; Steiner et al., 2018; Vilar- Compte, Gaitán-Rossi, Pérez-Escamilla, 2017; Heflin, Altman & Rodriguez, 2019; Orr et al., 2019). Second, prior literature also suggests that medication non-adherence by seniors forced to trade-off food and prescription drugs which often results in higher healthcare utilization costs (Zilliak & Gundersen,2018; Berkowitz, Seligman, Choudhry, 2014; Afulani P, Herman D, Coleman-Jensen A, Harrison, 2015; Bengle R,

Sinnett S, Johnson T, Johnson MA, Brown & Lee, 2010; Bhargava & Lee, 2016; Bhargava & Lee, 2017; Berkowitz, Basu, Meigs & Seligman, 2018). Benefits received from the Supplemental Nutrition Assistance Program (SNAP), the nation's largest nutrition assistance program, may reduce the linkage between food insecurity and poor health by improving diet quality and by reducing medication non-adherence (Srinivasan and Pooler, 2017). SNAP is the largest food and nutrition assistance program in the United States and has been shown to reduce food insecurity (Nord & Prell, 2011).

In 2019, 28% SNAP households contained an older adult, a 13 percentage point increase since 1992, and 16% of all SNAP participants are age 60 or older (U.S. Department of Agriculture, 2021). However, SNAP participation among eligible adults age 60 or older is roughly half that of the general population: 48% compared to 84% overall in 2017 (Vigil, 2019).

The social and economic burdens of hypertension and diabetes are profound. Cardio-metabolic diseases such as diabetes and hypertension are among the leading causes of morbidity and mortality in the United States (Xu et al., 2013). More than 66% of adults ages 60 years or older were living with the hypertension between 2011 and 2014, and 25% of adults 65 or older were living with diabetes (CDC, 2015; CDC. 2017). However, 49% of adults ages 60 years or older with hypertension had their blood pressure controlled (SBP/DBP <140/90 mm Hg) (Fryar et al., 2017).

Furthermore, between 2003 and 2014, on average, the adjusted annual incremental cost of hypertension was $131 billion per year higher among adults with hypertension compared to adults without hypertension (Kirkland et al., 2018). The total (direct and indirect) cost of diabetes care was $327 billion in 2017 (American Diabetes Association, 2018). These costs are exacerbated by medication non-adherence, which results in avoidable hospitalizations (Egede et al., 2012; Ho et al., 2006). Avoidable costs due to medication non-adherence for diabetes and hypertension was estimated to be $43.2 billion in 2013 (IMS, 2013).

Cardio-metabolic diseases such as diabetes and hypertension are of particular concern among older adults who are food insecure. Not only are diabetes and hypertension more prevalent among low-income and food insecure individuals (CDC, 2017; American Diabetes Association, 2018; Jih et al., 2018), food insecure individuals living with diabetes and/or hypertension have poorer disease control, such as sub-optimal glycemic or blood pressure control (Bawadi et al., 2012; Wang et al., 2015). This may be because food insecure individuals living with diabetes and/or hypertension have poorer diet quality (Orr et al., 2019), but also because they have higher rates of cost-related medication non-adherence (Berkowitz, et al., 2014; Gundersen & Ziliak, 2015), even after controlling for socio-demographic characteristics (29).

The "eat or treat" hypothesis refers to the observation that low-income households with scarce resources face tradeoffs between purchasing food and purchasing prescription drugs to treat chronic illnesses such as diabetes and hypertension. According to Berkowitz and colleagues (2014), among those who reported a chronic illness in the National Health Interview Survey, 23.4% of adults reported cost-related medication underuse, 18.8% reported food insecurity, and 11% reported both.

For food insecure individuals living with diabetes and/or hypertension in particular, poor disease control related to poor diet quality and medication underuse may result in costly and potentially avoidable emergency department visits or hospitalizations (Bhargava & Lee, 2016). Older adults living with type 1 or 2 diabetes who are not adherent to medications are at risk for developing diabetic complications-such as hypoglycemia, hyperglycemic hyperosmolar state or diabetic ketoacidosis. Older adults living with hypertension are at risk of hypertensive urgency or emergencies with acute target organ disease (Simpson, Lin & Eurich, 2016).

SNAP participation, on the other hand, may reduce the incidence of diabetic and hypertensive emergencies by improving diet quality and by reducing medication non-adherence,

especially if SNAP benefits free-up household resources that would otherwise be spent on food for medication purchases. For example, recent research using a propensity score matching technique to account for selection in SNAP participation on observable characteristics found that SNAP reduced the rate of cost-related medication underuse for older adults (Srinivasan & Pooler, 2018).

However, the current literature on medication non-adherence and food insecurity has several significant limitations. First, most of the research documenting the "treat or eat" phenomenon uses survey data (Berkowitz, Seligman, & Choudhry, 2014; Afulani et al., 2015; Srinivasan & Pooler, 2018), which likely contains measurement error in the self-reports of chronic diseases, medication under-use, and SNAP participation. Second, within the medical literature, the standard approach to studying medication non-adherence requires administrative data containing pharmacy claims, but this data typically lacks information on patient income and SNAP participation (Calip, Elmore & Boudreau, 2017; Kim et al., 2018). Finally, although older adults consume a large share of medical resources and increasingly comprise a larger share of the total population, most of the research to date has not focused on this age group (Herman et al., 2015). This study contributes to the literature by combining Medicaid pharmacy claims and SNAP administrative data (containing both benefit level and exact disbursement data) over a nine-year period for adults ages 60 and older in the state of Missouri, a Midwestern state where the older adult population is very similar to the average older adult population of the United States, except in terms of race and ethnicity (see Table 1).

To fill this important gap in the literature, this project aims: (1) to investigate demographic characteristics of the older adult SNAP population by risk of churn, and frequency and duration of churn spells, and (2) to examine how SNAP benefits are related to medication non-adherence and health care utilization for diabetes and hypertension among older Americans,

Table 1: Demographic Characteristics of US and Missouri (MO) population

2007-2014 Age 60 and Over

Characteristics	Overall population		SNAP recipients	
	MO	US	MO	US
Average age (years)	71	71	70	70
Homeowners	81%	79%	55%	51%
Receiving SNAP	7%	7%	100%	100%
Female	56%	55%	65%	64%
Married	60%	59%	29%	32%
White	90%	84%	73%	64%
Hispanic	1%	7%	2%	18%
With Health Insurance	97%	96%	93%	93%
At Least High School	87%	86%	71%	64%
Under Poverty Line	13%	12%	40%	37%
Disabled veterans	14%	14%	2%	2%
Independent Living Difficulty	16%	15%	29%	27%

Source: US Census Bureau: American Community Survey, 2007-2014. The US Census Bureau collects self-reported data of race (White, Black, Asian, Other, Multiple races) and ethnicity (Hispanic origin and non-Hispanic origin). Authors collected these data using IPUMS (https://usa.ipums.org/usa/).

Research Questions and Hypotheses

This study answers four research questions. The first question is related to our first aim: "investigate demographic characteristics of the older adult SNAP population in relationship by risk of churn, and frequency and duration of churn spells":

1) Is administrative churn an issue for the older adult population and what are the characteristics of older SNAP participants who experience administrative churn? These characteristics include prevalence of chronic diseases and medication adherence.
2) The last three questions are related to our second aim: "examine how SNAP benefits are related to medication non-adherence and health care utilization for hypertension among older Americans." What is the prevalence of hypertension and diabetes among older

adult SNAP participants and the associated level of medication adherence?

3) Is there a relationship between SNAP participation, concurrent SNAP and Medicaid enrollment, patterns of SNAP participation, and medication non-adherence among low-income Medicaid-insured older adults living with chronic diseases?
4) Did changes in SNAP benefit size due to the American Recovery and Reauthorization Act in April 2009 affect chronic disease medical claims, emergency room claims, or medication adherence?

Based on our research questions and the prior literature, we hypothesize: 1) that SNAP recipients will have lower rates of medication non-adherence and diabetic and hypertensive emergencies that result in ED visits and hospitalizations, relative to Medicaid recipients not on SNAP; 2) that increases in the size of SNAP benefits will be protective against medication non-adherence and diabetic and hypertensive emergencies; and 3) that older adults will have lower rates of medication non-adherence and diabetic and hypertensive emergencies in the week after receipt of SNAP benefits.

Data description

We used administrative data including Medicaid claims and Medicaid enrollment linked to SNAP benefit receipts from the Missouri Department of Social Service for the period January 2006 to December 2014. The Medicaid claims data consist of separate records for each claim and each record includes the date of the medical service and the setting in which care was received. The SNAP data consist of separate records for each benefit payment including the date of disbursement, the benefit amount, and the size of the household. Our target population is Medicaid recipients over the age of 60 in the state of Missouri. Our study population is SNAP participants in Missouri, age 60 and older during the study period (n=154,020) who have Medicaid claims during the same

period.[1] We also compare SNAP participants in Medicaid to non-SNAP participants in Medicaid who are similar based on individual demographic characteristics such as age, sex, race, and Charlson comorbidity index score (CCI)- a weighted index that predicts ten-year mortality by accounting for the number and severity of comorbid diseases (Charlson, et al., 1987).

The data are from a single state, Missouri. Although the results of this study will not be generalizable beyond the state, Missouri is typical in population size (ranked 18 out of 50), is in the middle for educational attainment (ranked 27 out of 50 for percentage of adults with a high school diploma), and ranks a little lower on median income (ranked 37 out of 50) (US Census Bureau, 2019). Notably, Missouri was in the top 10 states for prevalence of household food insecurity in 2012, near the end of our study period (Coleman-Jensen & Gregory, 2014). And, although more than 70,000 Missourians 60 and over received SNAP benefits in 2015, only about 43% of eligible seniors received SNAP benefits (National Council on Aging, 2019) and 8.5% of households with seniors were food insecure (Food and Research Action Center, 2019)). Older adults in Missouri are very similar to older adults in the US (see Table 1). Finally, hypertension and diabetes are among the most diagnosed chronic conditions for older adults in Missouri, with its Medicaid program covering over $321 million in diabetes costs in 2012 (Missouri Department of Health and Senior Services, 2015).

[1] Medicaid is a means-tested entitlement program. Missouri's Medicaid program, MO Healthnet for the Aged, Blind, or Disabled helps to cover the costs of medical care for low-income individuals who are ages 65 and older (35). Individuals with incomes below 85% of the federal poverty line are eligible for Medicaid if they have cash or other liquid assets of less than $2,000 ($4,000 if married). Individuals with incomes above 85% of the federal poverty line can qualify for Medicaid if their medical expenses result in income below 85% of the FPL, a process known as "spending down" (35). Medicaid also covers the cost of medical care for older individuals through Medicare Cost Savings Programs, which require that states' Medicaid programs cover costs such as Medicare premiums, deductibles, and coinsurance for individuals enrolled in Medicare Parts A or B (36). The Missouri Qualified Medicare Beneficiary (QMB) program covers Medicare costs for individuals with incomes up to 100% of the FPL and the Specified-Low-Income Medicare Beneficiary (SLMB) program covers Medicare costs for individuals with incomes between 100% and 135% of the FPL. Medicaid also covers additional services such as prescription drug costs for low-income Medicare enrollees (36).

Measures

Outcome measures

Emergency Care and Hospitalizations for Hypertension and Diabetes. Among Medicaid recipients over the age of 60, we will identify claims for care received in an emergency department setting following the same methodology used in previous research. We identified claims related to hospitalizations using admission dates and claim-type, revenue-type, and facility-type codes for inpatient services following Bansai & Vashishta (2016). Then, we used ICD-9 codes to identify emergency department visits and hospitalizations related to hypertension (401.x-405.x, 437.2) and hypertensive emergencies with acute target organ damage (362.81, 377.01, 428.0, 428.1, 428.20, 428.21, 428.23, 428.30, 428.31, 428.33, 428.40, 428.41, 428.43, 428.9, 410.x, 414.12, 443.21, 443.22, 443.23, 443.24, 443.29, 441.x, 430, 431, 432.x, 434.x, 435.x, 436, 437.2) following Janke et al. (2016)[2]. We used the ICD-9 250.0-250.9 to identify claims related to a diagnosis of diabetes following Washington, Andrews & Mutter (2013).

Medication Non-adherence. We identified non-adherence to medications associated with hypertension and diabetes including antihypertensives (angiotensin-converting enzyme inhibitors, beta blockers, calcium channel blockers, diuretics), oral diabetes medications (metformin, sulfonylureas), and statins following Calip, Elmore & Boudreau (2017). We measured medication non-adherence in a given period by using information associated with pharmaceutical claims to calculate the proportion of days covered (PDC) by the medication, defined as the number of days on which the individual has the medication available divided by the number of days in a specified study period. We used PDC because it produces more conservative results compared to Medication Possession ratio and it is also used by Medicare to calculate medication adherence

[2] We used broader codes than what would be considered diabetic or hypertensive emergencies in the strictest sense, which will allow us to do robustness checks to our identification of emergency room visits and hospitalizations for these conditions.

(Linden, 2019). We used a Stata program *medadhere* to calculate this measure (Linden, 2019).

Explanatory measures

SNAP. We used administrative data on monthly SNAP benefit receipts to construct measures of SNAP program participation (whether an individual lived in a household that received SNAP), SNAP benefit amount (how much the household received), and SNAP benefit timing (day of the calendar month that the households received SNAP benefits, length of time between SNAP benefit receipt and when a health event occurred, and the proportion of days in a given period that the individual was covered by SNAP).[3]

Covariates

We used demographic and household information from the Medicaid claims records and the SNAP benefit receipts records to construct measures of age, sex, race and ethnicity, household size, whether the household has earned income, and geography.

Age. We used four categories of age: 60 to 64 (reference category), 65 to 69, 70 to 79, and 80 and older.

Sex. We used self-reported sex: male (reference category) and female.

Race. We used racial self-classification, which is the race individuals checked on the official Medicaid or SNAP application form. We used five categories: White (reference category), Black/African American, Asian, Other race (which comprised American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Multiple races), and unknown. Other race was created in the deidentified data because of disclosure concerns. These individuals together represent less than

[3] Missouri's SNAP program, called the Missouri Food Stamp Program, helps low-income households purchase food. In Missouri, households with incomes up to 130% of the FPL are eligible for SNAP benefits provided they have less than $2,250 in cash and other liquid assets. For households where all members are at and above the age of 60, the asset limit is $3,500 (Missouri Department of Social Services, 2019). Generally, once eligibility for SNAP is established, SNAP benefits are disbursed to households one time each month through an electronic benefit transfer (EBT) (Hoynes McGranahan & Schanzenbach 2015).

0.5% of all older adults in our sample. Additionally, due to small sample size, in some analyses we combine the categories “other race” and “unknown/missing race.”

Ethnicity. Similar to race, we used ethnic self-classification, which included two categories: non-Hispanic (reference category) and Hispanic.

Household size. We used four categories: one member (reference category), two members, three members, four or more members.

Earned income. Category of income that determines earned income. We used two categories: unearned income/no income from employment (reference category) and earned income. Example of earned income is income from employment and example of unearned income/no income from employment is the Supplemental Security Income.

Geography. Two categories were used: rural (reference category) and urban area.

Research Question #1: Is SNAP administrative churn an issue for older adult SNAP participants and what are the characteristics of older SNAP participants who experience administrative churn?

There is little research on the issue of administrative churn for the older adult population. Administrative churn occurs when a household stops receiving SNAP benefits for one to three months, often when program eligibility needs to be recertified, before returning to the program (Mills, Vericker, Koball et al., 2014). Rates of SNAP administrative churn are known to vary from 17% to 28% (Mills, Vericker, Koball et al., 2014), and are associated with health care utilization patterns (Heflin, Hodges and Ojinnaka, 2020).

While overall administrative churn for the older SNAP adult population is less likely than for the rest of the SNAP population, among those who are due for recertification, households containing older adults are more likely to churn (Mills, Vericker, Koball et al., 2014). This may suggest that the longer certification period for older adults may merely extend the period on SNAP before churn occurs. It is important to mention that this study was not representative of the overall US population, but only used data from six states: Florida, Idaho, Illinois, Maryland, Texas, and Virginia. To date, no empirical studies have focused on documenting patterns in churn specifically among the older adult SNAP population.

Data

We used administrative SNAP records from the state of Missouri for all adults aged 60 and older who participated in SNAP for three or more consecutive months between 2006 and 2014 (n=141,584). We used this data to calculate administrative churn (when people stop receiving benefits for a period of 1 to 3 months), timing of churn (at the mandatory recertification period, at the mid-certification review period, or at any other time), frequency of churn, and duration of churn.

While we recognize that churn is a household event, our analysis is conducted at an individual level. Even though we include households that are not headed by seniors, 90% of our sample resides in a 1 or 2 person household. Nonetheless, we estimated models that clustered standard errors at the household level and results are unchanged from those presented.

We used three outcome variables: ever churn, number of churn spells, and length of churn spell in days.

Churn. Consistent with previous work (Heflin, Hodges, and Ojinnaka 2020; Mills et al. 2014), we defined churn as occurring when we observe three or more months of consecutive SNAP receipt followed by a gap in SNAP receipt for up to four months before a return to SNAP.

Number of churn spells. Defined as the number of times that churn is observed for a given individual over the full observation period.

Average length of churn spell in days. It is defined as the number of days between the first date that an expected benefit payment was not issued and a subsequent benefit payment divided by the number of churn spells.

Statistical Analysis

We first split the sample into those SNAP older adults who *ever* experienced a period of churn and those who did not, and showed differences by demographic, household, and geographic characteristics for the two groups; we used means and percentages for both groups and statistical differences were examined using t-tests. For the sample that experienced churn, we present descriptive information regarding whether churn occurred around the mandatory recertification period, at the mid- certification review or at some other point in the SNAP spell. We document the frequency and length of churn spells for the overall sample of churners and by demographic, household, and spatial characteristics. Finally, we run multivariate regression

models to identify factors associated with the probability of ever experiencing churn, the frequency of churn events and the duration of churn, using probit models to estimate the probability of ever experiencing churn, and OLS models to estimate the number of churn spells and the duration of churn in months. Our results for the number of churn spells were robust to estimation using a negative binomial model, which controls for the overdispersion on zero[4].

Results

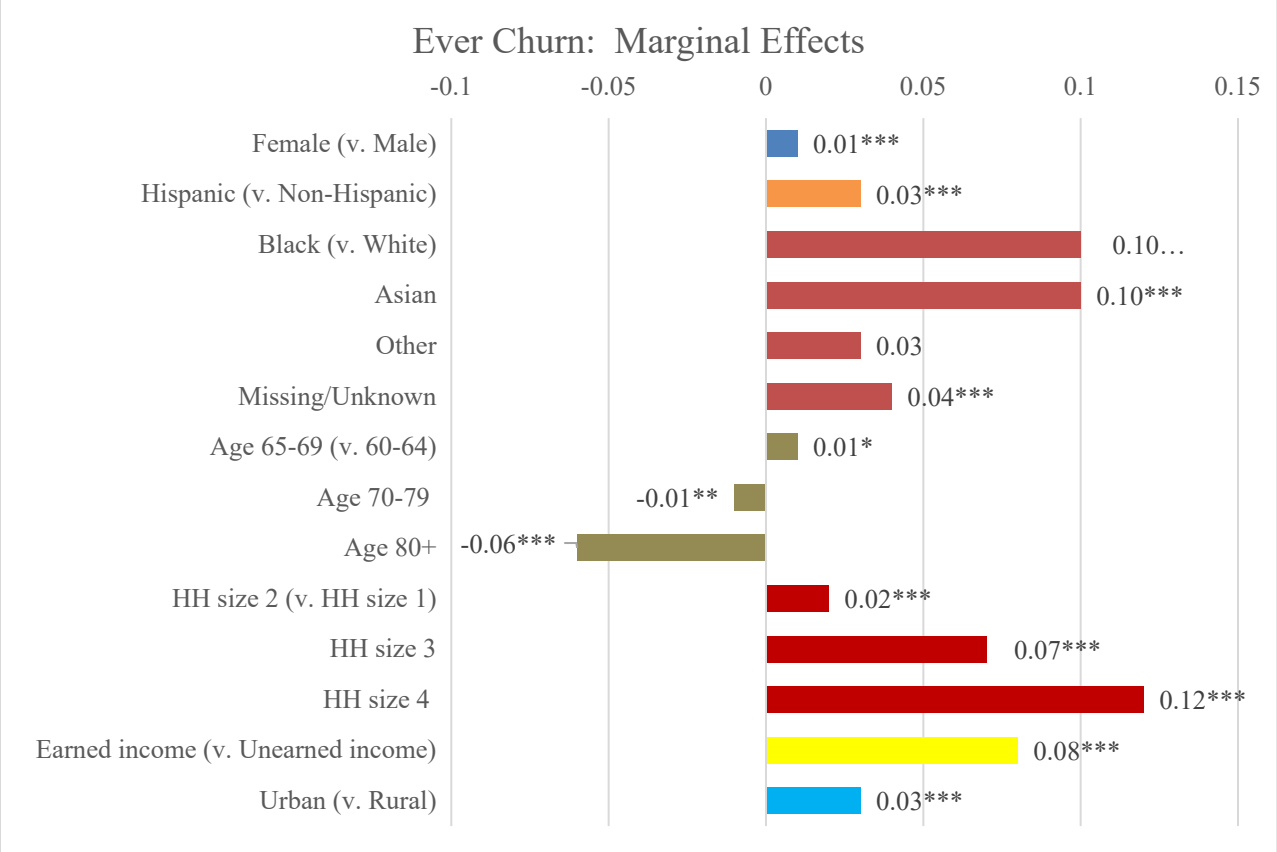
Our study shows that 24% of SNAP adults 60 years and older in Missouri experienced a churn event at some point between 2006 and 2014. We also investigated the relationship between certification periods and administrative churn. Certification periods in Missouri vary from six to 24 months, with the longest period reserved for households headed by elderly and disabled adults. About 74% of our sample had a 24-month certification period, 13% had a 12-month certification period, and 11% had a 6-month certification period. We found that most churn spells (60%) occurred at the end of the certification period, when the level of administrative burden associated with recertification of SNAP eligibility is high. We also found that another 20% of churn spells occurred mid-way through the certification period, which is when participants are required to confirm continuing eligibility through the mail. The remaining 20% of churn spells occurred outside of these two formal review points.

We then used regression analysis to examine factors associated with ever experiencing a churn spell. Figure 1 shows that being Hispanic, Black, and Asian are associated with an increased risk of churn relative to being non-Hispanic or White ($p<0.001$). Being female is also associated with an increased risk of churn relative to being male ($p<0.001$). We also found that

[4] For both number of churn spells, and the duration of churn in days, estimates are robust to negative binomial models. For number of churn events, the Akaike's information criterion (AIC) and Bayesian information criterion (BIC) suggest that the OLS model is preferred to the Negative Binomial model. For duration of churn in days, the Akaike's information criterion (AIC) and Bayesian information criterion (BIC) suggest that the Negative Binomial model is preferred to the OLS model, although the estimated coefficients are very similar.

enrolling in SNAP at age 65-69 is positively associated with an increased risk of churn relative to being ages 60-64, while enrolling SNAP at ages 70 to 79 or 80 or older is associated with a decreased risk of 1 percentage point and 6 percentage points, respectively, of experiencing churn, compared to adults aged 60-64 at first SNAP receipt ($p<0.001$). Household size is also positively associated with ever churning. For example, a household size of 4 or more has a 12 percentage point higher risk of ever churning ($p<0.001$). We found that older adult households with any earned income are 8 percentage points more likely to experience churn than those without any earned income ($p<.001$). Finally, living in an urban area is associated with an increased risk of ever churning ($p<0.001$).

Figure 1. Predictors of administrative churn (ever churn)

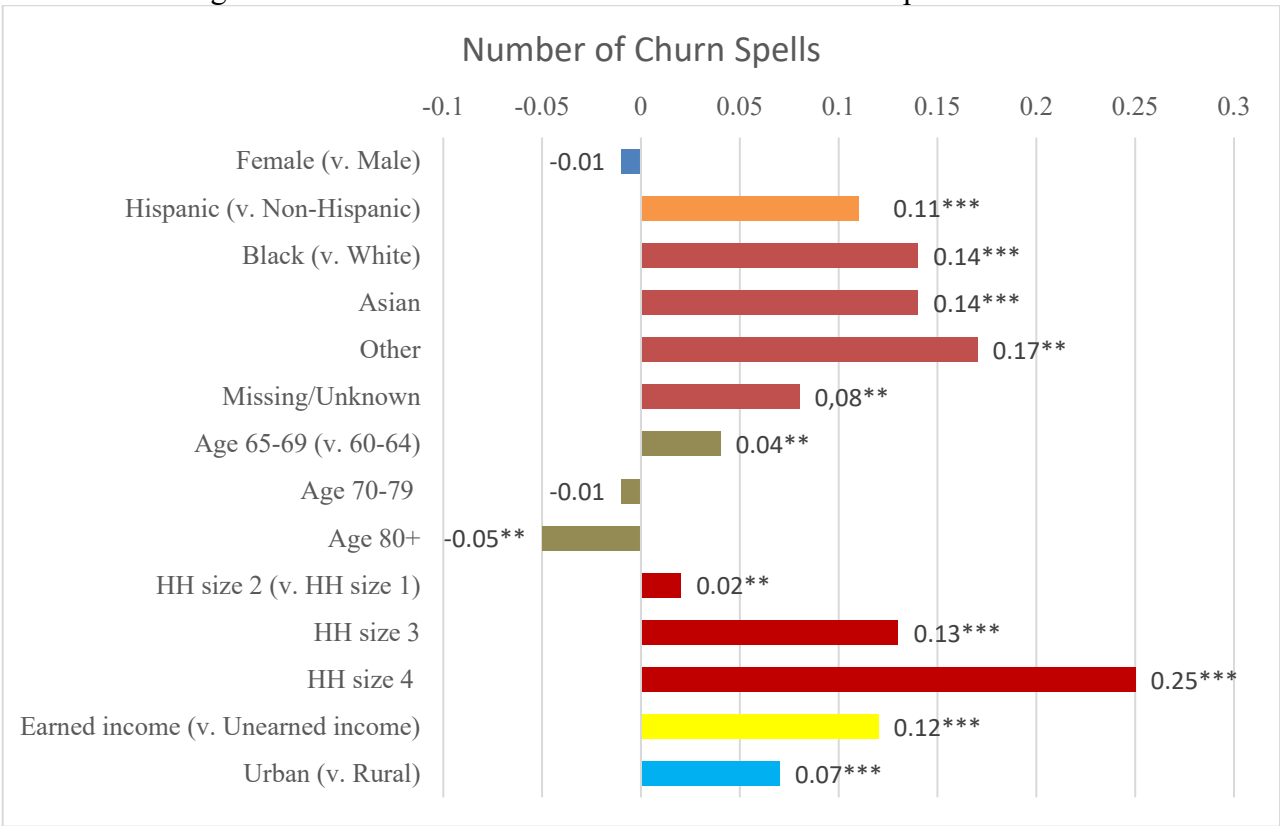


Note: n=141,584 older adult SNAP participants who received SNAP for three or more consecutive months between January 2006 and June 2014. Marginal effects from probit regression models predicting likelihood of experiencing a churn event.
*** $p<0.001$, ** $p<0.01$, * $p<0.05$. Each categorical variable is in different color and when a variable has multiple categories, the reference variable is stated only for the first category, although it applies to all categories. Males is the reference category for sex, non-Hispanic is the reference category for ethnicity, White

is the reference category for race, 60 to 64 years of age is the reference category for age, one-member household is the reference category for household size, unearned income is the reference category for income, and rural is the base category for geographic location.

Figure 2 shows predictors of number of administrative churn spells using an OLS model. While we observe that the coefficients are statistically significant, they are not practically significant given that they are very small in terms of number of churn spells associated with race and ethnicity, age, household size, and earned income. In terms of ethnicity, we found that being Hispanic is associated with 0.11 higher number of churn events ($p<0.001$). Similarly, we found that being Black, Asian, or other racial groups (American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, or Multiple race, or missing race) relative to White is associated with a higher number of churn spells ($p<0.005$). In terms of age, being 65-69 is positively associated with number of churn events while being 80 or older is negatively associated with number of churn events relative to being age 60-64 at first SNAP enrollment ($p<0.01$). We also found a higher household size (relative to single household size) is positively associated with more administrative churn spells ($p<0.001$). Finally, having any earned income is positively associated with number of churn spells ($p<0.001$). Living in an urban area is also positively associated with a higher number of churn spells.

Figure 2. Predictors of number of administrative churn spells



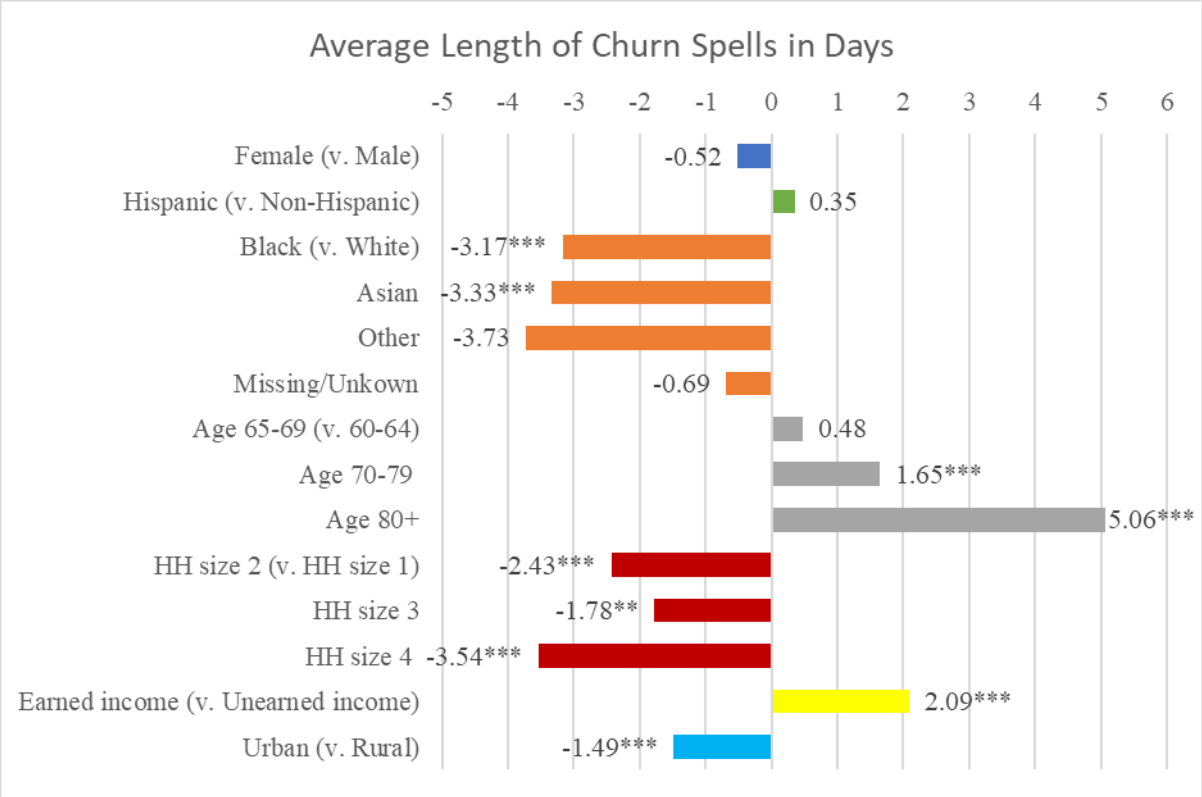
Note: *** p<0.001, ** p<0.01, * p<0.05. Each categorical variable is in different color and when a variable has multiple categories, the reference variable is stated only for the first category, although it applies to all categories. Males is the reference category for sex, non-Hispanic is the reference category for ethnicity, White is the reference category for race, 60 to 64 years of age is the reference category for age, one-member household is the reference category for household size, unearned income is the reference category for income, and rural is the reference category for geographic location.

Figure 3 presents OLS estimates predictors of duration in days of administrative churn.

We observe that older adults who are Black have churn spells that are 3.17 days shorter than Whites (p<.001), and Asians have spells that are 3.33 days shorter than Whites (p<0.01). As the age of first SNAP receipt increases, the length of the churn spell increases. For example, adults 80 and older at first SNAP receipt experience, on average, 5.06 more days of churn relative to those age 60-64 (p<.001); while adults 70 to 79 at first SNAP receipt experience, on average, 1.65 more days of churn relative to those age 60-64 (p<0.001). We also observe that having

additional household members reduces the length of churn spell: adults in households of four or more experience churn spells that are on average, 3.54 days shorter than those in single person households (p<.001). Additionally, any earned income is associated with a 2.09 day increase in the duration of churn spell (p<.001). Finally, living in urban areas in comparison to living in rural areas is associated with a 1.49 day decrease in the duration of churn spell (p<0.01).

Figure 3. Predictors of length (in days) of administrative churn



Note: *** p<0.001, ** p<0.01, * p<0.05. Each categorical variable is in different color and when a variable has multiple categories, the reference variable is stated only for the first category, although it applies to all categories. Males is the reference category for sex, non-Hispanic is the reference category for ethnicity, White is the reference category for race, 60 to 64 years of age is the reference category for age, one-member household is the reference category for household size, unearned income is the reference category for income, and rural is the base category for geographic location.

Sensitivity Analysis: Ruling out potential confounders

It can be argued that any change in categorical eligibility, certification procedures, and reporting requirements in Missouri between 2006 and 2014 could have affected churn. It should also be noted that there was an increase in SNAP benefits due to ARRA in 2009 and a decrease in 2013

due to the sunset of ARRA changes. We examined models that include dummy variables where SNAP benefits changed due to ARRA. We found that the probability of churn decreased with the benefit increase (relative to the probability of churn before ARRA). However, we also found that at the time of the sunset of ARRA changes, there was an even larger reduction in churn. We looked to year dummies to examine this pattern more closely. We found that the level of churn was consistent from 2006-2008 and then dropped but remained consistent from 2009-2011 before falling in 2012 and 2013 and then increasing sharply in 2014. Missouri expanded the average recertification length from 6 months to 12 months for households with earnings in 2011. However, among elderly SNAP units in Missouri, the focus of our study here, the median recertification length has consistently been 24 months, although the annual share of elderly cases with recertification periods of 24 months did vary between 86-96% of the elderly caseload over our observation period. In addition, online document submission began in 2013.

Conclusions

Findings suggest that stable access to SNAP is a significant problem for 24.4% of older adult participants. For this quarter of the older adult SNAP population, 26.5% experience more than one spell of churn and each churn spell lasts for about a month on average. We studied individual, household, and geographic characteristics to identify risk and protective factors associated with churn, churn frequency, and churn length. We found a consistent pattern that the factors associated with lower frequency of churn are also associated with longer durations of churn. For example, adults aged 80 and above and those in households of 4 or more persons experience the fewest churn spells but when churn spells occur, they last longer (relative to those age 60-64 and one-person households, respectively). One interpretation is that these households have the highest need for SNAP benefits but also have a harder time dealing with the administrative burden of returning to SNAP quickly when their benefits lapse.

These findings suggest that for a significant portion of older adults, SNAP benefits are unstable, which may interrupt healthy eating patterns necessary to maintain health and balanced nutrition. Furthermore, unlike other household types that may experience churn as a result of fluctuations in household income, which could change household SNAP eligibility, older adult households are likely to have less volatile sources of income as most of them are retired. It is likely that for these older adults much of churn is related to administrative burden.

Our findings are intended to provide valuable information for program administrators who can identify older adults who are at greater risk of experiencing disruptions in SNAP benefit receipt. Moreover, to the extent that stable access to SNAP promotes access to healthy foods, continuous enrollment in SNAP may be associated with better health care utilization and health outcomes. Previous research demonstrates that disruptions in SNAP participation among infants decreases well-visits (Arteaga, Hodges, & Heflin, 2021) and disruptions in SNAP participation among the non-elderly population is associated with patterns in health care utilization, particularly more inpatient care and less pharmacy use and outpatient care (Heflin, Hodges, and Ojinnaka 2020). Future research could examine how churn is related to health care utilization among older adults.

Research Question #2: What is the prevalence of hypertension and diabetes among older adult SNAP participants and the associated level of medication adherence?

Empirical Strategy

We conducted three analyses. First, we estimated the prevalence of hypertension and diabetes among older adult SNAP participants who were dually enrolled in Medicaid and SNAP, by age group, sex, race/ethnicity, citizenship and geography. Second, using Medicaid pharmacy claims, we estimated levels of non-adherence to prescribed antihypertensives and anti-diabetic medications for individuals who were enrolled in both SNAP and Medicaid for all 12 months of a given year. Third, after creating our key measures for prevalence of chronic diseases and levels of medication non-adherence, we used regression analysis to predict rates of medication adherence for antihypertensives and antidiabetic medications, controlling for demographic characteristics. We also estimated the likelihood of medication adherence, controlling for demographic characteristics.

Data

We merged administrative SNAP records for older adults ages 60 and over with Medicaid claims and Medicaid enrollment data from the Missouri Department of Social Service for the period January 2006 to December 2014. During this time period, 161,964 older adults participated in SNAP. We were able to find 154,020 individuals enrolled in Medicaid, representing 95% of all older adult SNAP participants in Missouri during this time period.

Our study sample consists of 154,020 Missourians ages 60 and older dually enrolled in SNAP and Medicaid. Of these, 106,197 had a diagnosis of hypertension and 60,965 had a diagnosis of diabetes. We calculated medication non-adherence on an annual basis using the proportion of days covered (PDC) from the date of the first fill for a medication through December 31st of that year (Linden, 2019). PDC is widely used in the literature and also by the

Centers for Medicare & Medicaid Services who reports PDC rates for both diabetes and hypertension. This measure of medication adherence works under the assumption that filling and refilling a prescription translates to taking the medication as recommended by the medical expert. We present the average of the annual rates of medication adherence to antihypertensives and to antidiabetics for SNAP participants with diagnosis of these conditions by demographic characteristics. In line with previous studies, we define non-adherence as PDC below 0.80 (Centers for Medicare & Medicaid Services, 2018; National Quality Forum, 2015; Pharmacy Quality Alliance, 2018).

Results

Figure 4 shows that 69% of our study sample had a diagnosis of hypertension and 40% had a diagnosis of diabetes. This figure also presents information on the percentage of non-adherence, based on a PDC less than 0.80, (Centers for Medicare & Medicaid Services, 2018; National Quality Forum, 2015; Pharmacy Quality Alliance, 2018). We found that within the older adult SNAP population with hypertension, 24% were non-adherent on average. For the older adult SNAP population with a diabetes diagnosis, we found that 36% were non-adherent.

Figure 4: Prevalence of Hypertension and Diabetes among older adult dually enrolled in SNAP and Medicaid

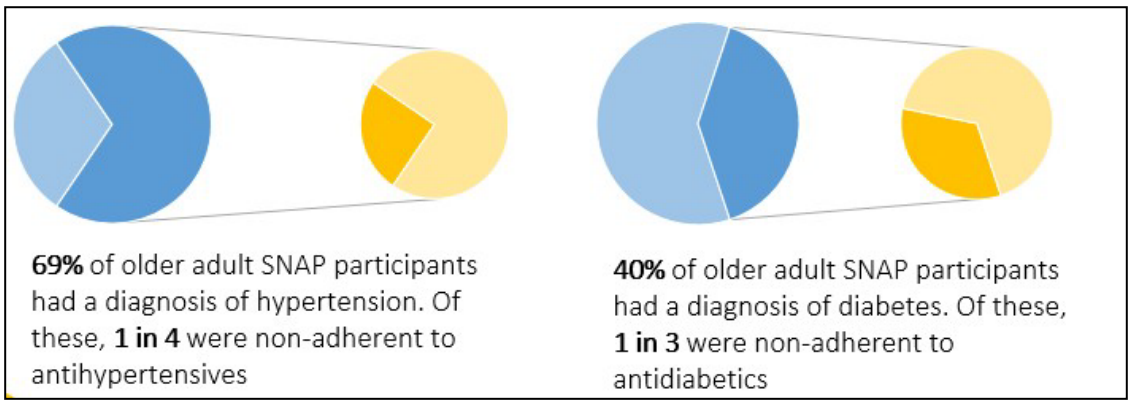


Table 2 presents information on annual rates of adherence to antihypertensives and anti-diabetes medication, as well as percentage of participants who were non-adherent. Among older adults dually on SNAP and Medicaid with hypertension, annual estimated average rates of medication adherence ranged from 0.86-0.88 across age groups while the average percentage non-adherent ranged from 22% to 26%. For those with diabetes, annual rates of medication adherence ranged from 0.79-0.82 across age groups and the average percentage non-adherent was 33% and 38%. We observe differences by race in terms of the percentage non-adherent (Blacks 42%; Hispanics 34%; Whites 34%; Others 33%). In terms of geography, we find higher rates of medication adherence in rural areas in comparison to urban areas both for hypertension (0.88 v. 0.85), and diabetes (0.81 v. 0.79). Similarly, percentage of non-adherence was lower for rural areas in comparison to urban areas, both for antihypertensives medication (22% v. 27%) and anti-diabetic medication (34% v. 38%).

Table 2. Annual Rates of Medication Adherence and Percentage Non-adherent by Demographic Characteristics for Older Adults dually on SNAP and Medicaid in Missouri, 2006-2014

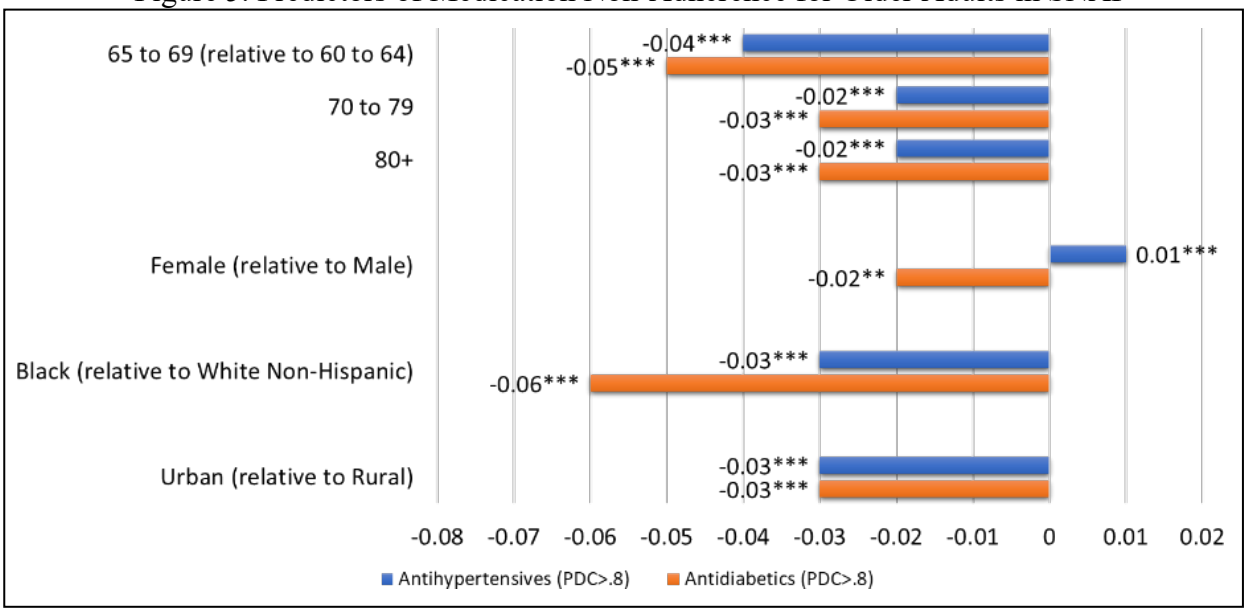
	Hypertension Patients			Diabetes Patients		
	Persons Per Year[a]	Adherence Rate[b]	Percentage Nonadherent (PDC<.8) [b]	Persons Per Year[c]	Adherence Rate[b]	Percentage Nonadherent (PDC<.8) [b]
	21,755	0.86	24.35%	5,298	0.80	35.81%
Age						
60 to 64	5,346	0.88	22.27%	1,348	0.82	32.89%
65 to 69	5,416	0.86	26.03%	1,404	0.79	37.83%
70 to 79	7,186	0.86	24.67%	1,787	0.80	36.07%
80 and over	3,807	0.86	24.21%	760	0.80	36.95%
Sex						
Female	16,135	0.87	24.09%	3,886	0.80	36.31%
Male	5,621	0.86	25.10%	1,412	0.81	34.43%
Race and Ethnicity						
White	15,542	0.87	23.18%	3,812	0.81	34.47%
Black	4,482	0.84	27.79%	1,026	0.77	41.63%
Hispanic	293	0.85	26.87%	87	0.80	35.46%
Other race[d]	1,438	0.86	25.75%	372	0.81	33.78%
Citizenship Status						
Citizen	21,234	0.86	24.30%	5,147	0.80	35.92%
Noncitizen	522	0.85	26.56%	151	0.82	32.46%
Geography[e]						
Rural	10,972	0.88	22.28%	2,770	0.81	33.83%
Urban	10,784	0.85	26.54%	2,528	0.79	38.05%

Notes: a. Sample inclusion in each year is conditional on diagnosis of hypertension and 12 months of SNAP and Medicaid participation. b. Annual estimates averaged across the eight- year study period. c. Sample inclusion in each year is conditional on diagnosis of diabetes and 12 months of SNAP and Medicaid participation. d. Other race includes Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Multiple race. e. Urban designation based on living in an OMB Metro County.

Figure 5 presents results of multivariate models that examine associations between medication non-adherence and demographic characteristics. In terms of age, we found medication adherence is lower among SNAP recipients ages 65 and older than those ages 60-64

for both hypertension and diabetes (p<.001 for each age group and both outcomes) after controlling for other demographic characteristics. We find that females have higher levels of medication adherence than males for hypertension but lower levels for diabetes after controlling for other demographic characteristics. In terms of race, on average Blacks (p<.001) have lower levels of medication adherence than Whites for hypertension and diabetes. US citizenship has no relationship with medication adherence for hypertension after controlling for other demographic characteristics; for diabetes, non-citizens have higher rates of medication non-adherence than do U.S. citizens (p<.01). In terms of geography, living in urban areas is associated with lower levels of medication adherence than living in rural areas for both hypertension and diabetes after controlling for other characteristics (p<.001).

Figure 5. Predictors of Medication Non-Adherence for Older Adults in SNAP



Note: Marginal effects from probit regression models predicting annual rates of medication adherence (proportion of days covered by medication > 0.8)

Conclusions

Using linked SNAP administrative data from the state of Missouri for older adults with Medicaid and pharmacy claims during 2006-2014, we investigated hypertension and diabetes prevalence, as well as medication non-adherence for the overall study group and by race, ethnicity, age, sex, citizenship, household size, geography and earned income. Prior literature has only used survey data for SNAP participation and on self-report of chronic diseases and medication non-adherence. As such, this is the first study to describe population level health of the older adult SNAP population and document prevalence of medication non-adherence for diabetes and hypertension.

While this study is descriptive, it contributes to the literature because there is a lack of understanding of chronic diseases in the older adult population of SNAP participants. Understanding these variables and trends, as well as associations with demographic factors can help policymakers and practitioners to better serve older adult SNAP participants.

A 2017 study by Yang and collaborators reports on prevalence of diabetes and hypertension in Medicare beneficiaries as well as medication non-adherence for these two diseases (Yang et al., 2017). we report a much higher prevalence of diabetes among the older adult SNAP population than among Medicaid beneficiaries in that study, and substantially higher levels of medication non-adherence related to both diabetes and hypertension, even though hypertension prevalence in our study population is similar to that reported by Yang et al.in the Medicaid population (Yang et al., 2017). However, that study uses all Medicare fee-for-service beneficiaries aged 66-79 years who were newly diagnosed with hypertension and started an antihypertensives medication program in 2008-2009. High rates of medication non-adherence have important implications for both patient health and state Medicaid budgets

because medication non-adherence has been associated with higher hospitalization and mortality rates among people with diabetes (Ho et al., 2006), and with high prevalence of acute cardiovascular events, high emergency department and hospitalization costs for those with hypertension (Yang et al., 2017).

Findings from this study highlight a need for targeted interventions towards the older adult SNAP subpopulations at risk for medication non-adherence. Medication adherence is essential to control chronic diseases and prevent avoidable hospitalizations and emergency room visits. Clearly this is an area of research that deserves further attention (Gellad etal., 2011; Krousel-Wood et al., 2011).

Research Question #3: Is there a relationship between SNAP and medication non-adherence among low-income Medicaid-insured older adults with chronic diseases?

Hypertension is one of the leading modifiable risk factors for cardiovascular disease, increases with age, and significantly contributes to morbidity and mortality in the US. This study investigates the relationship between hypertensive medication nonadherence and SNAP participation, duration, frequency, and stability as a potential preventive factor to decrease nonadherence. We control for demographic characteristics, and comorbidity index. Identifying the association between medication non-adherence and SNAP could guide interventions to improve disease management among this sub-population.

We hypothesize that SNAP participation and stability of SNAP participation is positively associated with medication adherence.

Data

We used the Missouri Medicaid administrative claims data linked to SNAP data from 2006 to 2014. The Medicaid claims data contained information on monthly Medicaid coverage, diagnosis, pharmacy claims and demographic characteristics of Medicaid-insured individuals. The SNAP data contained information on demographics and monthly SNAP benefit receipt. The study sample included older adults (60 years and older) who were continuously enrolled in Medicaid for 12 months following their first observed claim for hypertension at or after age 60. We restricted the sample to individuals who were continuously enrolled in Medicaid for 12 months because one of our outcomes of interest is medication adherence and the medical literature typically measures the proportion of days covered (that a person has access to their medication) over 365 days. The sample size was 69,823.

Variables and Analytical Strategy

Outcome. The outcome measure was medication adherence assessed using PDC (0= <80% PDC; 1=≥80% PDC).

*Independent variable*s. We had four independent variables of interest: 1) Ever received SNAP (0=no; 1=yes)[5]; 2) whether an individual who participated in SNAP received SNAP benefits during the 12-month Medicaid continuous enrollment post-hypertension diagnosis (0=no, 1=yes); 3) duration of SNAP participation during the 12-month continuous Medicaid enrollment post-hypertension diagnosis (1=≤3 months, 2=4-6 months, 3=7-9 months, 4=10-12 months); and 4) SNAP participation pattern (1= any SNAP receipt within six months prior to hypertension diagnosis and for at least 11 months following diagnosis, 2=no SNAP receipt prior to diagnosis but continuous receipt following diagnosis, 3=SNAP receipt for at least three continuous months in year following diagnosis, followed by no return to SNAP, 4=unstable SNAP participation=individuals who had intermittent SNAP participation that does not meet any of the previous definitions). For ease of interpretation, the SNAP participation variable is presented as follows: 1= *"always SNAP",* 2= *"onto SNAP"*, 3= *"off SNAP"*, 4= *"unstable SNAP".* Covariates were race, rural/urban residence, sex, age and Charlson comorbidity index score (CCI)-a weighted index that predicts ten-year mortality by accounting for the number and severity of comorbid diseases.

This study uses multivariate linear probability models to investigate the association between PDC and SNAP.

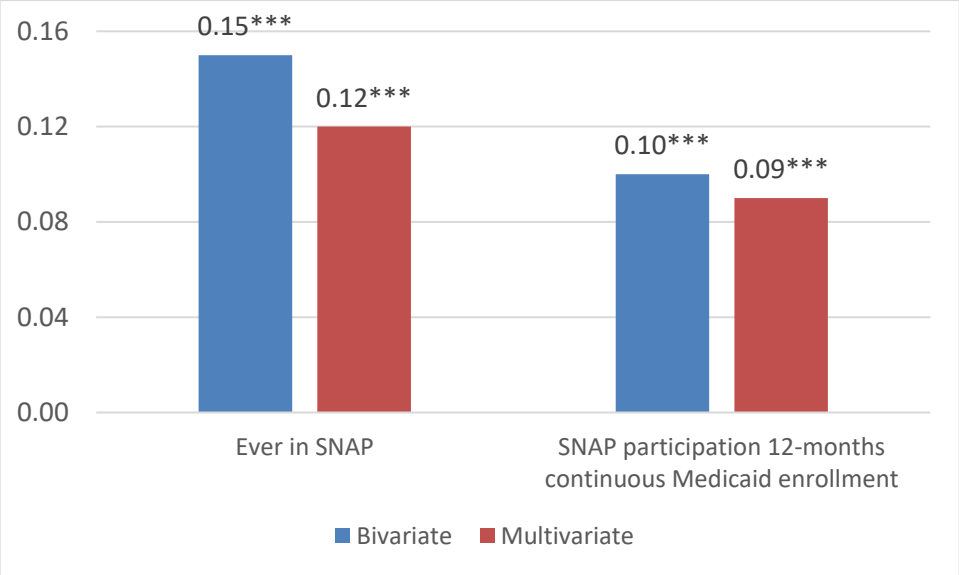
Results

Figure 6 shows coefficients of regression analyses of the association between ever being on SNAP during the study period and medication adherence, and being on SNAP during the 12

[5] Ever in SNAP means that an individual had been a SNAP participant at some point, but not necessarily during the 12-month continuous Medicaid enrollment period.

months continuous Medicaid enrollment and medication adherence. We observe that individuals who were ever on SNAP during the study period were more likely to be adherent to medications compared to non-SNAP beneficiaries. Among those who were ever on SNAP, based on bivariate analysis, there was an increased likelihood of medication adherence among those who were on SNAP during the 12-month continuous Medicaid enrollment compared to those who were not on SNAP during this period.

Figure 6: Association between SNAP Participation among Older Medicaid-Insured Individuals living with Hypertension and Medication Adherence

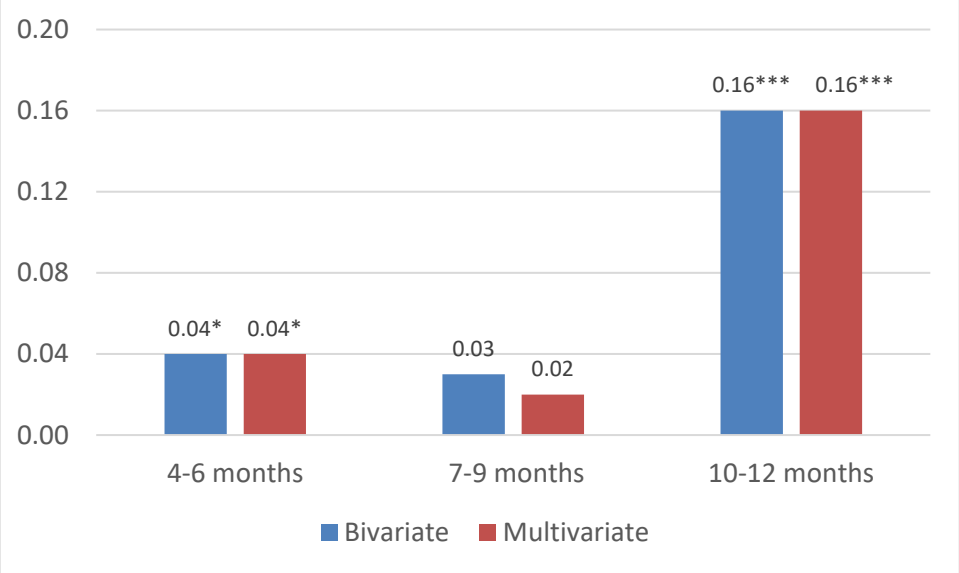


Note: Figure reports regression results for bivariate model (blue bar) and multivariate model (red bar). Multivariate models control for age, sex, race/ethnicity, residency, and Charlson comorbidity index.
Ever in SNAP bars report coefficients of linear probability regressions where the dependent variable is medication adherence, and the independent variable is ever on SNAP during the study period.
SNAP participation 12-months continuous Medicaid enrollment bars report coefficients of linear probability regression where the dependent variable is medication adherence, and the independent variable is SNAP participation during the 12-months continuous Medicaid enrollment.
Sample size for "ever on SNAP" regression is 69,823. Sample size for "SNAP participation 12-months continuous Medicaid enrollment" is 39,678.
*** $p<0.001$, ** $p<0.01$, * $p<0.05$

Figure 7 reports regression coefficients of duration on SNAP and medication adherence during the 12-months continuous enrollment. Compared to those who participated in SNAP for three months or less during the 12-month continuous Medicaid enrollment, there was an increased

likelihood of medication adherence among those who were enrolled in SNAP for 4 to 6 months or 10 to 12 months. The relationship between SNAP participation for 7 to 9 months and medication adherence was positive but not statistically significant (p>0.10).

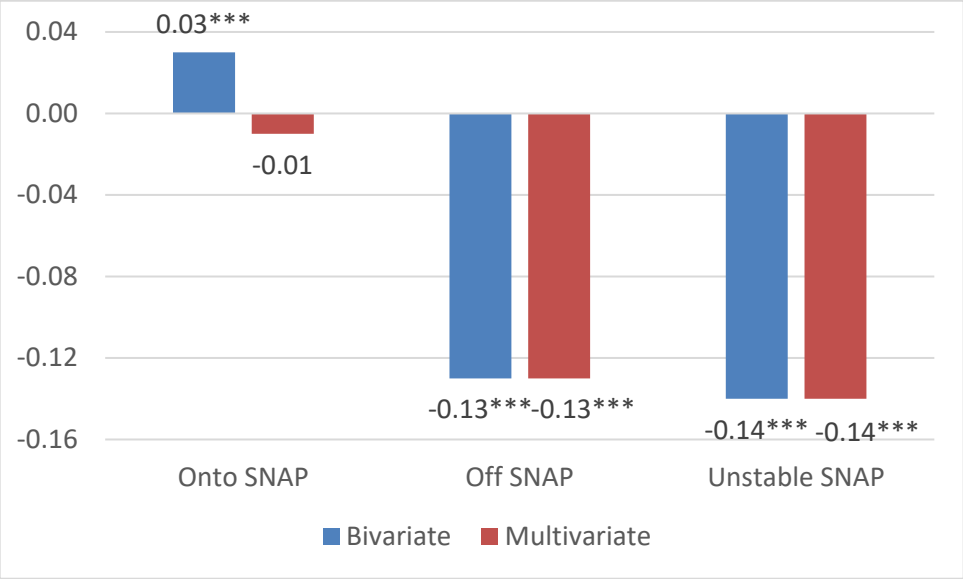
Figure 7: Regression Analyses of Medication Adherence and Months of SNAP Participation among Older Medicaid-Insured Individuals living with Hypertension (n=33,101)



Note: Figure reports regression results for bivariate model (blue bar) and multivariate model (red bar). Multivariate models control for age, sex, race/ethnicity, residency, and Charlson comorbidity index. Bars report coefficients of linear probability regressions where the dependent variable is medication adherence, and the independent variable is months of SNAP participation, where the reference category is 3 months or less of SNAP participation.
*** p<0.001, ** p<0.01, * p<0.05

Figure 8 presents results for pattern of SNAP participation. Individuals dropping off SNAP or with unstable SNAP have a lower likelihood of hypertension medication adherence than those who are consistently receiving SNAP (*always SNAP*).

Figure 8: Associations between Medication Adherence and Months of SNAP Participation Patterns among Older Medicaid-Insured Individuals living with Hypertension (n=33,347)



Note: Figure 8 reports regression results for bivariate model (blue bar) and multivariate model (red bar). Multivariate models control for age, sex, race/ethnicity, residency, and Charlson comorbidity index. Bars report coefficients of linear probability regressions where the dependent variable is medication adherence, and the independent variable is SNAP participation patterns, where the reference category is "always in SNAP".
*** p<0.001, ** p<0.01, * p<0.05

Conclusions

Overall, our study findings suggest that SNAP participation is positively associated with hypertension medication adherence. Importantly, not only did ever SNAP participation have a positive association with PDC, but so did having continuous participation (10-12 months). Clinical interventions that support SNAP enrollment among eligible patients may have the potential to reduce medication non-adherence among older low-income adults living with hypertension.

Research Question #4: Do changes in SNAP benefit size impact medication adherence and ER claims among hypertensive low-income older adults?

The effects of SNAP benefit size and impact on health and chronic disease management are important policy questions with broad implications for health and health equity, especially considering that 70% of older adults in the US have hypertension (Kulkarni et al., 2020). SNAP provides additional resources to low-income households to purchase food which may free up other household economic resources to purchase medication.

Previous research has examined the effects of changes in SNAP benefit size as a response to the Great Recession, but no research has focused on older adults (Nord, 2013; Kim, 2016; Kim, Rabbitt & Tuttle, 2020). The older adult population is unique. They have fewer financial resources, especially if they are low-income (Thompson & King, 2017). Additionally, the financial resources they may have are not as tangible (Thompson & King, 2017), and they are typically retired and cannot get additional resources from other sources like jobs or additional jobs. Finally, most older adults live alone or with only one other person. SNAP has special rules for adults age 60 and older that make it easier to qualify for benefits and remain enrolled in the program. For instance, households that consist entirely of elderly (or disabled) members are not subject to work requirements. Additionally, in some States, certification periods for the elderly (or disabled) are longer, typically lasting 24 or 36 months, rather than the standard 6 or 12 months.

Our evaluation of the effect of the SNAP benefit increase during the Great Recession is of particular policy interest right now, given the October 2021 update to the Thrifty Food Plan, which increased SNAP benefit allotments. This evaluation seeks to understand how a SNAP benefit increase will affect medication adherence and emergency department (ED) visits for diabetes and hypertension among the older adult population.

We examined if increases in SNAP benefit size ($24 for a 1-person household) due to the American Recovery and Reauthorization Act (ARRA) in April 2009 affected hypertension claims, hypertension-related ED visits, and hypertension medication non-adherence for older adults (≥60 years) (n=43,269 individuals; 1,038,46 claims). This study contributes to the literature as, for the first time, we study the effects of changes in SNAP benefit size due to ARRA for the older adult population using administrative data.

Conceptual Framework

This study aims to explore the relationship between SNAP participation and medication non-adherence and ED claims and hospitalizations for hypertension and diabetes. To answer these questions, we rely on a neoclassical economic theoretical framework. Specifically, we draw on the Southworth hypothesis (Southworth, 1945), which states that inframarginal households (i.e., those who spend more on food than what they receive in benefits) treat an in-kind benefit, in our case SNAP benefits, in the same way as they treat a cash transfer. In other words, households treat receiving SNAP benefits as if they were receiving additional income. That means that after receiving SNAP benefits, households will purchase more food and nonfood goods. This theoretical framework allows us to investigate how SNAP participation, as well as changes in SNAP benefit size (which increased after ARRA implementation and decreased after ARRA expiration), affect purchasing non-food goods (i.e., prescription medication), and the implications for health care utilization for treatment of hypertension and diabetes.

Data

We used Missouri Department of Social Service administrative SNAP data merged with Medicaid enrollment, claims, and pharmacy data from January 2008 to December 2009. Our treatment group is composed of 19,599 individuals who were age 60 or older, who had a diagnosis of hypertension prior to our study period, and who were continuously enrolled in SNAP and

Medicaid from January 2008 to December 2009[6]. We require enrollment for the whole period to ensure that the comparison across time periods is not biased by including individuals who became eligible for SNAP due to economic conditions at the time of the ARRA benefit increase. By focusing on those who were already in SNAP prior to the ARRA, we are more confident that we can separate the effects of SNAP from the characteristics of individuals that might be associated with certain health behaviors and outcomes. By focusing on those who were already in SNAP prior to the ARRA, we are more confident that we can separate the effects of SNAP from the characteristics of individuals that might be associated with certain health behaviors and outcomes. Our comparison group is composed of 23,670 individuals who were age 60 or older, had a diagnosis of hypertension, continuously enrolled in Medicaid, and did not receive SNAP during our study period. Our goal was to examine the effect on those who were already in SNAP, so our main analysis only included individuals who were continuously observed from January 2008 to December 2009. Our sample consists of 43,269 individuals age 60 and older who continuously participated in SNAP during the study period. We observed 824,396 person-months Medicaid monthly claims during this time period.

Empirical Strategy

The present study uses administrative SNAP and Medicaid data. We found 95% of SNAP participants in the Medicaid enrollment and claim data. We matched our treatment group, SNAP participants, with Medicaid participants who were not in SNAP but were similar based on the Charlson comorbidity index, geographic location (urban area), and basic demographic characteristics such as age, sex, household size, income, race, and ethnicity. The Charlson

[6] Individuals were diagnosed with hypertension prior to the study period because we examined a benefit increase on treatment compliance for those who are already managing hypertension.

comorbidity index is used to predict mortality for patients who may have a range of comorbidity conditions out of a total of 22 conditions, such as liver disease, heart disease, AIDS, and cancer (Charlson et al., 1987).

In a first stage, we predict the probability of being enrolled in SNAP and then use this estimated probability as a weight in a second stage, where we run our difference-in-difference model. By assigning individuals a larger (or smaller) propensity score weight if their SNAP participation status is underrepresented (or overrepresented) given the covariates, this method reweights the sample so that individuals with higher estimated probability of receiving SNAP are given smaller weights. Similarly, individuals are assigned larger weights if individuals have smaller estimated probabilities.

In the second stage, we estimate a difference-in-difference model to compare the outcomes of the treated group, SNAP recipients, before and after ARRA implementation/expiration (first difference) to the outcomes of the control group, non-SNAP recipients, before and after ARRA implementation (second difference), as follows:

$$med\_adherence_{it}^{J} = \alpha_i + \beta_1 Post_t + \beta_2 SNAP_i \; x \; Post_t + \beta_3 X_{it} + \gamma_t + \delta_m + \theta_y + \mu_{it} \quad (1)$$

where *med_non-adherence*$_{it}$ represents the share of month with prescribed antihypertensives medication on hand, for panel J (either panel 1 that compares before and during ARRA or panel 2 that compares during ARRA with after ARRA expiration), for individual *i* in period *t*. *P*ost$_t$ takes a value of 0 in the pre-ARRA implementation/expiration period and 1 in the post-policy periods; SNAP$_i$ takes a value of 1 if individual $_i$ is a SNAP recipient, and 0 otherwise; X$_{it}$ represents individual characteristics that vary over time; γ_t is the period claim for each individual and allows identification to stem from within individual variation over claim periods; δ_m and θ_y are calendar month and year fixed effects to control for seasonality and any unobserved macroeconomic conditions, respectively; and μ_{it} represents idiosyncratic error. Our coefficient of interest is β_2,

which indicates the average effect of increase in SNAP benefit size (ARRA implementation)/ decrease in SNAP benefit size (ARRA expiration) on medication non-adherence[7].

Similarly, we estimate equation (2)

$$Emergencies_{it}^{KJ} = \alpha_i + \beta_1 Post_t + \beta_2 SNAP_i \; x \; Post_t + \beta_3 X_{it} + \gamma_t + \delta_m + \theta_y + \mu_{it} \quad (2)$$

where $emergencies_{it}$ present ED and hospitalization claims for condition *K* (hypertensive emergencies), panel *J* (either panel 1 that compares before and during ARRA or panel 2 that compares during ARRA with after ARRA expiration), for individual *i* in period *t*. All other variables are the same as in equation (1) and our coefficient of interest is β_2.

For equations (1) and (2) we use the propensity score estimated in step (1) as a weight in our regressions. This method is known as the difference-in-difference matching approach. We use this method to evaluate the effect of SNAP benefit size on our outcomes of interest. The difference in difference approach enables control by unobserved constant characteristics because the same individuals are evaluated before and after the changes in ARRA.

This approach enables identification of the group of SNAP participants as the treated group and selects another group that, although satisfying the eligibility conditions given that older adults participate in Medicaid, didn't receive SNAP. The latter group is the "eligible group". These two groups consist of different people and therefore have different observable and unobservable characteristics that must be controlled in the study. The matching (propensity score) method allows us to reweight the sample such that the SNAP participants (treatment group) and non-SNAP participants (comparison group) are similar in observable characteristics to each other. The difference in difference approach also enables control by non-observable characteristics that may

[7] One challenge to identifying the effect of ARRA is that there is overlap with the implementation of the ACA. Our main specification limits the sample to those on SNAP both before and after the ARRA and uses a dummy variable to identify the period of ACA implementation.

affect the SNAP and non-SNAP groups in different ways that, if not controlled for, can bias the apparent effect of the treatment.

Results

Table 3 shows descriptive statistics for individuals in the sample that we continuously observe during the study period prior to using a propensity score technique. Because we observe data for these individuals during the whole study period the share of month with prescribed antihypertensives medication on hand is very high (95.72), although the standard deviation is high too (17.69). Hypertension claims are also high (92%), but ER claims are lower (40%). The SNAP and non-SNAP group look very similar in terms of average values for the outcomes. For the covariates, we observe a higher proportion of Whites in the non-SNAP group (81%) than the SNAP group (71%), a higher proportion of males in the non-SNAP group (31%) than the SNAP group (25%), and a higher proportion of 80 and older adults in the non-SNAP group (41%) than the SNAP group (15%).

Table 3: Descriptive Statistics

	ALL (n=43,269)		SNAP (n=19,599)		Non-SNAP (n=23,670)	
Variables	Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev.
Medic. Adherence[1]	95.719	17.689	96.361	16.250	95.183	18.792
Hypertension Claims	0.925	0.263	0.943	0.232	0.913	0.282
ER claims	0.395	0.489	0.393	0.489	0.396	0.489
White	0.769	0.422	0.706	0.455	0.811	0.391
Black	0.184	0.387	0.225	0.417	0.156	0.363
Asian	0.011	0.067	0.019	0.083	0.006	0.052
Other	0.001	0.019	0.001	0.022	0.001	0.016
unknown	0.035	0.184	0.049	0.215	0.026	0.158
Male	0.288	0.453	0.250	0.433	0.313	0.464

Female	0.712	0.453	0.750	0.433	0.687	0.464
60-64	0.203	0.402	0.281	0.449	0.138	0.345
65-69	0.188	0.391	0.237	0.425	0.148	0.355
70-79	0.315	0.465	0.328	0.470	0.304	0.460
80+	0.294	0.456	0.154	0.361	0.410	0.492
Rural	0.439	0.496	0.450	0.498	0.431	0.495
Urban	0.561	0.496	0.550	0.498	0.569	0.495
Comorbidity Index	2.637	2.333	2.367	2.221	2.820	2.389

Note: [1] Medic. Adherence= share of month with prescribed antihypertensives medication on hand.

To control for the differences in observed characteristics shown in Table 3, we used a propensity score approach. We aim to make the SNAP group comparable to the non-SNAP group. Thus, we first estimate the probability (propensity) to participate in SNAP. Table 4 shows that comorbidity is negatively associated with SNAP participation, being Black relative to White, Asian relative to White, and of an unknown race relative to White is positively associated with SNAP participation. Being female relative to male is positively associated with SNAP participation. Finally, living in an urban area relative to rural area, and being older than 65 years of age relative to 60 to 64 years of age is negatively associated with SNAP participation.

Table 4: Estimated Probability of SNAP Participation

Prob (SNAP participation)	Coef.	S.E.	z	P>z
Comorbidity Score				
1	-0.045	0.021	-2.17	0.030
2	-0.183	0.021	-8.52	<0.001
3	-0.263	0.023	-11.66	<0.001
4	-0.266	0.025	-10.57	<0.001
5	-0.321	0.029	-11.19	<0.001
6	-0.425	0.034	-12.44	<0.001
7	-0.444	0.042	-10.67	<0.001
8	-0.529	0.054	-9.77	<0.001
9	-0.400	0.061	-6.60	<0.001
10	-0.427	0.086	-4.97	<0.001
11	-0.412	0.119	-3.45	0.001
12	-0.474	0.164	-2.89	0.004
13	-0.538	0.208	-2.59	0.010
14	-0.673	0.305	-2.21	0.027
15	-0.229	0.370	-0.62	0.535
16	0.426	0.502	0.85	0.396
17	-0.635	0.571	-1.11	0.267
18	-0.024	0.854	-0.03	0.978
Race (Base: White)				
Black	0.404	0.017	23.31	<0.001
Asian	0.882	0.065	13.51	<0.001
Pacific Islander	0.499	0.306	1.63	0.103
Multiple Races	0.190	0.324	0.59	0.558
Unknown	0.499	0.035	14.21	<0.001
Sex (Base: Male)				
Female	0.240	0.015	16.28	<0.001
Age category (Base: 60-64)				
65 to 69	-0.167	0.020	-8.45	<0.001
70 to 80	-0.428	0.018	-24.15	<0.001
Urban area	-0.162	0.014	-11.92	<0.001
Constant term	0.346	0.023	14.79	<0.001

Note: We used a probit model

Next, we use the predicted probability of SNAP participation (propensity scores) conditioned on the covariates as weights in our difference in difference regression. Results from the difference-in-difference matching approach are presented in Table 5.

Table 5: Effects of Changes in SNAP Benefit Size

	Share of month with prescribed antihypertensives medication on hand			Hypertension Claims			Hypertension ER claims		
	Coef.	Std. Err.	P>t	Coef.	Std. Err.	P>t	Coef.	Std. Err.	P>t
Post	2.019	0.313	0.000	0.012	0.003	0.000	0.003	0.001	0.000
SNAP	6.287	0.377	0.000	-0.037	0.004	0.000	0.006	0.001	0.000
*SNAP*Post*	*5.034*	*0.442*	*0.000*	*-0.002*	*0.005*	*0.691*	*0.001*	*0.001*	*0.451*
Month cat (base=1)									
2	-2.268	0.152	0.000	-0.011	0.003	0.000	-0.001	0.001	0.413
3	-4.326	0.177	0.000	0.003	0.003	0.261	0.002	0.001	0.203
4	-5.411	0.221	0.000	0.007	0.003	0.031	-0.005	0.001	0.000
5	-4.327	0.223	0.000	-0.033	0.003	0.000	-0.008	0.001	0.000
6	-2.029	0.222	0.000	-0.006	0.003	0.032	-0.008	0.001	0.000
7	-1.703	0.222	0.000	0.001	0.003	0.814	-0.004	0.001	0.003
8	-0.367	0.224	0.102	-0.002	0.003	0.443	-0.006	0.001	0.000
9	-0.948	0.233	0.000	0.005	0.003	0.072	-0.005	0.001	0.000
10	0.567	0.239	0.018	0.013	0.003	0.000	-0.003	0.001	0.012
11	0.983	0.233	0.000	-0.010	0.003	0.000	-0.005	0.001	0.000
12	1.485	0.231	0.000	-0.016	0.003	0.000	-0.004	0.001	0.003
Year=2009	2.728	0.240	0.000	0.020	0.002	0.000	0.000	0.001	0.953
Black	-5.465	0.523	0.000	0.083	0.005	0.000	0.011	0.001	0.000
Asian	-4.694	2.267	0.038	-0.064	0.017	0.000	-0.012	0.003	0.000
Pacific Islander	-12.304	8.789	0.162	-0.096	0.075	0.202	-0.018	0.009	0.051
Multiple Races	-4.909	8.412	0.560	-0.049	0.050	0.334	0.002	0.014	0.887
Unknown	-4.680	1.115	0.000	0.017	0.011	0.114	-0.001	0.002	0.448
Female	1.400	0.437	0.001	0.015	0.005	0.001	0.002	0.001	0.036
Age in 2007									
65 to 69	-1.489	0.550	0.007	0.004	0.005	0.510	-0.002	0.001	0.082
70 to 80	-1.847	0.489	0.000	0.050	0.005	0.000	-0.002	0.001	0.122
80+	-3.248	0.549	0.000	0.125	0.006	0.000	0.001	0.001	0.227
Urban Area	-5.596	0.389	0.000	-0.004	0.004	0.356	0.005	0.001	0.000
Comorbidity Index	-0.022	0.078	0.781	0.026	0.001	0.000	0.005	0.000	0.000
Constant term	71.203	0.623	0.000	0.297	0.007	0.000	0.015	0.001	0.000

Note: $Post_t$ takes a value of 0 in the pre-ARRA implementation/expiration period and 1 in the post-policy periods.
$SNAP_i$ takes a value of 1 if individual $_i$ is a SNAP recipient, and 0 otherwise.

Our preliminary analysis suggests that changes in SNAP benefit sizes had a positive effect

on share of month with prescribed antihypertensives medication on hand, but not on hypertension claims or hypertension ER claims. These results were robust by sex, age in 2007, and urbanicity. We also ran models in which we interacted SNAP participation with every single month to investigate if there was a "jump" / discontinuity on April 2009 and we did not observe a significant effect on the interaction of SNAP with April 2009 with PDC, hypertension claim or hypertension ER claim. Additional tables and figures will be presented in the final report.

Conclusions

Using a difference-in-difference matching approach, we found an effect of changes in SNAP benefit sizes on medication adherence, but not on hypertension claim, hypertension ER claim. These results were robust to analytical approaches, samples, and subgroups.

These preliminary results shed light on important policy issues. While prior literature has shown that a small increase in SNAP benefits is associated with an increase in food expenditure, non-food expenditure and a reduction in food security (Kim, 2016; Nord & Prell, 2011), these studies did not specifically examine older adults, but overall SNAP households. Interestingly, when a study examined the effects of an increase in SNAP benefit size on food security and diet quality for youths, no effects were found (Hudak, Racine, Schulkind, 2021). Our study showed that a small increase in SNAP benefit increased medication adherence but did not reduce hypertension claims in older adults. Future research should examine whether larger increases in SNAP benefits, like the changes experienced during the pandemic, have similar effects. During the pandemic, SNAP benefits were boosted for every household to the maximum benefit for their household size (USDA, 2021). This meant an average increase of at least $75 per month, $115 per month, and $138 per month, for a 1-person, 2-person, and 3-person household, respectively (Center on Budget and Policy Priorities, 2022).

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