Cost-Related Medication Nonadherence for Older Adults Participating in SNAP, 2013–2015

Mithuna Srinivasan, PhD, and Jennifer A. Pooler, MPP

Objectives. To estimate the impact of Supplemental Nutrition Assistance Program (SNAP) participation on cost-related medication nonadherence (CRN) for older adults in the United States, with a particular focus on those who are food insecure and those threatened by hunger.

Methods. We used propensity score matching to create matched intervention and comparison groups of SNAP-eligible US adults aged 60 years and older with data from the 2013–2015 National Health Interview Survey. Intervention group participants were identified on the basis of self-reported SNAP participation in the past year.

Results. SNAP participants were 4.8 percentage points less likely to engage in CRN than eligible nonparticipants (*P* < .01). The effect of SNAP is about twice as large for older adults threatened by hunger (9.1 percentage points; *P* < .01), and considerable even for those who are food insecure (7.4 percentage points; *P* < .05).

Conclusions. Findings point to a spillover "income effect" as SNAP may help older adults better afford their medications, conceivably by reducing out-of-pocket food expenditures. When prescribing treatment plans, health systems and payers have a vested interest in connecting older patients to SNAP and other resources that may help address barriers to care. (*Am J Public Health.* 2018;108:224–230. doi:10.2105/AJPH.2017.304176)

See also Kennedy, p. 168; and also Galea and Vaughan, p. 171.

The adverse effect of medication non-adherence on health care costs, utilization, and hospitalizations, and individuals' health outcomes has been well established.[1,2] One study estimated the direct cost of medication nonadherence to be $105.8 billion in 2010 for adults with diabetes, hypertension, or dyslipidemia.[3] Another study found that improving medication adherence results in cost savings through reduced hospitalizations and emergency department use, especially for older adults with chronic conditions.[4]

One of the primary reasons older adults do not adhere to treatment regimens is their inability to afford prescription medication. Cost-related medication nonadherence (CRN) can include skipping or stopping medications because of cost, taking smaller doses to save money, or delaying or forgoing filling a prescription because of cost. Prescription drug coverage is an important protective factor against CRN.[5,6] Even with high rates of prescription drug coverage among this population, however, some researchers have estimated that more than 1 in 5 adults aged 65 years and older still engage in CRN-related behaviors at some point during the course of a year.[7,8]

Low-income individuals may forgo basic needs when faced with high health care costs.[9,10] The tradeoff between medication and other necessities may be especially acute in vulnerable households that cannot afford enough food to eat. The proportion of older adults facing the threat of hunger (those who are marginally food secure or food insecure) increased by 47% between 2001 and 2014.[11] At the same time, food insecurity (having limited or uncertain access to enough foods to maintain an active and healthy lifestyle)[12] also increased among older adults living alone: from 6.1% in 2001 to 9.2% in 2015.[12,13]

Not only has food insecurity been identified as an independent risk factor for engaging in CRN, but older adults threatened by hunger are also more likely to engage in at least 1 CRN behavior in the previous year.[7,14,15] Afulani et al. found that, compared with fully food secure older adults, the odds of CRN ranged from being twice as likely for the marginally food secure to 9 times more likely for those with very low food security.[7]

The Supplemental Nutrition Assistance Program (SNAP) is a food safety net program that provides a cash-like benefit to low-income households to purchase food with an electronic benefit card. In addition to alleviating hunger, SNAP may help eligible older adults better afford their prescription medications by reducing out-of-pocket costs for food. A small body of research has controlled for SNAP participation in analyses of CRN, but SNAP participation was not a focal variable. For example, Berkowitz et al. used the National Health Interview Survey (NHIS) to examine the relationship between CRN and food insecurity for the general population of adults with chronic conditions. Interestingly, the authors found that SNAP participation was associated with higher odds of both CRN and food insecurity.[16] However, they considered all adults and not only those who were low-income and eligible for SNAP, which may mask the true impact of SNAP participation on CRN.

To the best of our knowledge, our study is the first to rigorously examine the spillover "income effect" on CRN that may occur from participating in SNAP by matching participants with eligible nonparticipants.

ABOUT THE AUTHORS

At the time of this study, the authors were with IMPAQ International, Washington, DC.

Correspondence should be sent to Mithuna Srinivasan, PhD, IMPAQ International, 1101 Vermont Ave NW, Washington, DC 20005 (e-mail: mithunasrinivasan@gmail.com). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

Spillover effects signify potential indirect effects or unintended consequences of a program that extend beyond its primary goal. In the current context, the main goal of SNAP is to alleviate food insecurity, yet SNAP may have an additional or spillover income effect by increasing the amount of an older adult's income that may be spent on medication. Accounting for both the direct and indirect consequences of a program such as SNAP is important to assess its true potential or impact.[17] The purpose of this study is 2-fold:

1. To examine whether and to what extent participation in SNAP is associated with a lower likelihood of CRN among older adults (aged 60 years and older), and
2. To examine the extent of this relationship for 2 subgroups of older adults: those threatened by hunger and those who are food insecure.

Although the relationship between CRN and SNAP participation has not been looked at systematically for any age group, the older adult population is an especially relevant group to consider for this study because of their exceptionally low rates of SNAP participation—only 4 in 10 eligible adults aged 60 years and older participate in SNAP.[18] Older adults for this study included those aged 60 years and older because that is the threshold for SNAP participation under special rules for the elderly. Furthermore, older adults who are food insecure or threatened by hunger are of particular interest because they likely live on fixed incomes, have higher rates of chronic disease, and could face additional health-related consequences such as malnutrition because they lack access to adequate nutritious foods.[16,19]

METHODS

In the study, we used data from the 2013–2015 NHIS, an annual, cross-sectional survey of the US civilian noninstitutionalized population. NHIS data were extracted from the Integrated Public Use Microdata Series Health Surveys.[20] The NHIS is especially suitable for this analysis because it provides a large representative sample of older adults, has information on key variables of interest (CRN, SNAP participation, and food security), and has rich data on individual- and household-level characteristics.

The calculation of a household's SNAP eligibility was a critical component of the study. A household with a person aged 60 years or older or a person who is receiving certain types of disability payments must meet a net income test to be eligible for SNAP.[21,22] A household's net income was calculated by subtracting allowable deductions from a household's gross income—namely, the SNAP earned income deduction (20% of household income), the standard deduction (based on household size), and the monthly average out-of-pocket medical costs reported for the past 12 months.[23] Although shelter deductions are also used to determine SNAP eligibility, NHIS lacked those data, and so a slightly more conservative estimate of SNAP eligibility was calculated. Older adults' net income was then compared with the net income thresholds published by the US Department of Agriculture, Food and Nutrition Service, for households with adults aged 60 years and older.

Our final analytic sample included adults aged 60 years and older who were eligible for SNAP, who were prescribed medication in the 12 months before the survey, and who lived alone or in households with other older adults (to reduce error when calculating SNAP eligibility).

For the 2 subgroup analyses, we imposed additional restrictions by excluding households that were not facing the threat of hunger and who were not food insecure, respectively. We derived food security status from the 10-item US Adult Food Security Survey Module. First, we categorized respondents as fully food secure or threatened by hunger in the past 30 days. A response of "never true" to each question identified a household as fully food secure. Households were considered marginally food secure if they responded "sometimes true" or "often true" to 1 or 2 questions, and those who responded "sometimes true" or "often true" to 3 or more questions were categorized as food insecure.[24] The categorization of older adults facing the threat of hunger used in this analysis and in previous studies was less strict than the standard definition of food insecure and included both marginally food secure and food insecure households.[11]

Measures and Specifications

Outcome. The NHIS asks individuals whether they engaged in specific CRN behaviors in the past 12 months, including whether they (1) delayed refilling a prescription to save money, (2) skipped medication doses to save money, and (3) took less medication to save money. These validated measures[25] have been used in several previous studies.[2,7,8,10,16,26] Our outcome of interest was a binary variable indicating whether the individual engaged in at least 1 of these 3 CRN behaviors.

Treatment and comparison groups. Our key explanatory variable was an indicator for the treatment group, in which we assigned those participating in SNAP a value of 1 and eligible nonparticipants a value of 0. Because our analytic sample comprised only older adults eligible for SNAP, we assigned the values on the basis of whether the respondent reported SNAP participation in the past year.

Other explanatory variables. Following the literature, we included a number of important predictors of an individual's CRN.[5,7,8,16,26] Demographic characteristics included categories for age (60–64, 65–69, and 70–74, vs ≥ 75 years), gender, race (White vs all other races), Hispanic ethnicity, US citizenship, single or living alone (vs married with a spouse present or cohabiting), education (college degree or higher vs less education), and geographic region (South vs all other regions). Socioeconomic characteristics included being employed, the natural logarithm of per capita income, and being fully food secure in the past 30 days (vs being threatened by hunger). Health characteristics included self-reported health status (fair or poor vs good, very good, or excellent), having any nutrition-related chronic condition (heart disease, diabetes, or stroke), and having any functional limitations. We created a 3-category health insurance coverage variable to indicate older adults with no insurance, health insurance without prescription drug coverage, or health insurance with prescription drug coverage: health insurance could be public or private, and prescription drug coverage included private plans, Medicare Part D, or Medicaid. We also included an indicator for any out-of-pocket medical costs in the past year.

Statistical Analysis

Propensity score matching is a statistical method that involves the construction of a comparison group equivalent to the treatment group in terms of observable characteristics. The propensity score is the probability of the individual receiving the intervention (in this case, SNAP), given his or her demographic and other characteristics. Propensity scores may be estimated by using logistic regression models in which intervention assignment is the dependent variable, and individual characteristics are independent variables. Predicted probabilities from this model are the propensity scores that can be used to match intervention and comparison participants, such that the final samples of members in the 2 groups have similar propensities for treatment. We employed a doubly robust propensity score matching estimation method by using the 2 steps described in the next paragraphs.[27] We conducted all analyses with Stata version 14 (StataCorp LP, College Station, TX).

Matching procedure. We used a logistic regression model to estimate the probability of being a SNAP participant (propensity score). We chose covariates in the participation equation such that they influenced simultaneously engaging in CRN and the decision to participate in SNAP, but should not be affected by SNAP participation itself. We included all the demographic, socioeconomic, and health-related characteristics described previously, except for food security status, owing to the well-established relationship between SNAP participation and food security.

We used radius matching with replacement to match SNAP participants with eligible nonparticipants on their propensity scores. Radius matching uses all observations within a caliper (i.e., a maximum tolerance level that the maximum propensity score distance between the 2 groups cannot exceed). We used a caliper of 0.2 standard deviations of the mean propensity score, which is the recommended rule of thumb.[28] We conducted the matching thrice—first for the sample of all older adults, then for subsamples of older adults threatened by hunger and for older adults experiencing food insecurity. We retained observations that fell within the region of common support (that is, where the

propensity scores of the treatment and comparison groups overlap). The estimation results from the first stage are shown in Table A (available as a supplement to the online version of this article at http://www.ajph.org).

For each of the matched samples, we conducted a *t* test that indicated that the treatment and comparison groups were balanced on the included covariates. We also assessed matching quality in other ways, including graphical distributions of the propensity scores of the treatment and comparison groups, a standardized bias test, and a likelihood ratio test for the joint equality of covariate means between the treatment and comparison groups. The results of these additional tests are shown in Figures A and B and Tables C and D (available as supplements to the online version of this article at http://www.ajph.org).

Estimates of association. Within the matched sample of all older adults, we estimated the effect of SNAP participation on CRN by using a Probit regression model that

TABLE 1—Characteristics of All SNAP-Eligible Older Adults in Treatment and Comparison Groups, Before and After Matching: United States, 2013–2015

Characteristics	Before Matching		After Matching	
	Treatment Group (n = 2215), %	Comparison Group (n = 4790), %	Treatment Group (n = 1791), %	Comparison Group (n = 3408), %
Demographic characteristics				
Age, y				
60–64	27.8**	16.2	27.6	26.9
65–69	25.9**	19.2	25.9	26.1
70–74	18.8	17.6	18.8	19.7
Male	30.5**	35.7	30.5	31.3
White	46.9**	62.1	46.9	46.1
Hispanic	19.9**	13.9	19.9	19.8
US citizen	95.5	95.7	95.5	95.0
Single or living alone	91.9**	82.5	91.9	91.8
Education: bachelor's degree or higher	8.5	9.6	8.5	9.1
Residing in the South	38.8	39.2	38.8	38.4
Socioeconomic characteristics				
Employed	3.3**	8.9	3.3	3.6
Per-capita income[a]	9.1**	9.2	9.1	9.1
Fully food secure	53.9**	79.6	53.2**	79.4
Health- and health care–related characteristics				
In fair or poor health	49.1**	33.8	49.1	48.6
Have any functional limitation	84.8**	74.3	84.8	84.2
Have any nutrition-related chronic condition	55.6**	47.3	55.7	55.5
Have any health insurance with prescription drug coverage	82.7**	67.1	82.7	82.1
Have any health insurance without prescription drug coverage	13.7**	27.7	13.6	13.9
Have > $0 in out-of-pocket medical costs	69.9**	80.9	70.0	69.6

Note. SNAP = Supplemental Nutrition Assistance Program. Statistics for the reference categories are not provided.

[a]Natural log.

*P < .05; **P < .01.

included the treatment indicator and all other predictors of CRN described previously. We ran similar regression models for the matched samples of individuals threatened by hunger and food-insecure individuals.

The estimated coefficient on the SNAP indicator captures the population average treatment effect (PATE).[29] The PATE is the estimate of the program impact for the survey's target population, and is usually the policy parameter of interest. In the current setting, the PATE is the average difference in CRN between SNAP participants and eligible nonparticipants. We estimated the PATE by incorporating survey weights in the first and second stages of the propensity score matching analysis. Specifically, we used the survey weight as a predictor in the participation model (first stage). Then, to increase the comparability between the 2 groups and make estimates to be generalizable to the target population, the second stage is weighted by the product of the survey weight and propensity score weight (proportional to the number of times each comparison group observation was matched to a treatment group observation).

RESULTS

Table 1 shows the means of covariates before and after matching for the sample of all older adults. Before matching, the treatment and comparison groups differed significantly on several characteristics. For example, a smaller share of SNAP participants were male, compared with the pool of eligible nonparticipants. SNAP participants were also more likely to have insurance with prescription drug coverage.

After matching, there were 1791 older adults in the treatment group and 3408 in the comparison group: 81% of the treatment group and 71% of the comparison group were included in the matched sample. In all, 11.5% of the matched sample engaged in CRN in the past year and more than one third participated in SNAP (34.5%; data not shown). Matching resulted in highly comparable treatment and comparison groups, such that the difference between means was not statistically different for any of the characteristics. Food security status differed between the treatment and comparison groups both before

and after matching because this was not used as a matching variable.

Matching also resulted in highly comparable treatment and comparison groups for older adults threatened by hunger and those who were food insecure (Tables 2 and 3, respectively). In the matched subgroups, more than 90% of older adults were living alone or experiencing functional limitations, more than 80% had health insurance

with prescription drug coverage, and nearly three quarters had out-of-pocket medical costs.

CRN and Program Participation

Table 4 presents the results of the second-stage Probit regression model, showing the association between CRN and SNAP participation for the complete matched sample and

TABLE 2—Characteristics of SNAP-Eligible Older Adults Threatened by Hunger in Treatment and Comparison Groups, Before and After Matching: United States, 2013–2015

Characteristics	Before Matching		After Matching	
	Treatment Group (n = 1020), %	Comparison Group (n = 972), %	Treatment Group (n = 836), %	Comparison Group (n = 698), %
Demographic characteristics				
Age, y				
60–64	34.3**	27.3	34.2	34.6
65–69	27.4	25.7	27.4	26.8
70–74	16.7	18.0	16.7	17.7
Male	29.5**	35.9	29.5	28.8
White	46.4	49.3	46.3	46.4
Hispanic	18.0	16.7	18.1	18.5
US citizen	95.8	94.9	95.8	95.6
Single or living alone	92.2**	86.6	92.2	91.5
Education: bachelor's degree or higher	8.8	9.0	8.8	10.4
Residing in the South	40.1	44.4	40.2	40.2
Socioeconomic characteristics				
Employed	2.6**	8.0	2.6	2.6
Per-capita income[a]	9.1**	9.2	9.1	9.1
Health- and health care–related characteristics				
In fair or poor health	55.9*	51.0	55.9	56.1
Have any functional limitation	91.3**	87.4	91.3	89.4
Have any nutrition-related chronic condition	58.9	58.4	58.9	57.1
Have any health insurance with prescription drug coverage	82.8**	66.9	82.8	81.4
Have any health insurance without prescription drug coverage	13.0**	25.8	13.0	13.9
Have > $0 in out-of-pocket medical costs	71.6**	81.1	71.6	70.8

Note. SNAP = Supplemental Nutrition Assistance Program. Statistics for the reference categories are not provided.
[a]Natural log.
*P < .05; **P < .01.

TABLE 3—Characteristics of Food-Insecure SNAP-Eligible Older Adults in Treatment and Comparison Groups, Before and After Matching: United States, 2013–2015

Characteristics	Before Matching		After Matching	
	Treatment Group (n = 721), %	Comparison Group (n = 595), %	Treatment Group (n = 581), %	Comparison Group (n = 427), %
Demographic characteristics				
Age, y				
60–64	36.0	32.1	36.1	34.5
65–69	28.7	25.6	28.4	28.5
70–74	17.4	18.8	17.6	17.5
Male	30.8**	37.9	30.9	31.1
White	47.0	45.1	47.3	48.7
Hispanic	16.4	17.7	16.3	15.7
US citizen	95.9	95.1	96.2	96.2
Single or living alone	92.6*	88.8	92.6	90.4
Education: bachelor's degree or higher	8.8	9.7	8.9	9.1
Residing in the South	41.5	45.1	41.6	41.3
Socioeconomic characteristics				
Employed	2.4**	7.4	2.4	2.5
Per-capita income[a]	9.1**	9.2	9.1	9.1
Health- and health care–related characteristics				
In fair or poor health	59.2	57.4	59.4	58.1
Have any functional limitation	91.9**	87.2	91.7	91.3
Have any nutrition-related chronic condition	61.1	61.6	61.6	62.1
Have any health insurance with prescription drug coverage	83.1**	65.1	82.8	81.1
Have any health insurance without prescription drug coverage	13.2**	26.3	13.4	15.4
Have > $0 in out-of-pocket medical costs	73.8**	82.1	74.2	73.5

Note. SNAP = Supplemental Nutrition Assistance Program. Statistics for the reference categories are not provided.

[a]Natural log.

*$P<.05$; **$P<.01$.

2 matched subsamples (see Table B, available as a supplement to the online version of this article at http://www.ajph.org, for the full results from each model). For all older adults, SNAP participation was associated with a lower likelihood of CRN, even after we controlled for important factors such as health conditions, out-of-pocket health care costs, and health insurance and prescription drug coverage. On average, SNAP participants were 4.8 percentage points less likely to engage in CRN than eligible nonparticipants ($P<.01$).

Results for the subgroup of older adults threatened by hunger revealed that SNAP participation had about twice the effect on CRN for this population: among those threatened by hunger, SNAP participants were 9.1 percentage points less likely to engage in CRN than nonparticipants ($P<.01$). Finally, the estimated effect of SNAP on

CRN for food-insecure older adults was also substantially higher than that for the general sample of all older adults: food-insecure SNAP participants were 7.4 percentage points less likely to engage in CRN than were their nonparticipating counterparts ($P<.05$).

The estimated coefficients of several covariates were significantly associated with CRN, and the direction of most were consistent with previous research[5,7,8,10,16,26] (Table B, available as a supplement to the online version of this article at http://www.ajph.org). Out-of-pocket medical costs and health insurance with prescription drug coverage were important predictors of CRN: in the first model, older adults with out-of-pocket health care costs were 11.9 percentage points more likely to report CRN than were those without, and older adults with prescription drug coverage were 15.3 percentage points less likely to engage in CRN than were those without any coverage. Finally, older adults in fully food-secure households were 12.6 percentage points less likely to engage in CRN than were their counterparts threatened by hunger. The estimated coefficients of covariates in the subgroup models were similar to the results for the full sample.

Sensitivity Analyses

We conducted a number of sensitivity tests on the SNAP estimates, the results of which can be found in the appendix available as a supplement to the online version of this article at http://www.ajph.org. First, we experimented with nearest-neighbor matching and kernel matching (Table E). Second, we examined the individual effects of SNAP on each of the 3 items contributing to the binary CRN outcome (Table F). Third, we computed 2 alternative SNAP eligibility variables (1) based on gross household income and (2) based on net household income but excluding the deduction for out-of-pocket medical expenses (Table G). Finally, we considered 2 alternative definitions of the treatment group: (1) those who participated in SNAP for at least 6 of the previous 12 months (based on the total number of months reported in the survey) and (2) only those who participated in SNAP for all 12 months in the previous year. For this last sensitivity analysis, SNAP participants who did not participate for the specified number of months were

TABLE 4—Treatment Effect of SNAP Participation on Cost-Related Medication Nonadherence for All Older Adults, Those Threatened by Hunger, and Those Who Are Food Insecure: United States, 2013–2015

Sample	No.	% CRN Among SNAP Participants[a]	% CRN Among Eligible Nonparticipants[a]	Percentage Point Reduction in CRN Owing to SNAP[b] % (SE)	Percentage Point Reduction in CRN Owing to SNAP[b] 95% CI
All older adults	4347	11.4	16.2	–4.8** (0.015)	–1.9, –7.7
Older adults threatened by hunger[c]	1344	18.3	27.4	–9.1** (0.028)	–3.6, –14.7
Food-insecure older adults	886	21.5	28.9	–7.4* (0.036)	–0.3, –14.5

Note. CI = confidence interval; CRN = cost-related medication nonadherence; SNAP = Supplemental Nutrition Assistance Program. All regressions include a constant and all other covariates. For the full results from these models, see Table B, available as a supplement to the online version of this article at http://www.ajph.org. All regressions are weighted by the product of the propensity weight and the survey weight to produce nationally representative estimates.
[a]Regression-adjusted CRN rates among participants and eligible nonparticipants.
[b]The average marginal effect (robust standard error) estimated in the Probit regression model.
[c]"Threatened by hunger" includes both marginally food-secure and food-insecure older adults.
*P < .05; **P < .01.

included in the comparison group, which would plausibly make this group more similar to the treatment group on the basis of unobservables (such as stigma) associated with SNAP participation (Table H). The results of these robustness tests strongly supported the main findings presented in this article.

DISCUSSION

As the American population ages, it is critical to address the economic circumstances that may prevent older adults from effectively managing their medication regimens. With nationally representative data from the NHIS, this study was the first to rigorously examine the relationship between participating in SNAP and engaging in CRN for low-income older adults. Our findings suggest that increasing access to SNAP may allow low-income older adults to better afford their prescription medications. Especially noteworthy is that SNAP participation may have an independent effect on CRN, over and above the effects of prescription drug coverage, as well as other sociodemographic and health characteristics.

The findings point to a spillover "income effect" as SNAP may help older adults better afford their medications, conceivably by reducing out-of-pocket food expenditures, especially for the most vulnerable populations

(those threatened by hunger and those who are food insecure). This is particularly important, not only because SNAP participation among older adults has historically been low (with recent estimates suggesting that only 42% of eligible individuals enroll in the program[18]), but also because eligible nonparticipants fare worse on CRN than do their participating counterparts.

The associations between the model covariates and CRN are consistent with previous research.[5,7,8,10,16,26] Of particular interest, we found that older adults in a higher socioeconomic stratum (higher educated, higher per-capita income, or employed) are more likely to engage in CRN (albeit with varying statistical significance). Although this may seem counterintuitive, other authors have found similar effects.[7,16,26] One reason for this may be that individuals in lower socioeconomic strata may be better off than expected in terms of medication affordability as they are not only eligible for more SNAP benefits, but may also have access to other assistance programs, such as the Medicare Savings Program or subsidized housing.

SNAP benefits have the potential to reduce health care costs and utilization via 2 mechanisms: reducing food insecurity and increasing medication adherence. Although our findings provide strong evidence that SNAP can help reduce CRN, we did not examine other reasons for medication

nonadherence, such as medication side effects or patients not remembering to take their medication consistently. However, being able to afford prescription medications is the first step in an individual's decision to adhere to a medication regimen.

Limitations

The primary limitation of our study is that we could not control for unobserved confounders that may be correlated with both SNAP participation and CRN. We experimented with alternative comparison groups that were likely to be more similar to the treatment group in terms of unobservables, and our results remained robust. Also, we relied on self-reports of past-year CRN and SNAP participation, which may be subject to recall error. It is well known, though, that measurement error in the outcome variable does not lead to bias; it only increases the standard error of estimates. Bias may still result from possible underreporting of SNAP, leading to some participants being included in the comparison group. Without administrative data, it is not possible to quantify the degree of underreporting. However, insofar as SNAP participants are generally better off than nonparticipants in medication use, inclusion of some participants in the comparison group may lower the average rate of CRN for this group. Therefore, in the absence of such underreporting, the estimated effect of SNAP on CRN may be even higher.

Although we were able to identify the effect of SNAP on CRN for the target population, holding constant prescription drug coverage, because of the observational nature of the study and data limitations, we were not able to examine whether participation in SNAP was associated with participation in other programs that might also reduce CRN. For example, SNAP participants may have better access to other programs such as housing subsidies that could make them better able to afford their prescription medication.

Despite these limitations, our study provides compelling evidence of SNAP's potential impact on medication nonadherence, and is a step toward quantifying SNAP's benefit to health care utilization. Additional research seeking to evaluate the extent to which SNAP participation results in

improved health care management for older adults could consider a number of extensions. Further research could explore the impact of SNAP duration and benefit amounts on CRN or emergency department use among those with chronic conditions. Panel data techniques (such as fixed-effect models) can also be exploited along with propensity score matching with program administrative data. Finally, whereas this study focused on older adults, it may be worth examining the impacts of SNAP on CRN among households with children or working-age adults.

Public Health Implications

It is critical that states and the federal government continue to reduce barriers to SNAP participation for older adults. Though not examined in this study, cost savings might be attained by health systems and insurers by improving medication adherence via SNAP participation and other public assistance programs that address older adults' economic needs. Many patients are not aware of available resources in their community. Health plan sponsors, government payers, and health systems should continue to explore opportunities to screen for food insecurity and refer food-insecure older adult patients to community-based organizations that can help those individuals access SNAP and other resources for which they may be eligible.

Screening for food insecurity in a health care setting involves using just 2 validated questions that can be easily integrated into patient intake processes.[30] Stakeholders have a vested interest in connecting low-income older adults with food assistance programs given (1) the direct connection between food insecurity and poor health outcomes and (2) now strong evidence that SNAP participation can help older adults afford their prescription medications, especially for those threatened by hunger. AJPH

CONTRIBUTORS
Both authors designed the study and analyses and contributed to writing, refining, and finalizing the article. M. Srinivasan analyzed the data.

REFERENCES
1. Chen J, Rizzo JA, Rodriguez HP. The health effects of cost-related treatment delays. *Am J Med Qual.* 2011;26(4):261–271.

2. Mojtabai R, Olfson M. Medication costs, adherence, and health outcomes among Medicare beneficiaries. *Health Aff (Millwood).* 2003;22(4):220–229.

3. Nasseh K, Frazee SG, Visaria J, Vlahiotis A, Tian Y. Cost of medication nonadherence associated with diabetes, hypertension, and dyslipidemia. *Am J Pharm Benefits.* 2012;4(2):e41–e47.

4. Roebuck MC, Liberman JN, Gemmill-Toyama M, Brennan TA. Medication adherence leads to lower health care use and costs despite increased drug spending. *Health Aff (Millwood).* 2011;30(1):91–99.

5. Kennedy J, Wood A. Medication costs and adherence of treatment before and after the Affordable Care Act: 1999–2015. *Am J Public Health.* 2016;106(10):1804–1807.

6. Kesselheim AS, Huybrechts KF, Choudhry NK, et al. Prescription drug insurance coverage and patient health outcomes: a systematic review. *Am J Public Health.* 2015;105(2):e17–e30.

7. Afulani P, Herman D, Coleman-Jensen A, Harrison GG. Food insecurity and health outcomes among older adults: the role of cost-related medication underuse. *J Nutr Gerontol Geriatr.* 2015;34(3):319–342.

8. Zivin K, Ratliff S, Heisler MM, Langa KM, Piette JD. Factors influencing cost-related nonadherence to medication in older adults: a conceptually based approach. *Value Health.* 2010;13(4):338–345.

9. Mukherjee K, Nobles-Knight D. Assessment of trade-offs made by people due to financial stress from medical care in the USA. *J Pharm Heal Serv Res.* 2013;4(2):95–99. Available at: http://doi.wiley.com/10.1111/jphs.12015. Accessed January 2, 2017.

10. Madden JM, Graves AJ, Zhang F, et al. Cost-related medication nonadherence and spending on basic needs following implementation of Medicare Part D. *JAMA.* 2008;299(16):1922–1928.

11. Ziliak P, Gundersen C. The state of senior hunger in America 2014: an annual report. National Foundation to End Senior Hunger. 2016. Available at: http://www.nfesh.org/wp-content/uploads/2016/05/State-of-Senior-Hunger-in-America-2014.pdf. Accessed November 21, 2017.

12. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A. Household food security in the United States in 2015. US Department of Agriculture, Economic Research Service. 2016. Available at: https://www.ers.usda.gov/publications/pub-details/?pubid=79760. Accessed November 21, 2017.

13. Nord M, Andrews M, Carlson S. Household food security in the United States, 2001. US Department of Agriculture, Economic Research Service. 2002. Available at: https://www.ers.usda.gov/publications/pub-details/?pubid=46684. Accessed November 21, 2017.

14. Bengle RA. Food Insecurity and Cost-Related Medication Non-adherence in a Population of Community-Dwelling, Low-Income Older Adults in Georgia [master's thesis]. Athens, GA: University of Georgia; 2009. Available at: https://getd.libs.uga.edu/pdfs/bengle_rebecca_a_200908_ms.pdf. Accessed November 21, 2017.

15. Sattler EL, Lee JS, Bhargava V. Food insecurity and medication adherence in low-income older Medicare beneficiaries with type 2 diabetes. *J Nutr Gerontol Geriatr.* 2014;33(4):401–417.

16. Berkowitz SA, Seligman HK, Choudhry NK. Treat or eat: food insecurity, cost-related medication underuse, and unmet needs. *Am J Med.* 2014;127(4):303–310.e3.

17. Bartfeld J. SNAP and the school meal programs. University of Kentucky Center for Poverty Research Discussion Paper Series. DP 2013-08. 2013. Available at: https://uknowledge.uky.edu/ukcpr_papers/19. Accessed November 21, 2017.

18. Farson K, Cunnynham K. Trends in Supplemental Nutrition Assistance Program participation rates: fiscal year 2010 to fiscal year 2014. Washington, DC: US Department of Agriculture, Food and Nutrition Service. 2016. Available at: http://www.fns.usda.gov/sites/default/files/ops/Trends2010-2014.pdf. Accessed November 21, 2017.

19. Gundersen C, Ziliak J. Food insecurity and health outcomes. *Health Aff (Millwood).* 2015;34(11):1830–1839.

20. Blewett LA, Rivera Drew JA, Griffin R, King ML, Williams KCW. IPUMS Health Surveys: National Health Interview Survey, Version 6.2. Minneapolis, MN: University of Minnesota; 2016.

21. US Department of Agriculture Food and Nutrition Service. SNAP special rules for the elderly or disabled. 2015. Available at: http://www.fns.usda.gov/snap/snap-special-rules-elderly-or-disabled. Accessed January 1, 2016.

22. US Department of Agriculture Food and Nutrition Service. Supplemental Nutrition Assistance Program (SNAP) eligibility. 2016. Available at: http://www.fns.usda.gov/snap/eligibility. Accessed January 1, 2016.

23. Jones T. SNAP's excess medical expense deduction: targeting food assistance to low-income seniors and individuals with disabilities. Center on Budget and Policy Priorities. 2014. Available at: https://www.cbpp.org/sites/default/files/atoms/files/8-20-14fa.pdf. Accessed November 21, 2017.

24. Bickel G, Nord M, Price C, Hamilton W, Cook J. Guide to measuring household food security. Alexandria, VA: US Department of Agriculture, Office of Analysis, Nutrition, and Evaluation; 2000.

25. Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey. Available at: https://meps.ahrq.gov/mepsweb. Accessed November 21, 2017.

26. Herman D, Afulani P, Coleman-Jensen A, Harrison GG. Food insecurity and cost-related medication underuse among nonelderly adults in a nationally representative sample. *Am J Public Health.* 2015;105(10):e48–e59.

27. Bang H, Robins JM. Doubly robust estimation in missing data and causal inference models. *Biometrics.* 2005;61(4):962–973.

28. Stuart EA. Matching methods for causal inference: a review and a look forward. *Stat Sci.* 2010;25(1):1–21.

29. DuGoff E, Schuler M, Stuart E. Generalizing observational study results: applying propensity score methods to complex surveys. *Health Serv Res.* 2014;49(1):284–303.

30. Gundersen C, Engelhard EE, Crumbaugh AS, Seligman HK. Brief assessment of food insecurity accurately identifies high-risk US adults. *Public Health Nutr.* 2017;20(98):1367–1371.