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Three Essays on Food Insecurity, Cognition, and Food Assistance in the Context of Aging and Family Dynamics

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Abstract

This dissertation consists of three chapters pertaining to Supplemental Nutrition Assistance Program (SNAP) participation, food insecurity, cognition impairment, and sibling correlation in SNAP participation over the life course. Participation in SNAP among eligible adults 60 and older is much lower than among the younger population, and rates continue to decline throughout the life course while, at the same time, the risk of cognitive impairment increases. The relationship between food insecurity and health outcomes among adults has garnered increasing attention. Some previous studies found an association between food insecurity and cognition outcomes among older adults. However, they were hampered by not considering midlife as a specific food insecurity exposure window and the effect of this hardship over a long-run time period. Even though siblings are essential players in family dynamics, previous research that carefully considered siblings' role in welfare participation is limited. Due to the high administrative burden associated with SNAP eligibility processes, the first paper examines if cognitive impairment is associated with low uptake of SNAP among the low-income older adult population. The second investigates the association between individuals' food insecurity in their fifties, measured as exposure experience at some point and total years of the exposure, and the cognitive ability and incident dementia in later years. The third paper adopts a nuanced familial paradigm in conceptualizing an individual's social network, thereby foregrounding an exploration into the influence of parental and sibling interrelationships on the likelihood of individual's SNAP participation.

In Chapter 1, co-authored with Colleen Heflin, I estimate linear probability fixed-effects models to assess the effect of cognitive decline on the likelihood of SNAP participation among eligible adults aged 60 and above, controlling for observed characteristics that change over time

as well as individual, time, and state fixed effects using panel data from the Health and Retirement Study. The results show that the reduced levels of cognitive functioning that rise to the classification of dementia were strongly associated with reductions in the probability of SNAP take-up among eligible older adults. Results were particularly salient for females and those living alone. One barrier to SNAP take-up among older adults may be cognitive impairment, with the size of the effect differing by gender and living arrangement. Policymakers may want to consider initiatives to increase SNAP participation among older adults, including a focus on further simplification of eligibility and recertification processes that reduce administrative burden.

Chapter 2 examines how exposure to food insecurity (FI) and the cumulative exposure duration during the age of fifties is associated with subsequent cognition ability and dementia onset risk using HRS data from 1995 to 2020. The findings suggest that food insecurity exposure experienced in age 50-59 is associated with higher dementia onset risk and a lower total cognition function score after age 60. In addition, each additional year of food insecurity exposure in the midlife stage is associated with a dose-response increase in dementia onset risk and a reduction in total cognition functioning score in later life. This study strengthened the literature that both the timing and extent of food insecurity exposure matters for later-life cognitive health and late-onset dementia. This study indicates that life course disadvantage accumulates during midlife to predict worse later-life cognitive function, which provides strong evidence for the cumulative inequality model.

Chapter 3 exploits data from the Panel Study of Income Dynamics (PSID) from 1975 to 2019 and estimates three-level mixed effects logistic models to assess the relationship between individuals' family network and their SNAP participation. The analysis has leveraged sibling

dyads to provide nuanced insights into intergenerational and sibling correlations in SNAP participation, simultaneously accounting for the effects of time-invariant early-life shared environments and time-variant parental, inter-sibling, and external environmental factors. I found that early-life SNAP exposures and current parental on SNAP are associated with individual’s SNAP participation in adult life. However, the influence of early-life exposure and sibling’s SNAP participation are nuanced and vary across gender and race. The study contributes to literature by combining both the intergenerational and intragenerational perspectives in understanding of welfare participation across the lifespan of two generations.

THREE ESSAYS ON FOOD INSECURITY, COGNITION, AND FOOD ASSISTANCE IN THE CONTEXT OF AGING AND FAMILY DYNAMICS

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Chapter I: Cognitive Impairment and Supplemental Nutrition Assistance Program Take-up Among the Eligible Older Americans

Introduction

Due to limited financial resources and declining health and mobility, food insecurity for older adults is a significant social problem (Ziliak & Gundersen, 2021) with a wide array of adverse health outcomes (Afulani et al., 2015; Gundersen & Ziliak, 2021; Heflin, Altman & Rodriguez, 2019). The Supplemental Nutrition Assistance Program (SNAP), the nation's largest domestic food and nutrition assistance program, provides monthly benefits to eligible low-income households to purchase food items at authorized retailers. However, the take-up rate in SNAP among eligible adults aged 60 and older is much lower than that of the general population: 48% compared to 86% overall in 2018 (Lauffer & Vigil, 2021). Furthermore, SNAP take-up among older adults continues to decline as age increases (Braun et al., 2017). One potential factor that has remained largely unexplored to date is the role that cognitive decline may play in low SNAP take-up.

Nonparticipation in SNAP among older adults is often attributed to the difficulty experienced in complying with the application processes, termed administrative burden, although some authors also suggest that attitudes related to one's independence, social stigma, and the perceived low value of the benefits may also play a factor (Alba, 2018; Haider, Jacknowitz & Schoeni, 2003; Meyer & Abdul-Malak, 2020; Pinard et al., 2017). Generally, means-tested programs (those whose eligibility is limited by household income), such as SNAP, have more complicated application processes and frequent recertification periods required for participation relative to universally available programs, such as the Social Security Program (Herd, 2015). Older adults with cognitive limitations may find it particularly difficult to comply with the administrative requirements within the short time frames necessary to remain on the program.

In this study, we focus on SNAP participation of low-income older adults aged 60 and above and the role of cognitive impairment among different groups. Specifically, we explore the hypothesis that cognitive impairment may decrease SNAP participation among eligible older adults, both with and without controlling for household-level food security status. We also explore the extent to which cognitive ability may differentially be associated with SNAP participation for individuals based on gender, race, and household living arrangement.

Among the full population, receipt of SNAP benefits reduced the likelihood of being classified as food insecure (Hoynes, McGranahan & Schanzenbach, 2016) or poor (Meyer & Wu, 2018), while improving health status (Gregory & Deb, 2015; Heflin, Ingram, et al., 2019; Miller & Morrissey, 2017) and increasing food expenditures (Hoynes & Schanzenbach, 2016; Hoynes, McGranahan & Schanzenbach, 2016). Improved SNAP participation rates are especially important for low-income older adults facing cognitive decline given the strong association between food insecurity and cognitive functioning among older adults (Gundersen & Ziliak, 2021; Frith & Loprinzi, 2018; Portela-Parra & Leung, 2019). For example, Gundersen and Ziliak (2021) report that the prevalence of dementia is 14 percentage points (or 227%) higher among food-insecure older adults (25%) than among their food-secure counterparts (11%)(Gundersen & Ziliak, 2021). Food insecurity is also associated with a wide range of modifiable risk factors for cognitive decline, such as diabetes, depression, functional limitation, hypertension, congestive heart failure, and lack of social support (Afulani et al., 2015; Gundersen & Ziliak, 2021). However, SNAP cannot adequately address food insecurity among the older population if barriers exist to program enrollment. Further, if low take-up of SNAP among older adults is partially related to the cognitive abilities of those eligible, typical outreach efforts used for other populations may be insufficient to effectively extend the program's benefits to this vulnerable group.

Cognitive impairment and SNAP administrative burdens

Cognitive impairment, which is also called "cognitive decline", is a broad term that refers to a problem or difficulty with one's memory, thinking, and other functions of the conscious brain, beyond what might be expected due to normal "cognitive aging". Though the greatest known risk factor for dementia is increasing age, it is not a normal part of aging (Alzheimer's Association, 2022). Dementia is a general term for a decline in mental ability severe enough to interfere with daily life, with Alzheimer's disease (AD) as the most common cause (Alzheimer's Association, 2022). Dementia is characterized by a noticeable decline in memory, language, and thinking capacity that impairs a person's ability to perform daily tasks and interpersonal interactions. People with dementia often lose their ability for problem-solving and emotional control and may go through personality changes and have behavioral issues, such as agitation, delusions, and hallucinations (Dementia Society of America, 2022).

About 6.07 million American adults aged 65 years and above had dementia in 2020 and this number is estimated to grow to 13.85 million in 2060 (Rajan et al., 2021). Almost two-thirds of Americans with dementia are women (Rajan et al., 2021). Nonwhite older adults and those with the most unfavorable socioeconomic conditions face a higher risk of both cognitive impairment and food insecurity relative to their White, more education, and higher-income peers (Casanova et al., 2020; Heflin, Altman & Rodriguez, 2019; Farina, Hayward, Kim, et al., 2020). For example, Garcia et al. (2019) reported that the number of years spent living with dementia for White and Black women was 1.6 and 3.9 years, respectively, while White men lived 1.1 years with dementia compared to 3.1 years for Black men. Further, Garcia et al. (2021) found that White respondents lived a greater percentage of their remaining lives cognitively healthy than their minority Black or Hispanic counterparts, regardless of the level of education.

In terms of living arrangements, individuals with dementia living in the community are more likely than older adults without dementia to rely on multiple unpaid caregivers, such as family members. In 2018, among those with dementia who live in the community, 74% live with someone and the remaining 26% live alone (Alzheimer’s Association, 2022). Living alone, perceived social support, and loneliness were associated with a greater risk of cognitive difficulty (Judith, Jeffrey & Roberts, 2017).

In this study, we view SNAP participation through a public management administrative burden theoretical lens to guide our understanding of individuals’ experiences in accessing SNAP benefits (Herd, 2015; Herd & Moynihan, 2018). Applying for SNAP benefits either requires submitting a paper application by mail or in-person, or in states with more modernized application systems, using a computerized interface to apply online. Many cognitively normal adults find paper applications confusing and applying in-person requires transportation and good enough health to last through what might be a long day, as well as the cognitive ability to quickly respond to complicated, detailed, and personal questions about household income and expenses. Applying online requires access to a computerized device and knowledge about how to navigate the SNAP website to access the necessary program information, no small task for someone with cognitive decline. The administrative burden associated with receiving SNAP benefits is likely to pose a barrier to older adults with cognitive limitations due to the reduced capacity associated with the condition in the areas of memory, language, and interpersonal skills. *Thus, we hypothesize (H1) that among adults aged 60 and above who are eligible for SNAP, those with* *cognitive impairment are significantly less likely to participate in SNAP than their cognitively normal counterparts, even after accounting for food insecurity status.*

Disparity in needs for food assistance among older adults

Another guiding theoretical perspective of this study is the social positioning of material hardship, which suggests that the risk of material hardship, including food insecurity, is related to the demographic and social position (Heflin, 2016; Heflin, 2017). Patterns found among the general population are also present among older adults: the risk of food insecurity is higher for women than men, for racial minorities than for Whites, and varies substantially by household living arrangement (Coleman-Jensen, Rabbitt, Gregory & Singh, 2021; Ziliak & Gundersen, 2021). In 2019, about 62 percent of SNAP participants aged 60 and above were female. Further, among female participants, 72% of those between the ages of 51 and 70 live alone, and 84% over the age of 70 live alone (Cronquist, 2021). While SNAP participation rates tend to be higher among older adults who are Black, and living alone, take-up rates for these groups still lag those of younger populations and administrative burden is thought to have differential impacts by race, and gender in social programs enrollment (Herd & Moynihan, 2018).

We conceptualized the gender and race differences in the impact of administrative burden as well as the risk of cognitive decline as potentially leading to more difficulty navigating the SNAP application process. Those female, minorities, and poor older adults who have cognitive impairments are the least advantaged and have more needs for SNAP benefits. However, these groups may have more difficulty completing the SNAP application process due to their fewer resources to manage and overcome the administrative burden. Thus, we expect that gender and race moderate the association between cognitive impairment and SNAP enrollment. *We hypothesize (H2) that among eligible older adults, the probability of SNAP take-up will be more* *negatively affected by cognitive impairment for females than males. We further hypothesize (H3) that among those eligible for SNAP, the probability of SNAP take-up will be more negatively affected by cognitive impairments for Black older adults than White older adults.*

Finally, to the extent that older adults must navigate the SNAP application process without the assistance of companions, family, or a social support network, social isolation can limit older adults' access to social programs and services, such as SNAP. Studies show that living alone is associated with higher levels of food insecurity among older adults (Burris et al., 2019; Vilar-Compte, Gaitán-Rossi & Pérez-Escamilla, 2017); thus, the need for SNAP benefits for older adults living alone may be higher than those living with others. However, given the gap in SNAP participation among eligible older adults, it is possible that cognitive impairment poses a more significant barrier to overcoming the administrative burden associated with the SNAP application process for those living alone, given their lower levels of social support resources. *Thus, we hypothesize (H4) that relative to their counterparts living with others, the presence of cognitive impairment is associated with lower odds of participation among the SNAP-eligible older adults who live alone.*

Method

Sample

We use eight waves of nationally representative and longitudinal survey data between 2002 and 2016 from the Health and Retirement Study (HRS), which surveys Americans over the age of 50 every two years. Given that state policies and economic conditions can lead to changes in the likelihood of SNAP take-up (Eslami, 2015), we link the HRS public-use data with the restricted-access geographic identifier file, which allows the use of state information to estimate

SNAP eligibility status and the inclusion of state fixed effects in our models (Health and Retirement Study, 2019).

Analytic Sample

The evolution of the analytic sample began with 10,945 survey respondents who were aged 60 years or above, who were estimated to be eligible for SNAP, were not institutionalized, and for whom we have a measure of cognitive ability through self-rating or proxy-rating. Then we delete 149 respondents (1.4%) who have missing values on food insecurity or race. To use the individual-level fixed effects model, the same individual must be observed multiple times across the panels. Thus, we furtherly omitted 4,302 respondents (39.8%) who contributed to the observations only once across the 2002, 2004, 2006, 2008, 2010, 2012, 2014, and 2016 surveys. These restrictions result in a sample of 6,494 unique individuals and 23,121 person-year observations for the fixed-effect analysis. We limit our sample to those 60 years old and above because the federal SNAP program has special and more generous rules for households with older or disabled members. Among the analytic samples, the estimated SNAP eligibility rates are much higher within cognitively impaired subgroups (42.3% among Cognitive Impairment but No Dementia subgroup, i.e., CIND, and 55.7% among Dementia subgroup) than in their cognitively normal counterparts (19.1%).

Measures

The dependent variable is dichotomous and has a value of 1 if a person received SNAP benefits at any time in the past two years and a value of 0 otherwise. SNAP take-up means SNAP participation among those estimated to be eligible. By linking the HRS Geographic State Restricted data with public HRS data, we estimate SNAP eligibility at the household level by using detailed individual and family information in addition to state of residence. Our calculation of each household's estimated eligibility in each state and year is based on both federal rules and state policy options related to eligibility. In estimating SNAP eligibility, we account for net household income tests, assets tests, and categorical eligibility and incorporate time-variant state-level policies. A full account of this estimation process can be found in Appendix A.

Our focal independent variable cognitive impairment has three levels and is categorized as cognitively normal, Cognitive Impairment but No Dementia (CIND), or dementia based on the Weir-Langa Classifications with cognitive normal as reference (Crimmins et al., 2011). The Weir-Langa Classifications employs a 27-point Telephone Interview for Cognitive Status (TICS) scale by summing immediate and delayed word recall, a serial subtraction test, and a backward counting test. On the basis of the clinically estimated prevalence of these statuses, three cut points were established for respondents: dementia (score of 0–6), CIND (score of 7–11), and normal (score of 12–27) (Crimmins et al., 2011). Respondents who were unable to take part in the TICS tests due to health reasons had their cognitive status assessed via three proxy assessment questions on proxy assessment of memory (0-4 points), sum of five Instrumental Activities of Daily Living limitations (0-5 points), and the interviewer assessment of cognitive impairment (0-2). Using this 11-point scale, the Weir-Langa Classifications determines three cognitive statuses for proxied respondents: dementia (score of 6–11), CIND (score of 3–5), and normal (score of 0–2) (Crimmins et al., 2011). Two important features of the Weir-Langa Classifications are that it includes proxy respondents, and it makes use of imputed information for the HRS cognitive measures. The HRS makes use of proxy respondents to reduce sample attrition in cases where the respondent is unavailable, unable, or unwilling to do the interview. The lack of inclusion of HRS proxy-respondents has been identified as an important source of bias in assessing secular trends in cognitive functioning. The two features are essential to ensure coverage of those with cognitive impairments (Kenneth et al., 2008).

Covariates

Demographic covariates included in our analysis are age, gender (male or female), race, family size (range 1-15), and marital status (0= unmarried, 1= married). Age is measured as two dichotomous variables indicating whether respondents are aged 70-79, or aged 80 and up, with 60-69 years old as reference. Race corresponds to whether the respondent is identified as a White, Black, or other race. The dichotomous variable Food Insecurity has a value of 1 if a respondent reported a negative response to the question of whether they have always had enough money to buy the food they need over the past two years. Living alone is defined based on the number of residents in the household (1= one resident; 0=otherwise). Activities of Daily Living (ADL) is calculated as the sum of 5 items reflecting difficulties in bathing, dressing, eating, in or out of bed, and walking across room. Instrumental Activities of Daily Living (IADL) is calculated as the sum of 5 items reflecting difficulties in making phone calls, managing money, taking medications, shopping, and cooking meals. Family income, assets, and individual's annual out-of-pocket medical expenses are all measured using the natural log values. Moreover, we controlled for important individual characteristics of health or social insurance and program coverage and social assistance benefits receipt status, which may influence individuals' chances of SNAP enrollment. These variables include Supplemental Security Income (SSI) or Social Security Disability Insurance (SSDI) receipt (0 = no, 1 = yes), Social Security receipt (0 = no, 1 = yes), and Meals-on-wheels availability (0 = no, 1 = yes). Health insurance coverage is also measured dichotomously indicating if the respondents are covered by any health insurance programs including Medicare, Medicaid, VA health insurance, private health insurance, long-term insurance, or other health insurance. Proxy status is measured as a dummy variable with 1 meaning the survey was answered by a proxy, and 0 meaning self-report. We used the 2003 Beale Rural-Urban Continuum Codes to categorize HRS respondents as living in an urban or rural area (Health and Retirement Study, 2019). Since we use individual fixed effects models in this study (which eliminates individual-level time-invariant covariates), all individual-level covariates included in our model are time-varying. We split the sample by race, gender, and living arrangement to incorporate these indicators into our analysis.

Statistical Analysis

We exploit the longitudinal nature of the data set and estimate linear probability fixed effects models to estimate the effect of a change in cognitive impairment overtime on the likelihood of SNAP take-up among eligible individuals. We include individual fixed effects using our panel data to control for individual differences in the underlying probability of SNAP take-up that remain constant over time, such as feelings of stigma regarding receipt of social welfare programs or general attitudes towards the welfare state. We include state and year fixed effects to control for unmeasured aspects of the state that might impede or support SNAP participation (such as specific state policies governing eligibility and application requirements), as well as differences in those factors that might change over time.

We firstly estimate the main effects of cognitive impairment on SNAP take-up and then assess subgroup differences of these models by gender, race, and living arrangement separately.

The model for the person i, living in state s, in time period t, is given as

$$SNAP_{ist} = \alpha_i + \beta_1 \, CIND_{ist} + \beta_2 \, Dementia_{ist} + \beta_3 \, FoodInsec_{ist} + X_{ist} + \theta_s + \delta_i + \mu_t + \varepsilon_{ist} \qquad (1)$$

where $SNAP_{it}$ (SNAP take-up), $CIND_{ist}$, $Dementia_{ist}$, and $FoodInsec_{ist}$ (food insecurity) are all dichotomous variables. X_{ist} are time-varying covariates. θ_s, δ_i, and μ_t are fixed effects for states, respondents, and time, respectively. Standard errors are clustered at the individual level. Given the endogeneity between food insecurity status and SNAP take-up, we estimate models both with and without controlling for food insecurity and present results for both models; results are robust to the inclusion of food security status. In results not shown, we further tested the hypothesis that food insecurity moderated the effects of cognitive impairment by including interaction terms between food insecurity and our two levels of impaired cognitive function. However, the interaction terms were not statistically significant in six out of the seven models that we estimated. We did find marginally significant results of a moderating effect of food insecurity on cognitive decline (both CIND and Dementia) among males at the p<.10 level. Results are available upon request.

Results

Table 1 displays descriptive statistics for the full analytic sample (n=23,121) and stratified by three levels of cognitive status (cognitively normal, CIND, and Dementia). The analytic sample is limited to individuals aged 60 and above who are estimated to be eligible for SNAP. The SNAP take-up rate and food insecurity rate among the analytic sample are 28.1% and 17.4%, respectively. The majority of the analytic sample is aged 60-69, female, unmarried, residing with others, white, does not respond via proxy to the survey, does not receive SSI or SSDI benefits, lacks access to Meals-on-wheels, but does receive Social Security benefits, and has health insurance coverage, and resides in a county classified as urban.

Table 1 columns 2-4 shows that relative to their cognitively normal counterparts, individuals who are classified as with CIND or with dementia are less likely to take up SNAP, be food insecure, older (age 80 and above), males, unmarried, black or of other race, recipients of SSI or SSDI, collecting Social Security benefits, covered by health insurance, Meals-on-wheels available, and rural residents. Nearly one-fourth (24.8%) of the sample with dementia used proxy respondents. On average, household income, liquid assets, and out-of-pocket medical expenses (MOOP) are lower among those with either level of cognitive impairment than those categorized as cognitively normal. Sample members who had developed cognitive challenges reported more ADL and IADL.

Main Analyses

Panel A of Table 2 presents results from individual fixed effects models for the full analytic sample in Model 1 unconditional on food security status. Models 2-7 separately assess subgroup differences by gender, race, and living arrangement. For each model, the reference category is cognitively normal. In the full sample shown in model 1, among eligible SNAP respondents, a within-individual change in meeting the criteria for dementia is associated with a 3.3 percentage point reduction in SNAP take-up (p=0.005). This finding confirms Hypothesis 1 that a change in cognitive status, particularly a classification of dementia status, is associated with a substantial reduction in SNAP take-up.

In Panel A of Table 2, the coefficient on cognitive status and SNAP take-up differs by gender and living arrangement. The negative effects of dementia on SNAP take-up are statistically significant among subsamples of those eligible for SNAP who are female (-4.3 percentage points, p=0.002) but are statistically zero for males (coefficients are statistically significant at the p<0.10 level). This finding is consistent with Hypothesis 2 that females who face cognitive decline experienced greater reductions in SNAP participation relative to their male counterparts.

Among Whites, a within-person change in dementia status is associated with a reduction in SNAP take-up by 3.9 percentage points (p=0.012). While this coefficient is statistically insignificant among Blacks, the magnitude of the coefficients on dementia is not significantly different between Whites and Blacks (based on an F-test) and so we cannot conclude that there are racial differences in the effects of dementia on SNAP-take-up (the coefficients between the two groups are similar in size but the standard errors for the Black sample are larger, possibly as a result of the smaller sample size). This finding is inconsistent with our third hypothesis which suggested that Black older adults who experienced cognitive decline would face greater barriers to SNAP participation than their White counterparts.

In terms of living situation, a within-person change in dementia status has a large negative effect on SNAP take-up among those living-alone (-6.3 percentage points; p=0.001). This finding is consistent with our fourth hypothesis that cognitive decline would present a larger barrier to SNAP participation among those living alone relative to their older adult counterparts living in household arrangements that include other adults.

In all cases, we find a negative effect on SNAP take-up for dementia but not for lower levels of cognitive impairment (i.e., CIND), controlling for observed time-varying individual characteristics, state and year fixed effects, and unobserved time-invariant individual characteristics, such as previous connection to SNAP, stigma, or program knowledge. Overall, a change in dementia status among eligible older adults corresponds to a 12% decline in SNAP take-up for the full sample, a 15% reduction for females, and a 22% reduction for those living alone.

Next, we explore the sensitivity of our results to the inclusion of food insecurity directly in the model to examine the extent to which the relationship between dementia and SNAP take-up is being mediated by food insecurity (Panel B of Table 2). We find that the effects of cognitive impairments on SNAP take-up do not change. We interpret this pattern of results as indicating that the relationship between dementia and SNAP take-up observed in Panel A of Table 2 is consistent conditional on food insecurity. Full parameter estimates of the models in Panel A and Panel B of Table 2 are presented in Supplementary Tables 1 and 2.

In Fig.1, we illustrate the predicted probability of SNAP take-up from the panel B models of Table 2 associated with a change in cognitive ability status. The figures indicate that among older adults, reductions in cognitive ability, particularly to the lowest level, are associated with reductions in SNAP take-up among those eligible, even after controlling for food security status, individual characteristics and household characteristics. Figure 1 indicates that the predicted probability of SNAP take-up is lowest among the subgroup of older adults who have experienced the most cognitive decline across all groups (although the differences between groups are not always statistically significant). Further, the groups with the lowest predicted probability of SNAP take-up are older adults with a change in cognition functioning who are in the lowest cognition group and are female and living alone. This finding is consistent with our theoretical frame that cognitive decline may be a barrier to SNAP take-up due to the administrative burden associated with the application process and that there are differential effects by social position.

Discussion

This study provides the first empirical evidence that cognitive decline is associated with lower SNAP take-up among older adults and that the effects differ by gender and living arrangement. Understanding how cognitive status affects SNAP take-up among eligible older adults contributes to evidence regarding the need for the development of appropriate interventions for addressing their food needs. Our estimation of SNAP take-up is based on the calculation of SNAP eligibility in which we consider both federal eligibility rules and state-level SNAP eligibility expansion rules. Thus, we contribute a more precise and reliable understanding of SNAP take-up.

The first hypothesis (H1) is supported. The effect of dementia is statistically significant and associated with a substantive difference in access to SNAP benefits among eligible older adults. As such, cognitive impairment may be an important explanation for the low participation rate of SNAP among older adults. We find that only a fraction of eligible older adults with dementia participated in SNAP (25.7% from Table 1), suggesting that administrative barriers may pose a barrier. Further, our findings align with past evidence that SNAP non-participation among adults of all ages is attributable to health characteristics and administrative hassles (Geiger et al., 2014; Meyerhoefer & Pylypchuk, 2014). Importantly, previous studies have also found that low cognition functioning is a consistent predictor of failure to take up Medicare supplemental coverage, Medicare Part D, and fully subsidized drug benefits among older Americans (Chan & Elbel, 2012; Kuye, 2016; McWilliams et al., 2011).

Our second hypothesis (H2) is also supported. After controlling for broad demographic, economic, and health characteristics such as marital status, household size, physical functional limitations, and income, we found that, among eligible older adults, dementia significantly affected SNAP take-up for females but not males. One possible explanation for this finding is that older aged women living in the community, especially those in lower socioeconomic groups, lack adequate care and social resources due to a lifetime accumulation of disadvantages (Goldberg, 2010). Women represent 70% of older adults living alone. Moreover, with longer life expectancies and typically married to older men, women often care for their husbands but, as widows, lack caregivers for themselves (Jung et al., 2017).

Our third hypothesis (H3) is that among eligible older adults, Black adults' chance of SNAP participation will be more negatively affected by cognitive impairments than White adults. As seen in panel B of Table 2, contrary to the third hypothesis, the coefficient of dementia on SNAP take-up is significant and negative among White adults but not among Black adults, although the size of the coefficient is very similar for both groups. Consequently, this finding may be a result of the lack of precision for the Black subgroup due to the smaller sample size. An alternative substantive explanation is that relative to Black older adults who may have faced cumulative disadvantage throughout the life course, White older adults may have experienced less need for SNAP benefits over their lifetimes and may be more easily discouraged from applying for SNAP benefits. This explanation is consistent with the literature that those potential welfare program beneficiaries who have less need place more weight on personal transaction costs (Alba, 2018). However, F tests indicate that the difference in coefficients between Whites and Blacks are not statistically significant, so the existence of heterogeneity by race in the association between dementia and SNAP take-up is rejected.

In both panels A and B in Table 2, the coefficients on dementia are significantly negative and statistically significant among those living alone but not among those living with others. Thus, the living arrangement hypothesis (H4) is supported, suggesting that barriers to SNAP may exist among eligible older adults with access to social networks and with dementia. The result is consistent with the literature that older adults' coping strategies for food insecurity were related to family networks and that having a partner in older adulthood can protect against food insecurity (Edin et al., 2013; Heflin, 2017).

Implications

For many years, the United States Department of Agriculture's (USDA) Food and Nutrition Service (FNS) has focused on simplifying administrative procedures, maintaining state flexibility, and expanding eligibility for federal food and nutrition programs (USDA, 2014). Among the general population, outreach efforts, clarity of information, and application assistance has been shown to lead to an almost 80 percent increase in SNAP applications relative to those who were informed they were eligible but given no special assistance (Herd & Moynihan, 2018). In USDA's annual budget summary for the fiscal year 2017, administrative complexities associated with applying and recertifying for SNAP were indicated as an important factor causing lower participation rates among older individuals (USDA, 2016). Based on the success of several state demonstration projects, the budget proposed creating a state option to improve SNAP access for low-income older adults, with a $10 million funding increase in 2017 for the first year of implementation (USDA, 2016). Currently, at least six states are participating in the Elderly Simplified Application Projects (ESAP), a USDA-sponsored demonstration project to offer a streamlined eligibility and application process for those aged 60 and over with no earned income. There is strong empirical evidence indicating that efforts to reduce learning and compliance costs associated with SNAP enrollment increase SNAP take-up (Levin et al., 2020). While this is a meaningful start, more action is needed. For example, (Jones, 2014) observed the difficulty older adults face in keeping track of and claiming the full amount of out-of-pocket medical expenses (OOPM), which involves a high administrative burden and impedes SNAP accessibility for older adults. Under federal law, adults aged 60 and above (and those with disabilities) can deduct the out-of-pocket medical cost from total gross household income in the SNAP eligibility determination process. However, to do so, applicants must provide bills, receipts, and provider statements. The federal government allows states to adopt the Standard Medical Deduction, which allows states to use a standard medical deduction amount in the determination process for those able to show at least $35 per month of medical expenses. However, currently, only 21 states adopt this provision.

Our results are consistent with previous literature in that the administrative burdens are not distributed evenly throughout society (Christensen et al., 2020) and that people's experience of administrative burdens (Chudnovsky & Peeters, 2021) vary in the case of SNAP enrollment. Our results suggest a priority focus for intervention among low-income older adults with dementia is on females and those living alone. Currently, about 29% of older adults live alone, with about twice as many older women living alone as men (Lloyd, 2017). In 2019, 83 percent of all SNAP households with older individuals were single-person households(Cronquist, 2021); SNAP application processes cannot assume that there are other adults around to help those facing cognitive decline navigate the application process.

As a community-based solution, health services and social workers provide an opportunity to link to other supportive in-home and community-based supports due to the potential that providers have in identifying older adults with cognitive decline at risk of being food insecure (Vilar-Compte, Gaitán-Rossi & Pérez-Escamilla, 2017). For example, health care providers, Medicaid case workers, and social workers could be educated on the issue of cognitive impairment and SNAP eligibility processes for older adults and incorporate assessments of food insecurity and social support during their home visits.

Limitations

There are a number of limitations to this study. One drawback of the HRS is that household income is only available on an annual basis instead of the monthly measure that would be used at application. Since our analyses of SNAP take-up among eligible households relied upon an annual measure of eligibility and take-up, our analysis likely underestimates the number of respondents eligible due to within-year fluctuations in income.

Second, our SNAP eligibility classification status is prone to error because the calculation is based on the accuracy and availability of income, earnings, assets, and other related information. However, the rich financial information in the HRS allows us to assess eligibility more accurately than other commonly used datasets, such as the Current Population Survey, by accounting for specific deductions and the asset limit that are part of the SNAP eligibility guidelines.

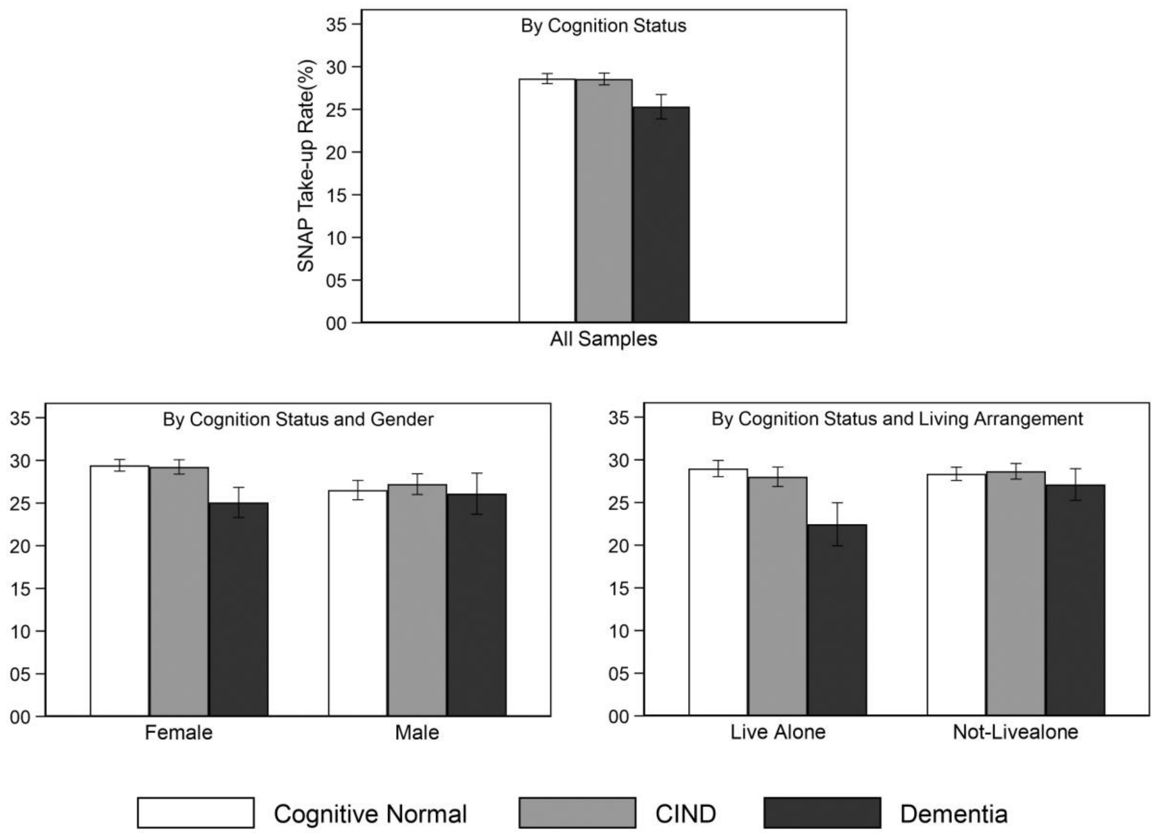
Third, the HRS relies on self-reports of SNAP participation. Measurement error may occur if respondents under-report their participation and this may partially explain the relatively low SNAP take-up rate among older adults. Unfortunately, underreporting of SNAP receipts is a common problem in survey data. However, previous research has documented that the SNAP participation rates recorded by HRS match administrative records better than the rates reported by the Survey of Income and Program Participation and the Current Population Survey (Haider, Jacknowitz & Schoeni, 2003; Nicholas, 2011).

Conclusion

Our results suggest that cognitive decline may be a barrier to SNAP take-up among older adults, particularly for those who meet the criteria for dementia. Those older adults who are female and living alone are priority subgroups in need of intervention to reduce the administrative burden associated with the SNAP application process. Additional research is needed regarding the incidence of cognitive limitations and the administrative burden in the SNAP older population. A growing understanding of this challenge might focus on the role of cognitive biases taking advantage of the behavioral science approach. The advent of behavioral economics and specifically its translation into SNAP policy nudges has encouraged experimentation with tailored techniques to reduce those burdens (Levin et al., 2020; Lopoo, Heflin & Boskovski, 2020), but much more remains to be done.

Figures & Tables

Figure 1. Predicted probability of SNAP take-up by cognition status, gender, and living arrangement among eligible older adults



Note: The figure illustrates the predicted probability of SNAP participation from the fixed effects models shown in Panel B of Table 2.

Table 1. Descriptive statistics of the analytic sample by cognitive status using HRS data between 2002 and 2016.

	All	Cognitively Normal	CIND	Dementia	P value
SNAP and Food Insecurity					
SNAP Take-up, %	28.1	28.7	28.3	25.7	0.046
Food Insecurity, %	17.4	16.7	18.7	17.2	0.000
Individual Characteristics					
Age 60-69, %	39.9	48.0	35.6	20.8	0.000
Age 70-79, %	36.2	36.0	37.6	33.8	0.266
Age 80 and Above, %	24.0	16.0	26.8	45.3	0.000
Female, %	68.9	70.9	67.5	65.2	0.000
Married, %	30.8	31.8	31.2	26.5	0.000
Living Alone, %	34.3	35.4	34.6	30.0	0.008
Annual Out-of-Pocket Medical Expenses, $ [a]	1654.1	1723.7	1577.8	1575.4	0.000
Race					
White, %	60.7	68.1	54.3	48.7	0.000
Black, %	30.2	23.8	35.4	41.0	0.000
Other, %	9.1	8.1	10.3	10.3	0.000
Physical Functional Limitations					
ADL, No.	0.7	0.5	0.7	1.4	0.000
IADL, No.	0.6	0.3	0.6	1.8	0.000
Proxy Respondents, %	7.4	3.1	6.3	24.8	0.000
Household Characteristics					
Family Size, No.	2.4	2.3	2.4	2.5	0.911
Household Income ($) [b]	25909.0	27837.3	23169.7	25048.4	0.000
Household Total Assets ($)	85115.3	109556.6	61833.5	50096.8	0.000
SSI or SSDI Receipt, %	17.5	14.7	19.4	23.0	0.000
Social Security Receipt, %	75.2	72.4	76.8	81.6	0.000
Any Health Insurance Coverage, %	93.2	92.1	93.9	95.7	0.000
Meals-on-wheels Available, %	6.0	4.0	7.3	10.1	0.000
Rural, %	19.9	17.9	20.8	24.8	0.000
Number of Individual Observations	23,121	12,148	7,442	3,531	
Number of Unique Respondents	6,494	3,991	1,887	616	

Note: a. Out-of-Pocket Medical Expenses is the annual individual-level value indexed by CPI to 2019. b. Household income is the annual value indexed by CPI to 2019. Standard deviations are reported in parentheses. The analytic sample consists of survey respondents who are aged 60 or above, who were eligible for SNAP and were not institutionalized at the time of the survey, and for whom we have cognitive ability test scores through self-rating or proxy-rating. Chi-square tests were used to compare distributions across three cognitive statuses. CIND indicates Cognitive Impairment but No Dementia.

Table 2. Estimated effects of cognitive impairments on SNAP take-up among eligible respondents aged 60 and above to the HRS between 2002 to 2016

	All	**Female**	**Male**	**White**	**Black**	**Live Alone**	**Not Live Alone**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A: Fixed Effects Models - Effects of Cognitive Impairments							
CIND	-0.0001	-0.001	0.008	-0.002	-0.010	-0.009	0.004
	(0.007)	(0.009)	(0.013)	(0.009)	(0.014)	(0.012)	(0.009)
Dementia	-0.033**	-0.043**[a]	-0.003[a]	-0.039*	-0.036	-0.063**[a]	-0.012[a]
	(0.011)	(0.014)	(0.020)	(0.015)	(0.019)	(0.020)	(0.015)
Adjusted R^2	0.494	0.504	0.474	0.534	0.436	0.563	0.477
B: Fixed Effects Models - Effects of Cognitive Impairments controlling for Food Insecurity							
CIND	-0.001	-0.002	0.007	-0.002	-0.010	-0.010	0.003
	(0.007)	(0.009)	(0.013)	(0.009)	(0.014)	(0.012)	(0.009)
Dementia	-0.033**	-0.043***[a]	-0.004[a]	-0.040*	-0.035	-0.065***[a]	-0.012 [a]
	(0.011)	(0.014)	(0.020)	(0.015)	(0.019)	(0.020)	(0.015)
Food Insecurity	0.063***	0.062***	0.061***	0.062***	0.067***	0.054**	0.071***
	(0.009)	(0.011)	(0.017)	(0.013)	(0.016)	(0.018)	(0.012)
Adjusted R^2	0.494	0.505	0.475	0.534	0.436	0.564	0.478
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y
Number of Observations	23,121	15,939	7,182	14,035	6,974	7,237	14,543
Number of Respondents	6,494	4,300	2,194	4,024	1,873	2,230	4,330

Note: CIND indicates Cognitive Impairment but No Dementia. The reference category of cognitive status is cognitively normal. The table shows results based on individual fixed effects models. Standard errors, clustered at the individual level, are provided in parentheses. All models included state and year fixed effects and controlled for age, marital status, rural or urban residence, household size, ADL, IADL, the natural log of income, the natural log of assets, the natural log of out-of-pocket medical expense, health insurance coverage, receipt of SSI or SSDI receipt, receipt of Social Security, Meals-on-wheels availability, and proxy status. a The coefficients between the corresponding two subgroups are significantly different at the p=0.1 level. Full parameter estimates from the Panel A and B models are presented in Supplementary Table 1 and 2, respectively. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Appendix

Appendix A. The SNAP eligibility calculation procedure

In addition to the SNAP recipiency status and benefits information, the HRS includes detailed data allowing us to accurately determine eligibility and benefit levels for SNAP: income, assets, living arrangements, shelter, and medical expenditures, as well as participation status for other programs which might confer categorically eligibility. Our calculation of each household's estimated eligibility in each state and year is based on both federal rules and state policy options related to eligibility.

Our primary information source includes:

a. U.S. Department of Agriculture, Food and Nutrition Service. 2021. *SNAP Quality Control(QC) Technical Documentations (Fiscal Year 2001-2017)*, Retrieved from http://snapqcdata.net/datafiles.

b. U.S. Department of Agriculture, Food and Nutrition Service. 2021. *SNAP Eligibility*, Retrieved from http://www.fns.usda.gov/snap/recipient/eligiblity

The specific details of this estimation are presented below.

Federal SNAP rules

We begin by applying federal rules to determine household eligibility. If households are eligible at the federal level, they are eligible at the state level as states cannot implement rules that restrict eligibility. The parameter values we used in the federal eligibility calculation for the standard deduction, excess shelter costs deduction cap, maximum allotment, asset limit, and federal poverty level (FPL) are all consistent with serial reports of "Trends in Supplemental Nutrition Assistance Program Participation Rates" prepared by Mathematica Policy Research for the USDA Food and Nutrition Service.

States SNAP eligibility expansion beyond the federal rules

The parameter values we used in the state-level eligibility rules are all consistent with serial reports of “Trends in Supplemental Nutrition Assistance Program Participation Rates” and “Technical documentation SNAP quality control database and the QC Minimodel” prepared by Mathematica Policy Research for the USDA Food and Nutrition Service.

The estimated SNAP benefits

The benefit formula is determined at the federal level. Each household’s monthly benefit is equal to a maximum monthly allotment, which increases with household size, minus 30% of net income.

The steps of SNAP eligibility estimation

Step1: calculate the federal-level SNAP eligibility status

a. Gross income Test: household income ≤130% FPL

Gross income test applies to families with no older adults or disabled only.

b. Net income test: Net household income ≤100% FPL

Net household income = household income-household earned income*20%-standard deduction- Excess Shelter deduction – adjusted Medical Cost (medical cost deduction only applies to those aged 60 and above or disabled individuals)

Where: Excess Shelter deduction=shelter expenses (rent + mortgage+ property taxes)-household gross income less the earned income, standard, and out-of-pocket medical expenses*50%. Excess Shelter deduction is capped for families with no older adults or disabled while there is no cap for families with any aged 60 and above or disabled household members.

The adjusted medical cost is calculated on an individual basis for amounts that exceed $35. The SMD applies for individuals with medical cost is larger than $35 and smaller than the state value of SMD for states that have adopted an SMD. For an individual with medical expenses that exceed the state SMD, the full amount of adjusted medical cost is used.

c. Asset Test: Adjusted Assets ≤ $2000 (Or $2250 after 2014) for families with no individuals aged 60 and above or disabled; Adjusted Assets ≤ $3000 (Or $3250 in 2012 and $3500 after 2014) for families with any family members aged 60 and above or disabled.

Where: Adjusted Assets=Total assets-value of primary residence -deductible vehicle value

Deductible vehicle value is capped at $4,650 in most cases for families with no individuals aged 60 and above or disabled.

Step 2: calculate whether the families are applicable for BBCE

Step 3: calculate the final SNAP eligibility status

The final SNAP Eligibility must meet each of the following two criteria

a. Both spouse receiving SSI OR being eligible at federal level OR being applicable under BBCE expansion rules

b. Estimated Household's monthly benefit is positive for household having three or more family members. (For the families having one or two members, they have a minimum monthly allotment).

Table A1. Estimated Effects of Cognitive Impairments on SNAP Take-up among respondents aged 60 and above to the HRS between 2002 to 2016 without controlling for food insecurity.

	All	Female	Male	White	Black	Live Alone	Not Live Alone
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CIND	-0.0001	-0.001	0.008	-0.002	-0.010	-0.009	0.004
	(0.007)	(0.009)	(0.013)	(0.009)	(0.014)	(0.012)	(0.009)
Dementia	-0.033**	-0.043**[a]	-0.003[a]	-0.039*	-0.036	-0.063**[a]	-0.012[a]
	(0.011)	(0.014)	(0.020)	(0.015)	(0.019)	(0.020)	(0.015)
Age 70-79	0.017	0.013	0.022	0.009	0.041	0.062**	0.005
	(0.011)	(0.014)	(0.021)	(0.014)	(0.021)	(0.021)	(0.014)
Age 80 and Up	0.020	0.019	0.016	0.014	0.062	0.084**	-0.0001
	(0.018)	(0.021)	(0.032)	(0.022)	(0.034)	(0.031)	(0.023)
Married	-0.007	-0.053*	0.076*	0.005	-0.007	0.104	-0.027
	(0.017)	(0.021)	(0.030)	(0.020)	(0.037)	(0.111)	(0.024)
Family Size, No.	0.008*	0.011**	0.004	0.003	0.026***		
	(0.004)	(0.005)	(0.007)	(0.005)	(0.007)		
Household Income (log)	0.001	-0.001	0.004	-0.001	0.001	-0.007	0.006
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Household Total Assets(log)	0.003*	0.002*	0.003	0.002	0.004*	0.003	0.003*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
Out-of-pocket Medical Expense(log)	-0.001	0.0002	-0.002	-0.001	0.001	0.001	-0.0001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
ADL	0.007*	0.006	0.011	0.005	0.013*	-0.0003	0.012**
	(0.004)	(0.004)	(0.007)	(0.005)	(0.006)	(0.006)	(0.005)
IADL	0.010**	0.011**	0.010	0.010	0.005	0.012	0.010*
	(0.004)	(0.005)	(0.007)	(0.005)	(0.007)	(0.008)	(0.005)
Proxy Respondent	-0.010	-0.036	0.025	-0.013	-0.030	0.015	-0.024
	(0.015)	(0.022)	(0.021)	(0.019)	(0.029)	(0.031)	(0.018)

SSI or SSDI Receipt	0.041**	0.048**	0.022	0.051**	0.017	0.060*	0.027
	(0.014)	(0.016)	(0.027)	(0.018)	(0.025)	(0.024)	(0.018)
Social Security Receipt	-0.003	-0.003	0.002	-0.007	0.003	-0.003	0.006
	(0.010)	(0.013)	(0.018)	(0.014)	(0.018)	(0.024)	(0.012)
Health Insurance Coverage	0.031*	0.020	0.048	0.008	0.042	0.035	0.035
	(0.015)	(0.019)	(0.026)	(0.019)	(0.030)	(0.034)	(0.018)
Meals-on-wheels Availability	0.015	0.031	-0.022	0.002	0.033	0.031	-0.007
	(0.016)	(0.019)	(0.028)	(0.019)	(0.030)	(0.024)	(0.022)
Rural	0.072*	0.067	0.107	0.078*	-0.025	0.109	0.064
	(0.033)	(0.037)	(0.070)	(0.037)	(0.079)	(0.073)	(0.044)
Constant	0.123	0.076	0.662*	0.290*	0.016	0.364*	0.082
	(0.107)	(0.098)	(0.267)	(0.137)	(0.152)	(0.121)	(0.169)
Year FE	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y
Number of Observations	23,121	15,939	7,182	14,035	6,974	7,237	14,543
Number of Respondents	6,494	4,300	2,194	4,024	1,873	2,230	4,330
Adjusted R^2	0.494	0.504	0.474	0.534	0.436	0.563	0.477

Note: CIND indicates a respondent is Cognitive Impairment but No Dementia. The reference category of cognitive status is cognitively normal. The table shows results based on individual fixed effects models. Standard errors, clustered at the individual level, are provided in parentheses. This table is the specification reported in panel A of Table 2 of the article. a We tested the differences of the coefficients of dementia between gender, race and living status at p=0.10 level. The coefficients between two gender and the two living status subgroups are significantly different. There is no significant difference between white and black subgroups. *p < 0.05 **p < 0.01 ***p < 0.001

Table A2. Estimated Effects of Cognitive Impairments on SNAP Take-up among respondents aged 60 and above to the HRS between 2002 to 2016 controlling for food insecurity.

	All (1)	Female (2)	Male (3)	White (4)	Black (5)	Live Alone (6)	Not Live Alone (7)
CIND	-0.001	-0.002	0.007	-0.002	-0.010	-0.010	0.003
	(0.007)	(0.009)	(0.013)	(0.009)	(0.014)	(0.012)	(0.009)
Dementia	-0.033**	-0.043***[a]	-0.004[a]	-0.040*	-0.035	-0.065***[a]	-0.012 [a]
	(0.011)	(0.014)	(0.020)	(0.015)	(0.019)	(0.020)	(0.015)
Food Insecurity	0.063***	0.062***	0.061***	0.062***	0.067***	0.054**	0.071***
	(0.009)	(0.011)	(0.017)	(0.013)	(0.016)	(0.018)	(0.012)
Age 70-79	0.016	0.013	0.022	0.009	0.041	0.062**	0.006
	(0.011)	(0.014)	(0.020)	(0.014)	(0.021)	(0.021)	(0.014)
Age 80 and Up	0.021	0.019	0.016	0.014	0.062	0.083**	0.001
	(0.018)	(0.021)	(0.032)	(0.022)	(0.034)	(0.031)	(0.023)
Married	-0.008	-0.053*	0.074*	0.004	-0.010	0.111	-0.028
	(0.017)	(0.021)	(0.030)	(0.020)	(0.036)	(0.111)	(0.024)
Family Size, No.	0.009*	0.012**	0.005	0.003	0.027***		
	(0.004)	(0.005)	(0.007)	(0.005)	(0.007)		
Household Income (log)	0.001	-0.001	0.005	0.0001	0.001	-0.007	0.007*
	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Household Total Assets(log)	0.003**	0.003*	0.004	0.002	0.005**	0.003	0.003*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
Out-of-pocket Medical Cost(log)	-0.001	-0.0001	-0.003	-0.001	0.0005	0.0005	-0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ADL	0.007*	0.005	0.011	0.005	0.013*	-0.001	0.011*
	(0.004)	(0.004)	(0.011)	(0.005)	(0.006)	(0.006)	(0.005)
IADL	0.010*	0.010*	0.009	0.009	0.004	0.011	0.009
	(0.004)	(0.005)	(0.007)	(0.005)	(0.007)	(0.008)	(0.005)

Proxy Respondent	-0.009	-0.035	0.026	-0.013	-0.028	0.015	-0.023
	(0.015)	(0.022)	(0.021)	(0.018)	(0.029)	(0.031)	(0.018)
SSI or SSDI Receipt	0.040**	0.046**	0.023	0.050**	0.015	0.059*	0.026
	(0.014)	(0.016)	(0.027)	(0.018)	(0.025)	(0.024)	(0.018)
Social Security Receipt	-0.002	-0.003	0.004	-0.005	0.003	-0.001	0.007
	(0.010)	(0.013)	(0.017)	(0.014)	(0.018)	(0.024)	(0.012)
Health Insurance Coverage	0.033*	0.021	0.051	0.010	0.043	0.035	0.038*
	(0.016)	(0.019)	(0.029)	(0.019)	(0.030)	(0.033)	(0.018)
Meals-on-wheels Availability	0.013	0.029	-0.024	0.0001	0.032	0.030	-0.009
	(0.016)	(0.019)	(0.029)	(0.019)	(0.030)	(0.024)	(0.022)
Rural	0.072*	0.069	0.103	0.078*	-0.021	0.108	0.064
	(0.033)	(0.037)	(0.071)	(0.037)	(0.080)	(0.073)	(0.045)
Constant	0.110	0.068	0.613*	0.268*	0.006	0.329**	0.066
	(0.104)	(0.097)	(0.262)	(0.132)	(0.151)	(0.121)	(0.164)
Year FE	Y	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y	Y
Number of Observations	23,121	15,939	7,182	14,035	6,974	7,237	14,543
Number of Respondents	6,494	4,300	2,194	4,024	1,873	2,230	4,330
Adjusted R^2	0.494	0.505	0.475	0.534	0.436	0.564	0.478

Note: CIND indicates a respondent is Cognitive Impairment but No Dementia. The reference category of cognitive status is cognitively normal. The table shows results based on individual fixed effects models. Standard errors, clustered at the individual level, are provided in parentheses. This table is the specification reported in Panel B of Table 2 of the article. a We tested the differences of the coefficients of dementia between gender, race and living status at p=0.10 level. The coefficients between two gender and the two living status subgroups are significantly different. There is no significant difference between white and black subgroups. *p < 0.05 **p < 0.01 ***p < 0.001

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Chapter II: A Lack of Food for Thought: Midlife Food Insecurity and Its Association with Subsequent Cognitive Ability and Dementia Risk

Introduction

As life expectancy increases and demographic aging occurs in American populations, the number of people with cognitive impairments is expected to increase. In 2019, about 6.07 million older adults were living with clinical Alzheimer's Disease, and 12.23 million had mild cognitive impairment (MCI). In the absence of improved preventive strategies and interventions, these two numbers are estimated to increase to 13.85 million and 21.55 million in 2060 (Rajan et al., 2021), during which time low-income and minority individuals are expected to be at higher risk due to increased risk-factor burden. A national report from 2019 estimated that about 4.0 million Americans between the ages of 50 and 59 experienced food insecure, representing 9.5% of this age group. This rate marked a 23% increase from 2001 and surpassed the fraction of food insecure among older Americans ages 60 and above, which stood at 7.1% (Ziliak & Gundersen, 2021). As a critical modifiable social determinant of health, food insecurity is associated with lower nutrient intake and poorer health outcomes, including higher rates of hypertension, cardiometabolic disease, diabetes, asthma, depression, frailty, functional impairment, and lack of social support (Afulani et al., 2015; Gundersen & Ziliak, 2021; Heflin et al., 2019; Miller et al., 2022; Pooler et al., 2019). The association between food insecurity among adults and cognitive dysfunction or late-onset dementia among adults is less well-established. Much of the literature that examined this association has concentrated on children (Huang et al., 2017). Prior research has documented midlife low income, poor dietary intake, substance usage, depression, and vascular conditions as important modifiable risk factors for late-life cognitive impairment and dementia (Akbaraly et al., 2019; Hughes & Ganguli, 2009; Kezios et al., 2022). Nonetheless, the association between midlife food insecurity and later-life cognitive health outcomes remains unknown.

In this study, the research question centers on whether food insecurity exposure during midlife has implications for cognition abilities and dementia onset risk in later life. Using longitudinal data from the 1995-2020 Health and Retirement Study (HRS) datasets, this study tracks dementia-free respondents in their fifties throughout the subsequent life course to examine the role of food insecurity exposure and the dosage of exposure duration experienced in the ten years of their age 50-59 as predictors of dementia onset risks and cognitive decline after they turn 60 years old. Understanding the relationships will help inform public health initiatives and interventions to address food insecurity and its potential long-term cognitive impacts.

Long-run Midlife Food Insecurity Exposure

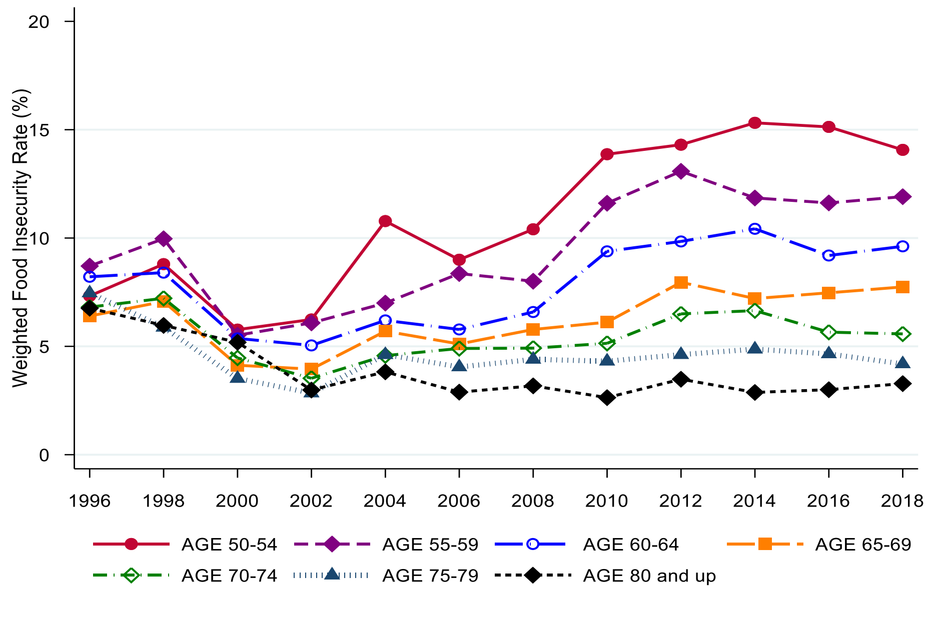
It is widely accepted that food insecurity negatively impacts cognitive development in children and adolescents (Bronchetti et al., 2018; Huang et al., 2017; Johnson & Markowitz, 2018). Systematic reviews suggest an adverse association between food insecurity experienced in early or later life and cognitive function in older adults, but the conclusion is based on sparse evidence which exploited mainly cross-sectional or regional data (Albert, 2022; Frith & Loprinzi, 2018; McMichael et al., 2022; Na et al., 2019). For example, a sample of 1,499 Puerto Ricans aged 45-75 living in the Boston area with a 2-year follow-up period documented a correlation between food insecurity and faster cognitive decline (Wong et al., 2016). One exception is recent research that investigated the longitudinal associations between food insecurity and cognitive function in older adults aged 65 and above using the national sample in 2012–2020. The findings reveal that food insecurity status in late life was adversely associated with faster cognitive decline in older adulthood (Na et al., 2023). According to another recent study, compared with Supplemental Nutrition Assistance Program (SNAP) participants, SNAP-eligible nonparticipants experienced 1.74 to 2.33 excess years of cognitive aging over a ten-year period. The proposed potential explanation is that through decreased food insecurity among SNAP participants, which affects their food insecurity-related mental, physical, and cognitive health outcomes (Lu et al., 2023).

Food insecurity is more prevalent among the middle-aged than older adults in the U.S. The rate of food-insecure among 50-59-year-olds was 9.5% (4.0 million) in 2019, and this number increased to 10.4% (4.3 million) in 2020, the first year of the COVID-19 pandemic (Ziliak & Gundersen, 2021a, 2022). Despite midlife risk exposures, public-health and individually tailored interventions, and healthy food availability have been emphasized in the guidelines for dementia prevention (Livingston et al., 2020), investigations of midlife food insecurity remain limited, and none explored cognitive health outcomes.

Figure 1 presents seven age groups' weighted food insecurity rates estimated using HRS datasets from 1996-2018. The figure illustrates that the prevalence of food insecurity remained relatively consistent across age groups between 1996 and 2002. However, a distinct pattern emerges with food insecurity prevalence decreasing with age during 2004-2018. Compared to their older adult counterparts who maintained stable or declined food insecurity rates, the 50-54 and 55-59 age groups exhibit higher levels of food insecurity, particularly after 2004 - 2006. Both the national reports and my estimates from the HRS data highlight a sharp rise in food insecurity following the onset of the Great Recession in 2008. While these rates for both the age 50-59 group and overall older populations began to decline around 2012-2014, they have yet to return to pre-Great Recession levels (Ziliak & Gundersen, 2021a, 2022).

Given the consequential food insecurity among middle-aged Americans and its potential impact on changes in health outcomes due to diet-dependent pathways (Glymour & Manly, 2008; Ziliak & Gundersen, 2022), this study aims to identify whether midlife food insecurity exposure is associated with subsequently decreased cognition and increased dementia risk independent of food insecurity experience in later life.

Figure 1 Trends in Weighted Food Insecurity Rates by age groups across 1996 - 2018



Data Source: Author's calculation using HRS data and respondent weights. **Life-course Cumulative Disadvantage and Progressive Cognitive Decline**

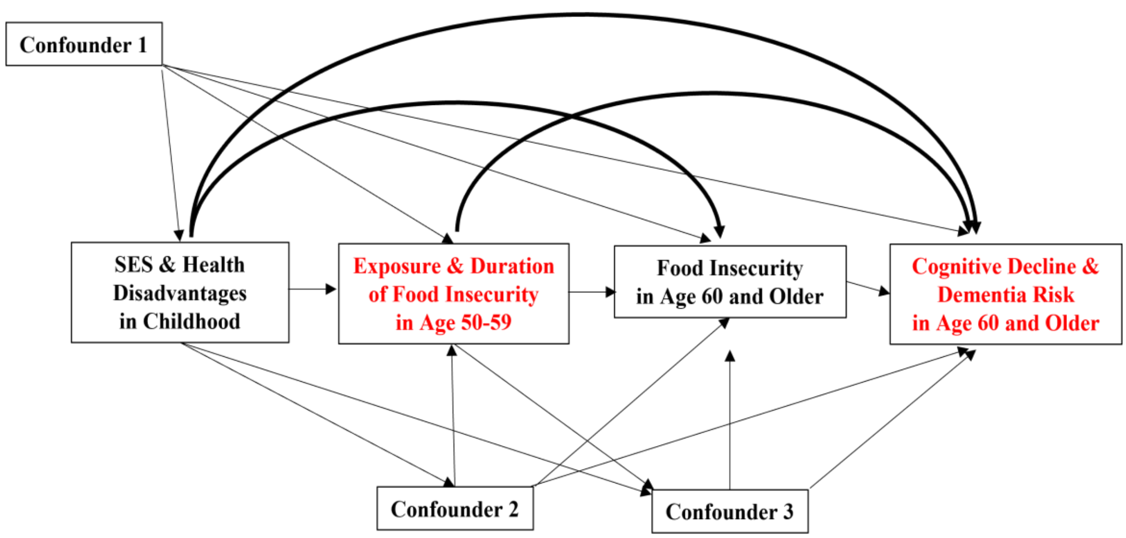
Cognitive decline is a gradual process that necessitates extended periods of observation, thus life-course cumulative perspectives are crucial for understanding cognitive decline in later life. Life course sociologists, epidemiologists, and psychologists further recognized the importance of specific periods in the life course for shaping later health outcomes. Young ages have been widely recognized as neurocognitively vulnerable ages and evidence suggests that socioeconomic risk factors accumulate over the life course and have substantial and long-term adverse effects on adult cognitive performance (Faul et al., 2021; Hale, 2017). Even though cognitive plasticity peaks in early life, it does not mean adult life experience is unimportant. However, the extant literature presented mixed results. On one hand, Marden et al. tested the impacts of different SES measurements for childhood, early adulthood, and older adulthood on late-life cognitive function, with consistent findings showing the benefits of high SES in all these three life stages for memory function later in life (Marden et al., 2017). Evidence linking modifiable midlife risk factors and later-life cognitive functioning shows that cardiovascular conditions (Kivipelto et al., 2005; Li et al., 2022), obesity (Loef & Walach, 2013), marital dissolutions (Susan et al., 2021), depression (Afsara et al., 2021) and low wages (Kezios et al., 2022) in midlife are significantly associated with cognitive decline and dementia in older age (Fancourt & Steptoe, 2019; Kezios et al., 2022). In terms of food insecurity, both early-life and later-life exposure are risk factors for cognitive ability in late adulthood (McMichael et al., 2022; Na et al., 2019). On the other hand, in examining the possible mediating effect of later-life SES on the association between childhood SES and later-life cognitive function, Faul et al. found that upward mobility may partially compensate for disadvantage early in life but does not protect against cognitive decline (Faul et al., 2021).

A better understanding of food insecurity as a modifiable risk for cognitive health is needed, especially on the independent effect of food insecurity among middle-aged Americans. The limited evidence recognized food insecurity as a critical social determinate of health (SDH) that could potentially be linked to cognitive dysfunction and dementia among older adults through pathways such as nutrient deficiencies, chronic stress, mental health issues, and chronic health comorbidities (Na et al., 2023; Na et al., 2019). Mechanistically, midlife food insecurity exposure alters dietary behavior and increases the risk of poor nutrition intake, physical and mental problems (Oi, 2017; Ziliak & Gundersen, 2021a), contributing to elevated allostatic load, inflammatory disturbances, cognitive impairment, and dementia due to neurodegenerative changes in the brain (Hughes & Ganguli, 2009). The current evidence linking food insecurity and cognitive function is limited in two ways. First, the few studies that examined this association have not differentiated the timing of the exposure. No study has directly tested the effect of midlife food insecurity on later-life cognitive health outcomes. Second, current studies have primarily relied on instantaneous or recent measures to capture the exposure to food insecurity. The inattentiveness to food insecurity as a deleterious exposure during a specific stage of life and its long-term cumulative quantity may miss crucial prevention windows and those most vulnerable groups for tailoring clinical interventions.

Conceptual Framework and Hypothesis

Cognitive aging is a life-course process that starts before birth, and risk factors and processes have been documented in all stages of the life span. Based on the extant research, Figure 2 shows this study's conceptual framework, which highlights the complexities of interrelated life-course processes underlying the associations between midlife food insecurity and cognitive health outcomes in later life. This framework also assumes that early adverse experiences synergize with midlife adverse experiences in association with later-life health outcomes, indicating that the accumulation of risk processes persists throughout the lifespan. Following (Marden et al., 2017), this framework controlled prior exposure, i.e., childhood SES and health disadvantages, in estimating the direct impact of midlife food insecurity exposure on cognitive health outcomes over time. As pointed out by (VanderWeele et al., 2020), it is essential to control prior exposure, i.e., childhood SES and baseline cognitive functioning level at age 50/51, in estimating the direct impact of food insecurity exposure on cognitive health outcome over time. Controlling these prior exposures can further reduce the potential for unmeasured confounding. Confounder 1 is related to the childhood stage, including sex and race, and confounder 2 represents the potential confounders for food insecurity in ages 50-59, including baseline cognition functioning score and ever-diagnosed chronic diseases at age 50/51. Confounder 3 is further controlled, which is related to the late-adulthood association between food insecurity and cognitive decline and dementia risk, including living alone, rural residence, family income, health behaviors, body mass index (BMI), and depression symptoms (CESD).

Figure 2 Conceptual Framework



Note: This framework is adapted from Figure 1 of (Marden et al., 2017).

This study aims to estimate the relationship between food insecurity (FI) exposure and its duration in the midlife years and later-life cognition. We expect that individuals' FI experience during midlife is associated with a higher likelihood of dementia onset and lower cognitive functioning after they aged 60 and above. Further, this study aims at estimating the dose-response relationship between food insecurity exposure and its duration in the midlife years and later-life cognition, reflecting the idea that the impact of food insecurity will likely be cumulative over time.

Specifically, four hypotheses are proposed in this paper.

- **H1:** Exposure to FI in age period 50-59 is associated with a higher risk of dementia in later life after age 60 and above.
- **H2:** Longer exposure to FI during ten years of fifties is associated with a higher cognitive impairment risk at age ⩾60 years.
- **H3:** Exposure to FI at 50 - 59 years of age is associated with lower cognition functioning scores at age⩾60 years.
- **H4:** Longer exposure to FI at 50–59 years of age is associated with lower cognitive functioning scores at ⩾60 years.

Method

Sample

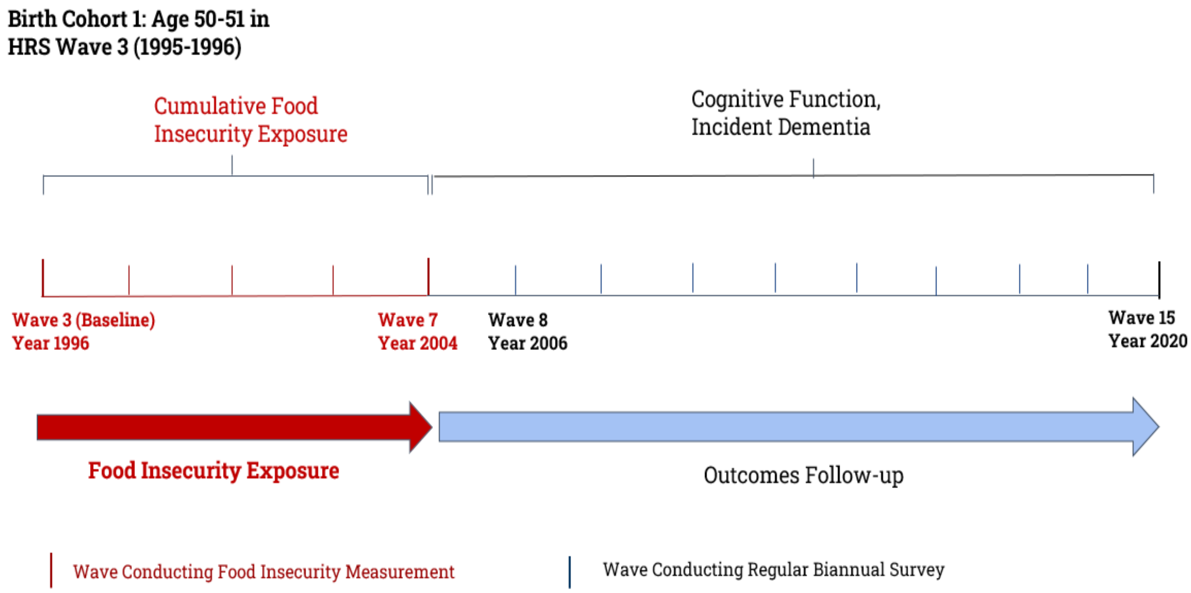
This study uses data from the 1995 to 2020 Health and Retirement Study (HRS), a longitudinal survey that began in 1992 and collects data on more than 20,000 Americans over the age of 50 every two years. The HRS is the major data source for research on aging and retirement issues in America and contains repeated measures on comprehensive information which is needed in this study, such as different levels of cognitive ability, food security status, sociodemographic characteristics, physical and mental health status, health behavior, and childhood socioeconomic status. The HRS was approved by the Institutional Review Board at the University of Michigan and the National Institute on Aging (HUM00061128).

Analytic Sample

The respondents included in this study are older adults aged 60 and older who had their cognitive ability measured at least once in wave 8 (2006) to wave 15 (2020) and had midlife cognitive ability and food security status measured in their age fifties. The evolution of the analytic sample began with 24,500 survey respondents consisting of eight birth cohorts who were 50 or 51 years old in wave 3 (1995-1996) to wave 10 (2009-2010), with samples censored at the onset of dementia and death, whichever came first. To reduce the possibility of reverse causality, 254 respondents with dementia in their age fifties or without baseline cognitive measurements were also excluded. After dropping respondents who failed to follow up at age 60 and above, had midlife food insecurity measurements less than four waves, or had missing values on all other covariates, the resulting sample size of the surviving analysis model is 11,168. See Appendix Figure 1 is the flowchart of the detailed information on sample selection. The sample selection of the mixed-effects analysis of cognition ability outcome followed the same steps, except that the samples were not censored based on dementia onset, resulting in an analytical sample size of 11,505.

For each of the above eight cohorts' respondents, 10-year data in their age fifties were used to evaluate cumulative food insecurity exposure, and data collected in their age 60 and above was used to assess cognition ability and dementia onset. The study timeline is presented in Figure 3. Take the birth cohort 1 who was 50 or 51 years of age in HRS Wave 3 (1995-1996) as an example, the food insecurity measurements were conducted from Wave 3 to Wave 7, and cognitive outcomes were assessed in the follow-up survey from Wave 8 (2005-2006) to Wave 15 (2019-2020).

Figure 3 Study Timeline and Design: Using Birth Cohort 1 as an example.



Note: The other seven Cohorts are: Cohort 2-age 50-51 in HRS Wave 4 (1997-1998); Cohort 3-age 50-51 in HRS Wave 5 (1999-2000); Cohort 4-age 50-51 in HRS Wave 6 (2001-2002); Cohort 5-age 50-51 in HRS Wave 7 (2003-2004); Cohort 6-age 50-51 in HRS Wave 8 (2005-2006); Cohort 7-age 50-51 in HRS Wave 9 (2007-2008); Cohort 8-age 50-51 in HRS Wave 10 (2009-2010). This figure is adapted from Figure 1 of (Li et al., 2022).

Measures

Cognitive Functioning and Dementia

The total cognitive function score ranges from 0 to 27, with higher scores representing better cognitive functioning. It was assessed using a 27-point Telephone Interview for Cognitive Status (TICS) scale by summing immediate and delayed word recall, serial subtraction, and backward counting tests. The scale is well suited to this study because it was administered among a nationally representative sample of adults aged 50 and older. Dementia cases were identified using the Weir-Langa Classifications defined based on the clinically assessed prevalence of these statuses in the Aging, Demographics, and Memory Study (ADAMS) (Crimmins et al., 2011). Cut points for dementia are set at the total cognitive functioning score of

0–6, together with a score of 7–11 as cutting points for Cognitive Impaired but No Dementia (CIND) and cognitively normal (a score of 12–27). In addition, the HRS employs proxy respondents to minimize sample attrition when the respondent is unavailable, incapable, or unwilling to partake in the interview. Respondents who did not participate in the TICS tests can have their cognitive status evaluated through three proxy assessment questions concerning memory appraisal, five Instrumental Activities of Daily Living limitations, and the interviewer's assessment of cognitive impairment. Utilizing this 11-point scale, the Weir-Langa Classifications establish three cognitive statuses for proxy respondents: dementia (score of 6-11), CIND (score of 3-5), and cognitively normal (score of 0-2) (Crimmins et al., 2011).

Food Insecurity Exposure

The HRS measures food security with a yes/no question. New respondents are asked, "In the last two years, have you always had enough money to buy the food you need?" Respondents who were interviewed in the previous survey wave are asked, "Since [month and year of previous interview], have you always had enough money to buy the food you need?" We code those who say "no" as being food insecure. This question was first asked in HRS in the 1995 wave of interviews, conducted only for respondents born in 1923 and earlier, and has been asked of all respondents since 1996. To derive a continuous measure of cumulative food insecurity duration during their midlife, we summed up the times each respondent lived through food insecurity measured in five waves from 50 to 59. Given the biennial nature of HRS, the exposure to food insecurity in one wave indicates the duration of food insecurity for two years. For a small number of individuals with only four measurements in food insecurity during their age fifties, we take the mean and multiply by five to estimate the midlife cumulative food insecurity exposure. The total food insecurity exposure score ranges from 0 to 10, with higher scores representing worse food security status. Midlife food insecurity exposure is a binary variable indicating that the respondent reported being food insecure at least once during the five waves of their age fifties. Later-life food insecurity is a dichotomous variable (1=yes, 0=no).

Early-life Characteristics

Early-life characteristics were measured using a range of variables reflecting childhood family SES and health status. Both maternal and paternal educational attainment were recorded as years of formal education, and missing cases were assigned the median values. A binary variable was coded for being non-missing on either of the parents' education and included as a control variable in the analysis. Respondents of HRS were asked questions about their childhood health and family financial status during childhood in 1998, and their responses were recorded as the baseline, non-varying values. In the subsequent waves after 1998, these questions were asked only of new respondents to the HRS sample. The childhood health disadvantage is measured using a self-reported five-point scale for health status during childhood, with Excellent as a reference and four binary variables indicating Very Good, Fair, and Poor. Respondents also reported if their families had low financial status (1 = Poor or Varied; 0 = Well-off or Average).

Covariates

Three sets of potential confounders that influence the association between each of the three life-course characteristics and late-life cognitive outcomes are controlled in the analyses (refer back to Figure 2). Sociodemographic factors are age in years, sex (0=male, 1= female), race, marital status (0= unmarried, 1= married), education level, living alone (0=no, 1=yes), family income (logged value), and rural residence. Race corresponds to whether the respondent is identified as white, black, or other. Education level is measured as two dichotomous variables indicating whether respondents are high school graduates, or higher than high school, with less than high school as the reference group. We used the 2003 Beale Rural-Urban Continuum Codes to categorize HRS respondents as living in an urban or rural area (Health and Retirement Study, 2019). Health factors included binary variables indicating ever-diagnosed hypertension, diabetes, heart attack, cancer, and stroke at baseline age. We also include body mass index (weight(kg)/height(m)^2). Depressive symptoms are assessed using the Center for Epidemiologic Studies Depression (CESD) scale by summing up six negative and two positive indicators of mood, with higher scores indicating more severe depression levels (St. Clair, et al., 2008). Health behaviors factors are three dichotomous variables consisting of cigarettes smoking (0=no, 1=yes), at least once per week alcohol consumption (0=no, 1=yes), and regular physical exercise at least once a week (0=no, 1=yes).

Statistical Analysis

To test the first and second hypotheses (H1 and H2), the association between midlife food insecurity exposure and food insecurity duration in years and subsequent later-year dementia onset was examined separately using Cox proportional hazard models with age as the timescale, calculating multivariate-adjusted hazard ratios (HR's) with 95% confidence intervals (CI's). The samples without dementia onset were censored at the last available cognition function measurement, and the proportional hazards assumption test was verified using the Schoenfeld residual test. Both sets of analyses were first adjusted for midlife food insecurity duration in years, cognitive functioning score at age 50/51, time-variant food insecurity status, sex, educational attainment, race, living alone, family income, and rural residence (Sean et al., 2015) (Model 1). This analysis was repeated by adding childhood SES and childhood health status (Model 2) and health and health behavior (Model 3) as additional covariates to test if the association between food insecurity and incident dementia was independent of different confounders.

To test Hypothesis 3 (H3), linear mixed-effects models were employed to examine the association between food insecurity exposure in the age of fifties and the subsequent cognitive ability measured during wave 8 (2005-2006) to wave 15 (2019-2020). Then the total cognition functioning score measured at later years of age was regressed on the number of years of food insecurity during their midlife period to test Hypothesis 4 (H4). Estimates can be interpreted as the association between an additional year of food insecurity exposure of the respondents in their fifties and means of cognitive function in their later years (age ⩾60 years old) adjusted by covariates. Like the analysis above, the basic Model 1 controlled the baseline cognition function at baseline (age 50 or 51), time-variant food insecurity, and sociodemographic characteristics. The analyses were further adjusted for Childhood characteristics (Model 2) and then added in a series of health and health behaviors (Model 3) (Donovan et al., 2017).

Results

Table 1 presents some basic descriptives for the total analytical sample (N=11,168), consisting of adults aged 60 and above, further delineated by the dementia onset status. The average age is 64.54 years old. Notably, nearly one in five (19.29%) of the analytical samples reported being food-insecure at least once during a period ranging from 2-10 years, with the average duration of food insecurity exposure being 0.74 years between the ages of 50-59. The distribution of household food insecurity exposure is as follows: no exposure 80.71%, 2 years 9.48%, 2.5 or 4 years 4.49%, and 5 or 6 years 2.51%. A minimal proportion of analytical samples (1.67% and 1.13%) reported persistent food insecurity for over 7.5 years during their fifties. About 6.86% experienced food insecurity exposure in their older years.

The mean cognitive scores at the baseline age of 50/51 and subsequently at age 60 and above are 17.73 and 16.90 out of 27, respectively. The distribution of the cognition scores, depicted in Appendix Figure 2, suggests a near-normal distribution. Most analytical respondents are females (72.03%) and identify as whites (78.03%). Regarding educational attainment, 15.8% did not complete high school, 51.10% held a high school diploma, and nearly one-third (33.10%) achieved education beyond high school. The average years of fathers' and mothers' education are 10.01 years and 9.91 years, respectively. A significant proportion, 25.48%, of analytical sample reported their childhood family' financial status to be below average. In terms of childhood health status, respondents reported their status as: excellent (54.71%), very good (25.21%), good (14.08%), fair (4.65%), and poor (1.28%). The sample's average BMI is 28.36, with the mean CESD score being 1.47 out of 8. A considerable 27.04% have ever been diagnosed with hypertension at baseline, and much fewer of them reported ever being diagnosed with diabetes (7.23%), heart Attack (6.25%), cancer (4.69%), and stoke (1.58%). In terms of health behaviors, more than one-fifth (21.75%) confirmed smoking, while around three-fifths reported alcohol consumption (61.54%) and regular physical exercise (58.05%).

Additionally, Table 1 shows that of the 2,808 dementia-free respondents at the end of their fifties, 3.9% (n = 109) received a dementia diagnosis in their later life. Comparative analyses showed considerable disparities between the samples who had a dementia onset in their later years and those who did not. Compared to their cognitively normal counterparts, individuals who were later diagnosed with dementia displayed higher propensities for food insecurity (and prolonged exposure to it during age fifties), older, non-white, lower education attainment, and living alone. They also reported fewer average years of parental education, decreased cognition functioning score both at baseline and in old-age years, elevated depression symptoms, heightened tendencies for smoking and alcohol drinking and reduced physical exercises. Notably, there are significantly elevated incidence rates of ever diagnosed with diabetes, heart attack, and stroke at baseline age among those who experienced incident dementia post the age of 60 compared to their dementia-free counterparts.

Table 2 presents the hazard ratios and 95% confidence intervals (Cis) from the Cox proportional hazards regression analyses. Across all three models, incident dementia was consistently associated with a lower cognition score at age 50/51, less education, and less family income. Relative to their counterparts who were never exposed to food insecurity throughout their fifties, there was a 74% elevated risk of developing dementia over the follow-up among older adults who experienced midlife food insecurity (95% CI, 1.16-2.60; P<0.01). This association persisted after controlling for the cognition score at baseline age, current food insecurity in later life, and a serial of sociodemographic characteristics (Model 1). The association between midlife food insecurity exposure and incident dementia onset risk was similar as the early-life SES and health status were furtherly controlled in Model 2 (HR, 1.76; 95% CI, 1.17-2.65; P<0.01). In the fully adjusted Model 3 which furtherly controlled for clinical and behavioral risk factors, ever diagnosed with diabetic at age 50/51 emerged as an independent risk factor for old-age dementia. There was a 66% increase in hazard risk of dementia onset in older age for those who experienced midlife food insecurity (95% CI, 1.09-2.53; P<0.05).

The covariates remain consistent in all three models of Table 3. To explore the potential dose-response effect of cumulative food insecurity duration, I replaced the dichotomous food insecurity exposure with a continuous variable measuring the midlife food insecurity exposure in years. Consistent with the findings in Table 2, a lower cognition score at baseline age, fewer years of education, and reduced income were significantly associated with higher risk of dementia onset in all three models. In the first model, one additional year of food insecurity exposure during one's fifties was associated with an 8% increase in dementia risk (95% CI, 1.01-1.16; P<0.05) in later life after age 60. This association was independent of baseline cognition ability, current food insecurity status, sex, education, race, living alone, rural residence, and family income. The magnitude and direction of the association between every additional year of midlife food insecurity exposure and increased risk of dementia onset among older adults remained consistent after further adjusting childhood SES and health status (HR, 1.09; 95% CI, 1.02-1.18; P<0.05). The third and fully adjusted model further substantiated this, showing the evidence that each additional year of food insecurity exposure in one's fifties is related to a 8% heightened risk of dementia onset in later years (95% CI, 1.00-1.17; P<0.05).

The linear mixed-effect models for the association between midlife food insecurity exposure and total cognitive function are displayed in Table 4. Model 1 shows that in this sample, a history of food insecurity exposure during individuals' fifties was significantly linked to a decrease in the cognitive function score by 0.46, net the effects of sociodemographic factors, total cognitive score at baseline age, and current food insecurity in old age (95% CI, -0.71 - -0.22; P<0.001). The association is consistent even after further accounting for parental education and childhood family financial and health disadvantage status (Model 2: HR, 0.45; 95% CI, -0.69 - -0.20; P<0.001). The magnitude of the association lessened to 0.26 but remained significant in the full adjusted Model 3 (95% CI, -0.51- -0.02; P<0.05). Being older age, female, less education, non-white, less family income, and reduced baseline cognitive score have consistently associated with diminished subsequent cognitive score in old age throughout the three models. In Model 2 and 3, factors such as fewer years of mothers' education, poorer childhood health status, having a diabetes diagnosis by age 50/51, elevated BMI, severe depression symptoms, smoking, no alcohol assumption, and lacking physical activity emerged as independent predictors of reduced cognitive score in later years.

Table 5 adopts a model structure similar to Table 4 but replaces the dichotomous midlife food insecurity metric with continuous measure, denoting the cumulative years of food insecurity over one's ages 50-59. The result in Model 1 indicates that each additional year of food insecurity exposure during age fifties was associated with a subsequent cognition functioning score reduction by 0.11 among older Americans aged 60 and above (95% CI, -0.16 - -0.06; P<0.001), factoring sociodemographic factors, baseline cognitive ability, and current food insecurity status. This association holds even after accounting for early-life family socioeconomic and health status (Model 2). The magnitude of the association dropped to 0.06 after further controlling for five baseline chronic disease diagnoses and other health and health behavior indicators, it remained statistically significant (95% CI, -0.11 - -0.01; P<0.05). The overall pattern of other covariates paralleled that in Table 4.

Sensitivity Test

Like other longitudinal studies on aging, the current analytical sample using HRS data is subject to attrition, in which respondents are prone to selective dropout due to death or poor health. Moreover, the analytic samples are limited to survey respondents who have been successfully followed up for at least four waves in the age fifties (for the age 60 and above study group). These restrictions may result in selective samples if the prevalence of missing value during midlife is high among the respondents who had their cognitive function assessed in later life. Ignoring those selective dropouts can result in bias in the analysis.

We used Inverse Probability Weighting (IPW) to examine the sensitivity of our results to attrition and to ensure that missing data did not influence the results. We first estimated the probability of being included in the analytical sample (no missing data) using the following covariates in logistic regression: sociodemographic variables, health behaviors, cardiometabolic and other diagnosed chronic conditions, depressive symptoms, and dementia status over the follow-up. The inverse of these probabilities was used as weights in the reanalysis of all the models in Table 2 to Table 5 using Cox regression and mixed-effects models. The results presented in four supplemental tables (*Supplement Table A* to *Supplement Table D*) show that the inverse probability weighting missing data yielded similar findings as the main analysis.

Given the skewed distribution of the midlife food insecurity duration (see Appendix Figure 3), we replaced the original years of duration with logged value and reanalyzed the two main models, i.e., Cox proportional hazard regression models in Table 3 and linear mixed-effects models in Table 5 test the robustness of the results to the measurement of food insecurity. The results do not change (see Appendix Table 5 and Appendix Table 6).

Discussion

Using prospective longitudinal data from the eight HRS birth cohorts aged 50 or 51 in wave 3 to wave 10, this study investigated the impact of the long-run prevalence of food insecurity during ten years in age fifties on the subsequent cognitive function and incident dementia over a 14-year follow-up period among American older adults. The findings suggested that individuals' food insecurity experiences between 50 and 59 is an independent risk factor for subsequent cognitive health outcomes. Moreover, midlife food insecurity exposure can have long-term additive effects on the progression of cognitive decline and the onset of dementia, lasting for even years or decades into old age.

There are several reasons why food insecurity may be deleterious to cognitive ability. In line with our results, other studies showed that food insecurity can increase the incidence of diabetes (Essien et al., 2016; Heflin et al., 2022), hypertension (Beltrán et al., 2020), and cardiovascular disease (Vercammen et al., 2019), which often coincides with cognitive decline and dementia (Sabia et al., 2019). Food-insecure adults with hypertension and diabetes tend to have poor disease self-management (Gucciardi et al., 2019) and medicine non-adherence (Heflin et al., 2022). Food insecurity exposure may also affect cognitive disorders through varied pathways, such as unhealthy nutrition and chronic stress (Glymour & Manly, 2008; McMichael et al., 2022).

Midlife constitutes a pivotal period in the life span featured by the unique constellations of balancing multiple family roles, opportunities such as career development and crystallized cognitive abilities, and challenges such as job insecurity, growing prevalence of chronic diseases and disabilities, poor diet, and psychological distress (Infurna et al., 2020; Péter et al., 2021). Alongside the disproportionally high rates of food insecurity (Ziliak & Gundersen, 2021a), there is strong evidence showing troubling signs of population health among middle-aged Americans (Kemp et al., 2022; Péter et al., 2021). According to a study examined a rich set of health indicators of successive cohorts of Americans aged 54–60 born between 1934 and 1959 using HRS data, almost all the health status indicators declined over recent decades, especially the worsening of the rates of obesity, diabetes, and levels of pain (Péter et al., 2021). Evidence adopting the cumulative biological models in examining neurodegenerative disease pathologies has also found strong evidence that the cumulated periods of exposure to risk factors can weather and wreak the underlying biological vulnerability, contributing to cognitive decline and development of dementia later in life (Glymour & Manly, 2008). Such mechanisms might support the hypothesis and finding of this study that midlife food insecurity and the total burden of being confronted with inadequate food across this life period is one pathway by which such deleterious exposure may increase the risk of poor cognitive outcomes, demonstrated through the additive effects of long-run food insecurity exposure risk.

This study indicates that both timing and the extent of food insecurity exposure in the life course matters for the later-life cognitive ability and risks of dementia onset. Previous study showed that to delay the onset of dementia, the optimum time window for interventions that target lifestyle-related risk factors might be middle age, and interventions are likely to be more effective (McMichael et al., 2022). The results presented in this study are also consistent with existed evidence that a 10% reduction in exposure to seven modifiable risk factors (low education, smoking, diabetes, midlife hypertension, midlife obesity, depression, and physical inactivity) in midlife could potentially prevent up to 1.1 million cases of AD per year worldwide. A prevention RCT study has highlighted the importance of appropriate timing of the intervention when designing and testing prevention strategies (Kryscio, 2014). Starting during preclinical or prodromal AD --i.e., before the onset of dementia—is likely to be more effective than starting when dementia is already established. Therefore, this study's clinical implication is that the interventions' efficacy to prevent or delay dementia onset may increase if food security is simultaneously addressed. The cognitive health inequality in later life can be decreased as a result of improved food security in mid-life.

Preventing hunger in midlife may be more effective than treating cognition diseases and reacting to the medical burden later. Of the largest publicly funded hunger safety programs covering the life course from the cradle to the grave in the USA[1] (Coleman-Jensen et al., 2022),

[1] The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federally funded nutrition program targeting pregnant, breastfeeding, and non-breastfeeding postpartum women, infants, and children younger than age 5 in low-income families. The National School Lunch Program (NSLP) is designed to target children in low-income families and operates in residential childcare institutions and schools. SNAP is broadly available to almost all low-income populations and predominantly serv households with children, elderly, and disabled members.

the Supplemental Nutrition Assistance Program (SNAP) is the most relevant and powerful lever for improving food security among middle-aged Americans. Due to age-based and strong work incentive SNAP eligibility and benefits rules, for the majority of community-living adults between the ages of 50 and 59 in the United States who are able-bodied and without dependent children at home, the support from SNAP to deal with food insufficiency has been thin (Heflin, 2021). Two essential report series offer a comprehensive overview of food insecurity among Americans, revealing higher food insecurity rate, lower SNAP eligibility rate, and increased SNAP participation and uptake rates among adults aged 50-59 compared with their older counterparts (Ziliak & Gundersen, 2021a, 2021b).

Recent research points to the growing role of U.S. policy contexts in resources for health and how state policy contexts may have contributed to unfavorable health outcomes among midlife adults (Kemp et al., 2022; Montez et al., 2021). This current study echoes scholars' calling for using a life-course perspective to understand public policy's short- and long-term implications (Wilmoth & London, 2021). One of the reasons for the high pervasive hunger and poverty among American adults aged 50 - 59 might be the age-based social policy. Pre-retirement, non-disabled middle-aged population groups are not eligible for Social Security benefits, Medicare, and the less restrictive SNAP eligibility rules applicable only to older adults of age 60 and above or disabled individuals. Revised policy solutions are necessary to address the high rates of food insecurity among the middle-aged population (Infurna et al., 2020).

Some studies point out that the effects of program participation and access to the social safety net can accumulate and condition the effects of other aspects of the social safety net across the life course. Moreover, growth and change are ongoing processes that are punctuated by sensitive periods, which set the stage for subsequent developmental stages (Wilmoth & London, 2021). Therefore, food assistant programs informed by a coherent life-course perspective (Heflin, 2021) and developmentally appropriate intervention time windows might be more effective than those that do not consider individuals' developmental stages (Wilmoth & London, 2021). This was confirmed in the present study. It seems that food assistance programs designed to meet the needs during adulthood do not adequately serve individuals aged 50-59. Based on these results, we recommend using SNAP as a preventive health policy by expanding lenient eligibility rules to the age 50-59 group and implementing life-course policies viewing the investment in healthy aging as an issue for the entire population rather than focusing solely on older individuals.

Contribution and Limitation

This study first explores the relationship between food insecurity exposure during middle age and subsequent later-life cognitive function and dementia risk in older American adults. Utilizing a nationally representative longitudinal dataset, this research accounts for a host of unobservable and observable socioeconomic, life-course, and later-life factors that may be related to the association between midlife food insecurity and subsequent later cognition outcomes. Another strength of this study is that I observed the long-term food insecurity exposure over ten years in respondents' age fifties due to the high level of transition into and out of food insecurity. Previous study revealed episodic nature of food insecurity and hence, the necessity of measuring persistence in material hardship over time to capture individuals' true capacity to meet their basic needs (Heflin & Butler, 2013). The current measurement of midlife food insecurity considered the fact that more individuals can be affected than at any given point, increasing the risk of experiencing food-related hardships throughout their lives. Heflin (2017) utilized nationally representative data to estimate the duration and long-term trends in material hardship, including food insecurity, and highlighted key demographic differences when analyzing material hardship over time (Heflin, 2017). Wilde et al. (2010) estimated the US national level food insecurity exposure in a period of 5 consecutive years and found that rate of 5-year food insecurity (16.9%) is much higher than the 1-year rate (6.3%) (Wilde et al., 2010). Using HRS data, (Levy, 2022) estimated the long-run risk of food insufficiency among individuals ages 60 and older. The results indicated that approximately 8% of seniors report experiencing food security over a long recall window, while 22% of older adults experienced food insufficiency at some point over the 20-year window of their 60s and 70s.

Among the limitations of the study is the absence of a comprehensive measurement of food insecurity such as the US Household Food Security Survey Module (Ziliak & Gundersen, 2021b). The food insecurity measurement in HRS is a single yes/no question about the financial constraint of food access that may underestimate the prevalence and be seen as a proxy for low and the current results may not be directly comparable to the studies using other food insecurity measures. However, Levy's recent study established the validity of the HRS food insecurity measure with a detailed comparison of it to a measure of food-related hardship[2] and a measure of food insecurity based on an 18-question sequence[3] in the Current Population Survey (CPS) Food Security Supplement. Although the HRS measurement is simpler and the recall period is longer than the CPS measurements, the estimates of food insecurity and trends over time in the three measures are quite similar (Levy, 2022). The second limitation pertains to the research design concerning the

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[2] Respondents are first prompted to consider food consumption and affordability in the past 12 months and are then asked, "Which of these statements best describes the food eaten in your household: enough of the kids of food (I/we) want to eat, enough but not always the kinds of food (I/we) want, sometimes not enough to eat, or often not enough to eat?" Those who choose the last two responses—sometimes or often not enough to eat—are coded as food insufficient.

[3] Households were coded as food insecurity if the responses were very low, low, marginal, or high over a 30-day or 12-month period.

age range of the analytical samples. Due to the study design and the current time coverage of the HRS datasets, the maximum age of the analytical samples is 76 years old. Nevertheless, in relevant health and medical literature, it is common to exclude samples of individuals over 80 years of age when the outcome of interest is dementia, as dementia onset after this age range may not represent a pathological symptom but rather a natural cognitive decline out of normal aging. Another possible limitation is that although this study provides evidence suggesting links between midlife food insecurity exposure, cognitive dysfunction, and dementia risk, further research is needed to establish a causal relationship and to understand the underlying mechanisms. It is also crucial to acknowledge that other factors not controlled in this study, such as genetics, diet quality, and nutrient intake, may also impact cognitive function and dementia risk.

Conclusion

Although food insecurity and its health outcomes have been discussed with increasing interest, there is much scarce work about this burden and its impact on health outcomes in middle-aged compared to children and older adults. My findings emphasize the dosage effect of food insecurity cumulation during midlife on later cognitive decline and dementia risks among older American adults. Results in this study showed that food insecurity exposure experienced in the midlife stage (age 50-59) is associated with higher dementia onset risk and a lower total cognition function score after age 60. The number of years of food insecurity exposure in the age period 50-59 is negatively associated with cognitive function and positively associated with dementia risk at 60 years and older. The evidence proved that life course disadvantage accumulates during midlife to predict worse later-life cognitive function, which provides strong evidence for the cumulative inequality model.

Table 1. Descriptive Statistics of the Analytical Sample, for the Total Sample and by Incident Dementia Status

	Total		No incident dementia		Incident dementia		Sig
Food Insecurity							
Midlife Food Insecurity Exposure Ever, n(%)	2154	(19.29)	2030	(18.76)	124	(35.73)	< 0.001
Midlife Food Insecurity Duration(years) ,mean (SD)	0.74	（1.85）	0.72	(1.82)	1.52	(2.54)	< 0.001
Midlife Food Insecurity Exposure Categories, n(%)							
None	9014	(80.71)	8791	(81.24)	223	(64.27)	< 0.001
2 years	1059	(9.48)	1013	(9.36)	46	(13.26)	0.015
2.5 or 4 years	502	(4.49)	468	(4.32)	34	(9.80)	< 0.001
5 or 6 years	280	(2.51)	258	(2.38)	22	(6.34)	< 0.001
7.5 or 8 years	187	(1.67)	173	(1.60)	14	(4.03)	< 0.001
10 years	126	(1.13)	118	(1.09)	8	(2.31)	0.035
Later-life Food Insecurity, n(%)	766	(6.86)	717	(6.63)	49	(14.12)	< 0.001
Socio-demographic							
Age (years), mean (SD)	64.54	（3.96）	64.56	(3.97)	63.85	(3.65)	0.001
Living alone, n(%)	1875	(17.01)	1797	(16.83)	78	(22.54)	0.005
Rural Residence, n(%)	3271	(29.29)	3151	(29.12)	120	(34.58)	0.027
Family Income ($)	73699.3	(91233.8)	74062.7	(91526.17)	39185.7	(50935.98)	< 0.001
Family Income (Logged)	10.83	(1.07)	10.9	(1.06)	10.09	(1.12)	< 0.001
Sex							
Male, n(%)	3124	(27.97)	3022	(27.93)	102	(29.39)	0.549
Female, n(%)	8044	(72.03)	7799	(72.07)	245	(70.61)	0.549
Race							
White, n(%)	8744	(78.30)	8541	(78.93)	203	(58.50)	< 0.001
Black, n(%)	1597	(14.30)	1496	(13.82)	101	(29.11)	< 0.001
Other races, n(%)	827	(7.41)	784	(7.25)	43	(12.39)	< 0.001
Education							
Less than high school, n(%)	1764	(15.80)	1622	(14.99)	142	(40.92)	< 0.001
High school graduate, n(%)	5707	(51.10)	5552	(51.31)	155	(44.67)	0.015
More than high school, n(%)	3697	(33.10)	3647	(33.70)	50	(14.41)	< 0.001
Childhood SES							

Father Education (years), mean (SD)	10.01	(4.15)	10.01	(4.17)	7.81	(4.86)	< 0.001
Mother Education (years), mean (SD)	9.91	(4.32)	9.95	(4.36)	7.67	(4.49)	< 0.001
Parents' Education Non-missing, n(%)	9411	(84.27)	9125	(84.33)	286	(82.42)	0.337
Family Financial Status Low, n(%)	2816	(25.48)	2700	(24.18)	116	(33.43)	0.001
Childhood Health Status							
Excellent, n(%)	6110	(54.71)	5951	(54.99)	159	(45.82)	0.001
Very Good, n(%)	2816	(25.21)	2729	(25.22)	87	(25.07)	0.95
Good, n(%)	1572	(14.08)	1502	(13.88)	70	(20.17)	< 0.001
Fair, n(%)	519	(4.65)	496	(4.58)	23	(6.63)	0.075
Poor, n(%)	143	(1.28)	135	(1.25)	8	(2.31)	0.084
Health Factors							
Cognition score (Baseline), mean (SD)	17.73	(3.73)	17.85	(3.63)	13.89	(4.65)	< 0.001
Cognition score, mean (SD)	16.90	(3.94)	17.1	(3.73)	10.20	(4.92)	< 0.001
BMI, mean (SD)	28.36	(5.92)	28.3	(5.88)	28.90	(6.86)	0.082
CESD, mean (SD)	1.47	(1.96)	1.44	(1.94)	2.13	(2.31)	< 0.001
Ever Hypertension at age50/51, n(%)	3020	(27.04)	2911	(26.90)	109	(31.41)	0.063
Ever Diabetes at age50/51, n(%)	808	(7.23)	753	(6.96)	55	(15.85)	< 0.001
Ever Heart Attack at age50/51, n(%)	698	(6.25)	655	(6.05)	43	(12.39)	< 0.001
Ever Cancer at age50/51, n(%)	524	(4.69)	514	(4.75)	10	(2.88)	0.105
Ever Stroke at age50/51, n(%)	176	(1.58)	163	(1.51)	13	(3.75)	0.001
Health Behavior							
Smoke, n(%)	2429	(21.75)	2323	(21.47)	106	(30.55)	< 0.001
Drink, n(%)	6873	(61.54)	6748	(62.36)	125	(36.02)	< 0.001
Exercise, n(%)	6483	(58.05)	6306	(58.28)	177	(51.01)	0.007
Number of Observation	11,168		10,821		347		
Number of Respondents	2,808		2,699		109		

Note: Descriptive statistics of 11,168 analytical samples in Table 1 and Table 2 with dementia onset risk as outcome variables for the total sample and by incident dementia during follow-up. The analytical sample size in Table 3 and Table 4 is larger (n=11,505) because the respondents are not censored by the dementia onset. Statistics are presented as the number of observations and percentage (%) for categorical variables or mean level and standard deviation (SD) for continuous variables. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression.

Table 2. Cox Proportional Hazards Regression to Predict Incident Dementia Risk at Age≥60 from Midlife Food Insecurity Exposure, HRS 2006 - 2020

	Model 1	Model 2	Model 3
Midlife Food Insecurity Exposure	1.74 [1.16,2.60]**	1.76 [1.17,2.65]**	1.66 [1.09,2.53]*
Total Cognition Score age50/51	0.79 [0.75,0.83]***	0.79 [0.74,0.83]***	0.80 [0.75,0.84]***
Later-life Food Insecurity	1.43 [0.90,2.29]	1.43 [0.90,2.28]	1.33 [0.83,2.14]
Sociodemographic Characteristics			
Female	1.19 [0.77,1.84]	1.19 [0.76,1.86]	1.12 [0.69,1.81]
High School Graduate[a]	0.46 [0.31,0.69]***	0.47 [0.31,0.71]***	0.49 [0.32,0.74]***
More Than High School[a]	0.37 [0.19,0.72]**	0.38 [0.20,0.74]**	0.39 [0.20,0.78]**
Race(Black)[b]	1.28 [0.81,2.04]	1.29 [0.78,2.12]	1.40 [0.86,2.28]
Race(Other Race)[b]	0.87 [0.46,1.65]	0.90 [0.48,1.68]	0.89 [0.47,1.69]
Live alone	0.44 [0.18,1.08]	0.42 [0.17,1.06]	0.41 [0.16,1.07]
Rural Residence	0.96 [0.65,1.43]	1.00 [0.67,1.48]	1.00 [0.67,1.50]
Family Income (Logged)	0.91 [0.85,0.97]**	0.91 [0.85,0.97]**	0.91 [0.85,0.97]**
Childhood SES and Health Status			
Father's Education(years)		0.98 [0.91,1.04]	0.96 [0.86,1.00]
Mother's Education(years)		0.90 [0.80,0.98]	0.88 [0.82,0.97]
Parents' Education Non-missing		2.52 [0.69,9.25]	2.56 [0.71,9.24]
Family Financial Status Low		0.94 [0.58,1.53]	0.94 [0.58,1.52]
Childhood Health: Very Good[c]		1.18 [0.74,1.87]	1.29 [0.81,2.07]
Childhood Health: Good[c]		1.20 [0.74,1.93]	1.32 [0.82,2.12]
Childhood Health: Fair[c]		1.19 [0.60,2.34]	1.38 [0.68,2.78]
Childhood Health: Poor[c]		1.38 [0.44,4.38]	1.54 [0.46,5.16]
Health and Health Behaviors			
Ever Hypertension at age50/51			0.92 [0.62,1.36]
Ever Diabetic at age50/51			2.14 [1.24,3.70]**
Ever Heart Attack at age50/51			1.47 [0.76,2.85]
Ever Cancer at age50/51			0.85 [0.32,2.29]
Ever Stroke at age50/51			2.48 [0.98,6.26]
BMI			0.96 [0.92,1.01]
Depression Symptom			1.01 [0.94,1.09]
Smoke			1.30 [0.86,1.97]

Drink			0.72 [0.46,1.14]
Physical Exercise			0.95 [0.64,1.41]
Number of Observation	11,168	11,168	11,168
Number of Respondents	2,808	2,808	2,808

Note: Hazard ratios and 95% confidence intervals in brackets were presented from Cox proportional hazard models, with age as the underlying timescale. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Table 3. Cox Proportional Hazards Regression to Predict Incident Dementia Risk at Age≥60 from Midlife Food Insecurity Duration, 2006 - 2020

	Model 1	Model 2	Model 3
Midlife Food Insecurity Duration(years)	1.08 [1.01,1.16]*	1.09 [1.02,1.18]*	1.08 [1.00,1.17]*
Total Cognition Score age50/51	0.80 [0.75,0.84]***	0.79 [0.75,0.84]***	0.80 [0.76,0.85]***
Later-life Food Insecurity	1.27 [0.74,2.18]	1.20 [0.69,2.09]	1.11 [0.64,1.94]
Sociodemographic Characteristics			
Female	1.09 [0.70,1.70]	1.10 [0.69,1.74]	1.02 [0.62,1.67]
High School Graduate[a]	0.48 [0.32,0.73]***	0.48 [0.31,0.72]***	0.50 [0.32,0.76]**
More Than High School[a]	0.39 [0.20,0.77]**	0.38 [0.20,0.74]**	0.40 [0.20,0.79]**
Race(Black)[b]	1.35 [0.83,2.18]	1.41 [0.86,2.34]	1.50 [0.91,2.49]
Race(Other Race)[b]	0.91 [0.45,1.83]	0.97 [0.49,1.93]	0.97 [0.48,1.98]
Live alone	0.42 [0.17,1.04]	0.41 [0.17,1.03]	0.39 [0.15,1.03]
Rural Residence	0.98 [0.65,1.49]	1.02 [0.67,1.53]	1.03 [0.68,1.57]
Family Income (Logged)	0.79 [0.70,0.89]***	0.79 [0.70,0.89]***	0.79 [0.70,0.90]***
Childhood SES and Health Status			
Father's Education(years)		0.98 [0.93,1.09]	0.98 [0.91,1.05]
Mother's Education(years)		0.93 [0.89,1.01]	0.92 [0.83,0.98]
Parents' Education Non-missing		3.34 [0.85,13.2]	3.31 [0.84,13.0]
Family Financial Status Low		0.98 [0.60,1.60]	0.98 [0.60,1.60]
Childhood Health: Very Good[c]		1.15 [0.72,1.84]	1.28 [0.79,2.06]
Childhood Health: Good[c]		1.08 [0.64,1.82]	1.19 [0.71,1.98]
Childhood Health: Fair[c]		1.16 [0.57,2.35]	1.34 [0.65,2.79]
Childhood Health: Poor[c]		1.55 [0.52,4.61]	1.62 [0.50,5.22]
Health and Health Behaviors			
Ever Hypertension at age50/51			0.93 [0.62,1.39]
Ever Diabetic at age50/51			2.13 [1.20,3.78]**
Ever Heart Attack at age50/51			1.59 [0.82,3.08]
Ever Cancer at age50/51			0.62 [0.20,1.97]
Ever Stroke at age50/51			2.29 [0.92,5.69]
BMI			0.97 [0.92,1.01]

Depression Symptom			1.02 [0.94,1.10]
Smoke			1.31 [0.85,2.02]
Drink			0.69 [0.43,1.09]
Physical Exercise			0.94 [0.63,1.40]
Number of Observation	11,168	11,168	11,168
Number of Respondents	2,808	2,808	2,808

Note: Hazard ratios and 95% confidence intervals in brackets were presented from Cox proportional hazard models, with age as the underlying timescale. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Table 4. Linear Mixed-Effect Models for the Association Between Midlife Food Insecurity Exposure and Cognitive Ability at Age≥60, 2006 - 2020

	Model 1	Model 2	Model 3
Midlife Food Insecurity Exposure	-0.46 [-0.71,-0.22]***	-0.45 [-0.69,-0.20]***	-0.26 [-0.51,-0.02]*
Total Cognition Score at age50/51	0.47 [0.44,0.50]***	0.46 [0.44,0.49]***	0.45 [0.42,0.48]***
Later-life Food Insecurity	-0.08 [-0.32,0.16]	-0.08 [-0.32,0.17]	0.02 [-0.22,0.27]
Sociodemographic Characteristics			
Age	-0.07 [-0.09,-0.06]***	-0.07 [-0.09,-0.06]***	-0.07 [-0.08,-0.05]***
Female	0.48 [0.27,0.68]***	0.49 [0.28,0.70]***	0.56 [0.35,0.78]***
High School Graduate[a]	1.36 [1.09,1.63]***	1.28 [1.01,1.56]***	1.14 [0.86,1.41]***
More Than High School[a]	2.39 [2.09,2.70]***	2.30 [1.98,2.61]***	2.04 [1.72,2.36]***
Race(Black)[b]	-0.95 [-1.22,-0.68]***	-0.94 [-1.21,-0.67]***	-0.82 [-1.09,-0.55]***
Race(Other Race)[b]	-0.62 [-0.97,-0.27]***	-0.56 [-0.92,-0.21]**	-0.57 [-0.91,-0.22]**
Live alone	0.16 [-0.17,0.49]	0.17 [-0.15,0.50]	0.19 [-0.13,0.52]
Rural Residence	0.06 [-0.13,0.26]	0.06 [-0.14,0.25]	0.10 [-0.10,0.29]
Family Income (Logged)	0.09 [0.05,0.14]***	0.09 [0.05,0.13]***	0.07 [0.03,0.12]***
Childhood SES and Health Status			
Father's Education(years)		0.01 [-0.02,0.05]	0.02 [-0.003,0.06]
Mother's Education(years)		0.04 [0.01,0.08]*	0.04 [0.005,0.10]*
Parents' Education Non-missing		0.22 [-0.63,1.07]	0.20 [-0.65,1.04]
Family Financial Status Low		0.19 [-0.06,0.45]	0.20 [-0.05,0.45]
Childhood Health: Very Good[c]		-0.02 [-0.25,0.20]	0.04 [-0.19,0.26]
Childhood Health: Good[c]		-0.42 [-0.70,-0.13]**	-0.32 [-0.60,-0.05]*
Childhood Health: Fair[c]		-0.42 [-0.86,0.03]	-0.31 [-0.75,0.14]
Childhood Health: Poor[c]		-0.34 [-1.12,0.45]	-0.24 [-1.02,0.55]
Health and Health Behaviors			
Ever Hypertension at age50/51			-0.16 [-0.38,0.06]
Ever Diabetic at age50/51			-0.58 [-0.92,-0.23]**
Ever Heart Attack at age50/51			-0.04 [-0.41,0.34]
Ever Cancer at age50/51			-0.15 [-0.58,0.29]
Ever Stroke at age50/51			0.07 [-0.62,0.76]
BMI			0.002 [-0.005,0.01]
Depression Symptom			-0.11 [-0.15,-0.08]***

Smoke			-0.53 [-0.77,-0.30]***
Drink			0.30 [0.09,0.50]**
Physical Exercise			0.27 [0.07,0.47]**
Constant	10.61 [9.55,11.67]***	10.66 [9.31,12.01]***	10.71 [9.24,12.18]***
Time variance	4.42 [4.09,4.78]***	4.39 [4.05,4.74]***	4.18 [3.86,4.52]***
Error variance	6.76 [6.56,6.96]***	6.75 [6.56,6.96]***	6.75 [6.55,6.95]***
Number of Observation	11,505	11,505	11,505
Number of Respondents	2,859	2,859	2,859

Note: Point estimates of coefficients and 95% confidence intervals in brackets were presented from linear mixed-effects models. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Table 5. Linear Mixed-Effect Models for the Association Between Midlife Food Insecurity Duration and Cognition Function at Age≥60, 2006 - 2020

	Model 1	**Model 2**	**Model 3**
Midlife Food Insecurity Duration(years)	-0.11 [-0.16,-0.06]***	-0.11 [-0.16,-0.06]***	-0.06 [-0.11,-0.01]*
Total Cognition Score at age50/51	0.47 [0.44,0.49]***	0.46 [0.43,0.49]***	0.45 [0.42,0.48]***
Later-life Food Insecurity	-0.01 [-0.26,0.24]	-0.01 [-0.26,0.24]	0.06 [-0.19,0.30]
Sociodemographic Characteristics			
Age	-0.07 [-0.09,-0.06]***	-0.07 [-0.09,-0.06]***	-0.07 [-0.08,-0.05]***
Female	0.49 [0.28,0.70]***	0.50 [0.29,0.71]***	0.57 [0.36,0.78]***
High School Graduate[a]	1.35 [1.07,1.62]***	1.27 [1.00,1.55]***	1.13 [0.86,1.41]***
More Than High School[a]	2.38 [2.08,2.69]***	2.29 [1.98,2.60]***	2.04 [1.73,2.36]***
Race(Black)[b]	-0.94 [-1.21,-0.67]***	-0.92 [-1.20,-0.65]***	-0.82 [-1.09,-0.54]***
Race(Other Race)[b]	-0.63 [-0.98,-0.27]***	-0.57 [-0.92,-0.22]**	-0.57 [-0.92,-0.22]**
Live alone	0.20 [-0.13,0.52]	0.21 [-0.12,0.53]	0.21 [-0.12,0.53]
Rural Residence	0.07 [-0.13,0.26]	0.06 [-0.14,0.26]	0.10 [-0.09,0.30]
Family Income (Logged)	0.09 [0.05,0.13]***	0.09 [0.05,0.13]***	0.07 [0.03,0.11]***
Childhood SES and Health Status			
Father's Education(years)		0.03 [-0.00,0.06]	0.03 [-0.00,0.06]
Mother's Education(years)		0.03 [0.01,0.07]*	0.04 [0.01,0.08]*
Parents' Education Non-missing		0.22 [-0.63,1.07]	0.20 [-0.64,1.04]
Family Financial Status Low		0.21 [-0.04,0.47]	0.21 [-0.04,0.46]
Childhood Health: Very Good[c]		-0.03 [-0.25,0.20]	0.04 [-0.19,0.26]
Childhood Health: Good[c]		-0.41 [-0.69,-0.13]**	-0.32 [-0.60,-0.04]*
Childhood Health: Fair[c]		-0.39 [-0.84,0.05]	-0.30 [-0.74,0.15]
Childhood Health: Poor[c]		-0.28 [-1.06,0.51]	-0.21 [-1.00,0.58]
Health and Health Behaviors			
Ever Hypertension at age50/51			-0.15 [-0.37,0.06]
Ever Diabetic at age50/51			-0.57 [-0.91,-0.22]**
Ever Heart Attack at age50/51			-0.02 [-0.40,0.35]
Ever Cancer at age50/51			-0.14 [-0.57,0.29]
Ever Stroke at age50/51			0.08 [-0.61,0.77]
BMI			0.01 [-0.01,0.02]

Depression Symptom			-0.11 [-0.15,-0.08]***
Smoke			-0.52 [-0.75,-0.29]***
Drink			0.30 [0.10,0.50]**
Physical Exercise			0.28 [0.08,0.47]**
Constant	10.65 [9.59,11.71]***	10.69 [9.34,12.04]***	10.66 [9.20,12.13]***
Time variance	4.41 [4.08,4.77]***	4.38 [4.05,4.74]***	4.17 [3.85,4.52]***
Error variance	6.75 [6.56,6.96]***	6.75 [6.56,6.96]***	6.75 [6.56,6.95]***
Number of Observation	11,505	11,505	11,505
Number of Respondents	2,859	2,859	2,859

Note: Point estimates of coefficients and 95% confidence intervals in brackets were presented from linear mixed-effects models. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Appendix

Figure A1. Analytical selection flowchart

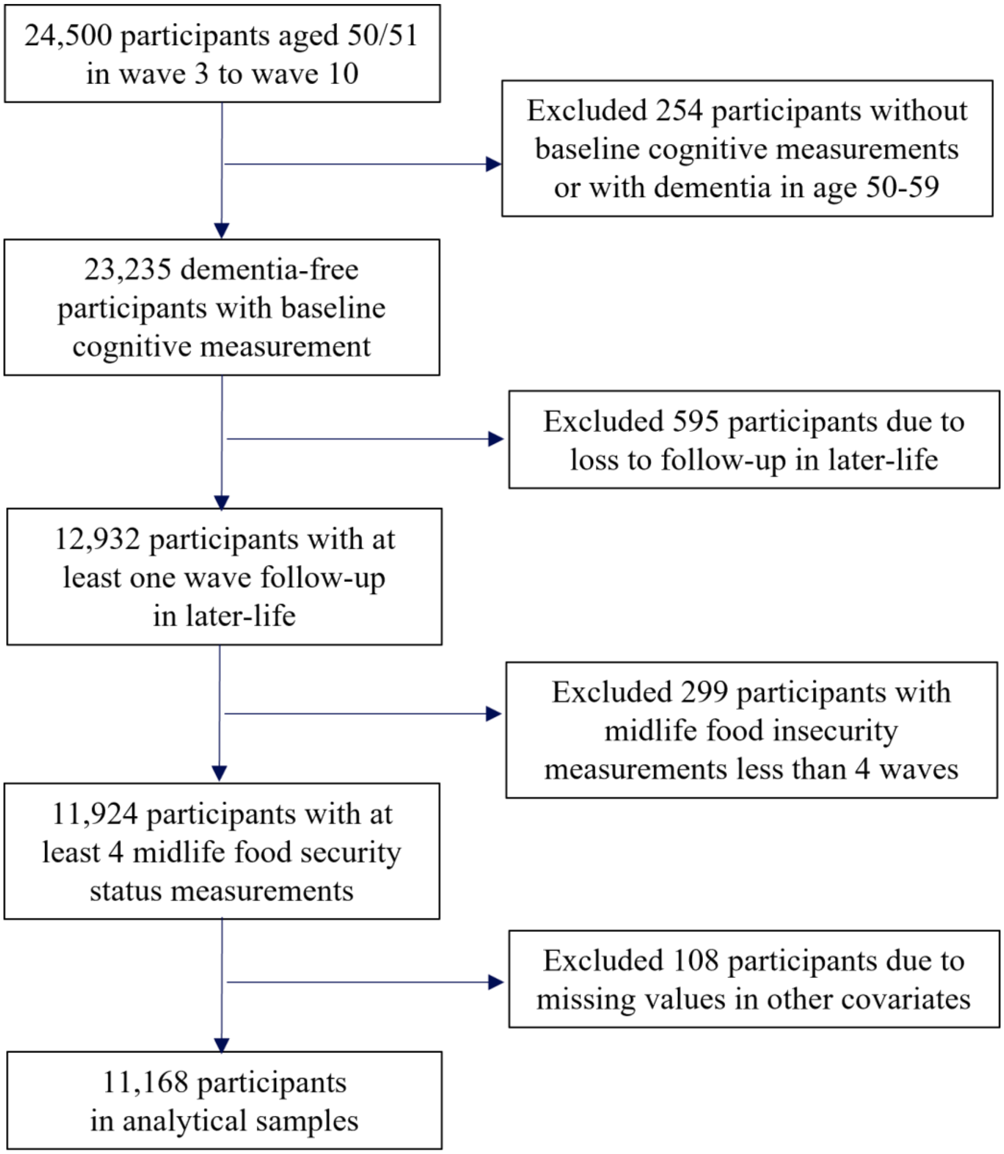


Figure A2. Distribution of total cognition scores

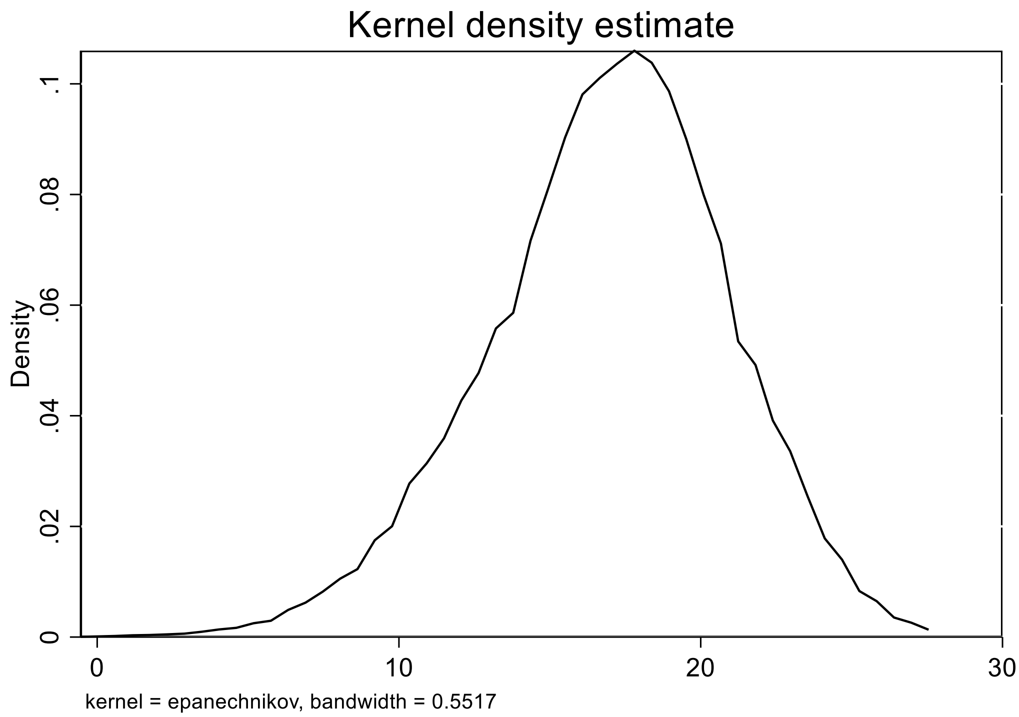
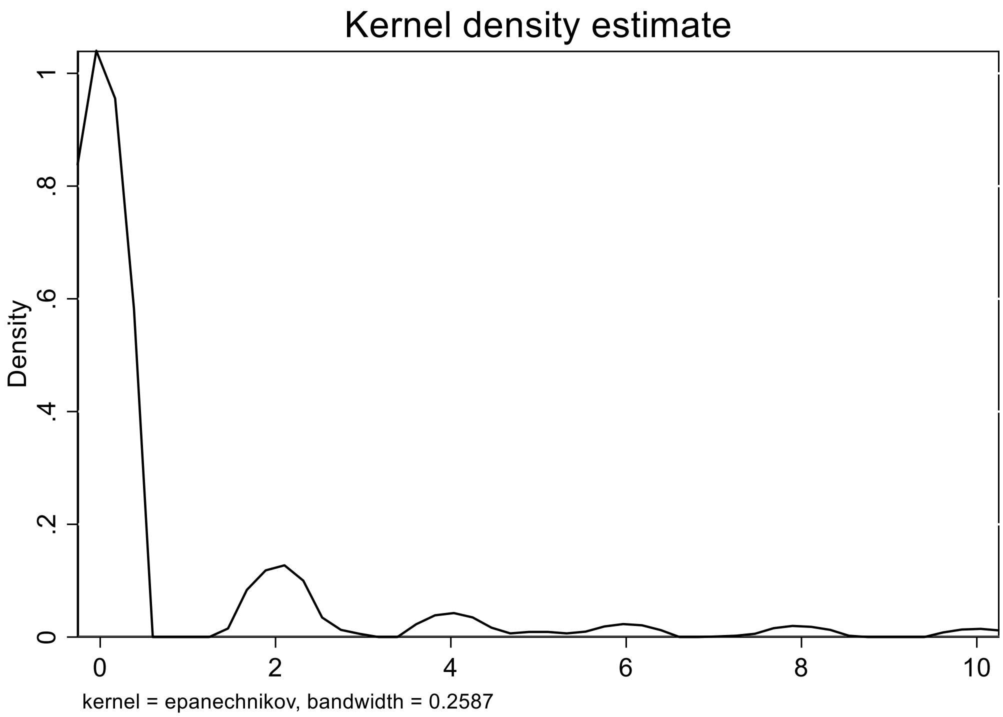


Figure A3. Distribution of midlife food insecurity duration in years



Appendix Table 1. Cox Proportional Hazards Regression to Predict Incident Dementia Risk at Age≥60 from Midlife Food Insecurity Exposure: Inverse Probability Weighted (IPW)

	Model 1	Model 2	Model 3
Midlife Food Insecurity Exposure	1.67 [1.11,2.51]*	1.68 [1.11,2.54]*	1.58 [1.03,2.42]*
Total Cognition Score age50/51	0.79 [0.75,0.83]***	0.78 [0.75,0.83]***	0.79 [0.75,0.84]***
Later-life Food Insecurity	1.50 [0.92,2.43]	1.50 [0.92,2.44]	1.38 [0.84,2.26]
Sociodemographic Characteristics			
Female	1.21 [0.80,1.83]	1.21 [0.80,1.84]	1.12 [0.72,1.76]
High School Graduate[a]	0.44 [0.29,0.67]***	0.44 [0.29,0.67]***	0.46 [0.30,0.71]***
More Than High School[a]	0.38 [0.20,0.72]**	0.38 [0.20,0.73]**	0.40 [0.21,0.79]**
Race(Black)[b]	1.28 [0.84,1.96]	1.33 [0.86,2.05]	1.39 [0.88,2.19]
Race(Other Race)[b]	0.93 [0.53,1.63]	0.96 [0.54,1.70]	0.93 [0.52,1.68]
Live alone	0.44 [0.19,1.04]	0.43 [0.18,1.03]	0.42 [0.17,1.01]
Rural Residence	0.96 [0.65,1.42]	0.98 [0.66,1.45]	1.00 [0.67,1.49]
Family Income (Logged)	0.92 [0.84,1.01]	0.92 [0.85,1.01]	0.92 [0.84,1.01]
Childhood SES and Health Status			
Father's Education(years)		0.98 [0.90,1.05]	0.96 [0.86,1.00]
Mother's Education(years)		0.89 [0.81,0.99]	0.88 [0.80,0.95]
Parents' Education Non-missing		2.52 [0.69,9.25]	2.56 [0.71,9.24]
Family Financial Status Low		0.94 [0.58,1.52]	0.95 [0.58,1.54]
Childhood Health: Very Good[c]		1.16 [0.73,1.85]	1.30 [0.81,2.07]
Childhood Health: Good[c]		1.19 [0.74,1.92]	1.26 [0.77,2.07]
Childhood Health: Fair[c]		1.19 [0.61,2.36]	1.43 [0.72,2.85]
Childhood Health: Poor[c]		1.57 [0.50,4.90]	1.58 [0.48,5.16]
Health and Health Behaviors			
Ever Hypertension at age50/51			0.94 [0.62,1.44]
Ever Diabetic at age50/51			2.07 [1.24,3.43]**
Ever Heart Attack at age50/51			1.73 [0.92,3.25]
Ever Cancer at age50/51			0.63 [0.21,1.94]
Ever Stroke at age50/51			2.22 [0.94,5.23]
BMI			0.97 [0.94,1.00]
Depression Symptom			1.02 [0.94,1.11]
Smoke			1.34 [0.89,2.01]

Drink			0.73 [0.48,1.10]
Physical Exercise			0.96 [0.65,1.40]
Number of Observation	11,168	11,168	11,168
Number of Respondents	2,808	2,808	2,808

Note: Hazard ratios and 95% confidence intervals in brackets were presented from Cox proportional hazard models, with age as the underlying timescale. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Appendix Table 2. Cox Proportional Hazards Regression to Predict Incident Dementia Risk at Age≥60 from Midlife Food Insecurity Duration: Inverse Probability Weighted (IPW)

	Model 1	Model 2	Model 3
Midlife Food Insecurity Duration(years)	1.07 [1.00,1.15]*	1.09 [1.01,1.17]*	1.08 [1.00,1.17]*
Total Cognition Score age50/51	0.79 [0.75,0.83]***	0.78 [0.74,0.83]***	0.79 [0.75,0.84]***
Later-life Food Insecurity	1.43 [0.84,2.44]	1.38 [0.80,2.36]	1.28 [0.74,2.21]
Sociodemographic Characteristics			
Female	1.21 [0.79,1.84]	1.20 [0.79,1.84]	1.12 [0.71,1.76]
High School Graduate[a]	0.44 [0.29,0.66]***	0.43 [0.29,0.66]***	0.46 [0.30,0.70]***
More Than High School[a]	0.36 [0.19,0.69]**	0.36 [0.19,0.69]**	0.38 [0.19,0.74]**
Race(Black)[b]	1.27 [0.82,1.95]	1.32 [0.85,2.05]	1.36 [0.86,2.17]
Race(Other Race)[b]	0.94 [0.54,1.64]	0.99 [0.56,1.73]	0.95 [0.53,1.71]
Live alone	0.44 [0.18,1.04]	0.43 [0.18,1.02]	0.41 [0.17,1.00]*
Rural Residence	0.93 [0.63,1.39]	0.97 [0.65,1.44]	0.98 [0.65,1.47]
Family Income (Logged)	0.91 [0.84,0.99]*	0.92 [0.84,1.00]*	0.91 [0.83,1.00]*
Childhood SES and Health Status			
Father's Education(years)		0.96 [0.90,1.01]	0.97 [0.91,1.05]
Mother's Education(years)		0.90 [0.85,1.02]	0.92 [0.80,1.01]
Parents' Education Non-missing		2.89 [0.72,11.69]	2.82 [0.68,11.63]
Family Financial Status Low		0.94 [0.58,1.53]	0.94 [0.58,1.53]
Childhood Health: Very Good[c]		1.19 [0.74,1.89]	1.32 [0.82,2.11]
Childhood Health: Good[c]		1.16 [0.72,1.89]	1.25 [0.75,2.06]
Childhood Health: Fair[c]		1.26 [0.64,2.47]	1.47 [0.74,2.92]
Childhood Health: Poor[c]		1.54 [0.49,4.87]	1.57 [0.48,5.21]
Health and Health Behaviors			
Ever Hypertension at age50/51			0.94 [0.61,1.44]
Ever Diabetic at age50/51			2.10 [1.26,3.49]**
Ever Heart Attack at age50/51			1.71 [0.91,3.21]
Ever Cancer at age50/51			0.63 [0.20,1.93]
Ever Stroke at age50/51			2.27 [0.96,5.36]
BMI			0.97 [0.93,1.00]

Depression Symptom			1.02 [0.93,1.11]
Smoke			1.33 [0.88,2.01]
Drink			0.72 [0.48,1.10]
Physical Exercise			0.94 [0.64,1.38]
Number of Observation	11,168	11,168	11,168
Number of Respondents	2,808	2,808	2,808

Note: Hazard ratios and 95% confidence intervals in brackets were presented from Cox proportional hazard models, with age as the underlying timescale. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Appendix Table 3. Linear Mixed-Effect Models for the Association Between Midlife Food Insecurity Exposure and Cognition Function at Age≥60: Inverse Probability Weighted (IPW)

	Model 1	Model 2	Model 3
Midlife Food Insecurity Exposure	-0.47 [-0.72,-0.21]***	-0.45 [-0.71,-0.19]***	-0.26 [-0.52,-0.01]*
Total Cognition Score at age50/51	0.47 [0.44,0.50]***	0.46 [0.43,0.49]***	0.45 [0.42,0.48]***
Later-life Food Insecurity	-0.08 [-0.34,0.18]	-0.07 [-0.34,0.19]	0.02 [-0.24,0.29]
Sociodemographic Characteristics			
Age	-0.07 [-0.09,-0.06]***	-0.07 [-0.09,-0.06]***	-0.07 [-0.08,-0.05]***
Female	0.47 [0.27,0.68]***	0.49 [0.28,0.70]***	0.56 [0.35,0.77]***
High School Graduate[a]	1.36 [1.06,1.66]***	1.28 [0.98,1.58]***	1.14 [0.84,1.43]***
More Than High School[a]	2.39 [2.06,2.72]***	2.30 [1.96,2.63]***	2.04 [1.70,2.38]***
Race(Black)[b]	-0.95 [-1.26,-0.65]***	-0.94 [-1.24,-0.63]***	-0.82 [-1.13,-0.51]***
Race(Other Race)[b]	-0.62 [-1.00,-0.24]***	-0.56 [-0.94,-0.19]**	-0.56 [-0.94,-0.19]**
Live alone	0.16 [-0.16,0.47]	0.17 [-0.15,0.49]	0.19 [-0.13,0.51]
Rural Residence	0.06 [-0.13,0.26]	0.06 [-0.14,0.25]	0.10 [-0.09,0.29]
Family Income (Logged)	0.09 [0.04,0.14]***	0.09 [0.04,0.14]***	0.07 [0.02,0.12]**
Childhood SES and Health Status			
Father's Education(years)		0.04 [-0.008,0.05]	0.03 [-0.01,0.07]
Mother's Education(years)		0.05 [0.009,0.07]*	0.04 [0.005,0.08]*
Parents' Education Non-missing		0.22 [-0.67,1.11]	0.19 [-0.68,1.06]
Family Financial Status Low		0.19 [-0.07,0.46]	0.20 [-0.06,0.46]
Childhood Health: Very Good[c]		-0.02 [-0.25,0.21]	0.04 [-0.19,0.27]
Childhood Health: Good[c]		-0.42 [-0.70,-0.13]**	-0.32 [-0.61,-0.05]*
Childhood Health: Fair[c]		-0.42 [-0.87,0.04]	-0.31 [-0.77,0.15]
Childhood Health: Poor[c]		-0.34 [-1.15,0.47]	-0.24 [-1.04,0.56]
Health and Health Behaviors			
Ever Hypertension at age50/51			-0.16 [-0.38,0.06]
Ever Diabetic at age50/51			-0.58 [-0.93,-0.22]**
Ever Heart Attack at age50/51			-0.03 [-0.40,0.33]
Ever Cancer at age50/51			-0.14 [-0.61,0.33]
Ever Stroke at age50/51			0.06 [-0.72,0.84]
BMI			0.004 [-0.01,0.02]

Depression Symptom			-0.11 [-0.15,-0.08]***
Smoke			-0.53 [-0.78,-0.29]***
Drink			0.30 [0.09,0.50]**
Physical Exercise			0.27 [0.08,0.47]**
Constant	10.62 [9.45,11.80]***	10.68 [9.24,12.12]***	10.73 [9.14,12.31]***
Time variance	4.47 [4.06,4.93]***	4.44 [4.03,4.89]***	4.23 [3.83,4.67]***
Error variance	6.72 [6.44,7.01]***	6.72 [6.44,7.01]***	6.71 [6.43,7.01]***
Number of Observation	11,505	11,505	11,505
Number of Respondents	2,859	2,859	2,859

Note: Point estimates of coefficients and 95% confidence intervals in brackets were presented from linear mixed-effects models. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Appendix Table 4. Linear Mixed-Effect Models for the Association Between Midlife Food Insecurity Duration and Cognition Function at Age≥60: Inverse Probability Weighted (IPW)

	Model 1	Model 2	Model 3
Midlife Food Insecurity Duration(years)	-0.11 [-0.16,-0.06]***	-0.11 [-0.16,-0.05]***	-0.06 [-0.11,-0.01]*
Total Cognition Score at age50/51	0.47 [0.44,0.50]***	0.46 [0.43,0.49]***	0.45 [0.42,0.48]***
Later-life Food Insecurity	-0.01 [-0.28,0.26]	-0.01 [-0.28,0.26]	0.05 [-0.22,0.33]
Sociodemographic Characteristics			
Age	-0.07 [-0.09,-0.06]***	-0.07 [-0.09,-0.06]***	-0.07 [-0.08,-0.05]***
Female	0.49 [0.28,0.69]***	0.50 [0.29,0.71]***	0.57 [0.36,0.78]***
High School Graduate[a]	1.35 [1.05,1.64]***	1.27 [0.97,1.57]***	1.13 [0.83,1.43]***
More Than High School[a]	2.38 [2.05,2.71]***	2.29 [1.95,2.63]***	2.04 [1.70,2.38]***
Race(Black)[b]	-0.94 [-1.24,-0.63]***	-0.92 [-1.23,-0.62]***	-0.82 [-1.13,-0.51]***
Race(Other Race)[b]	-0.62 [-1.00,-0.25]***	-0.57 [-0.95,-0.20]**	-0.57 [-0.94,-0.19]**
Live alone	0.19 [-0.13,0.51]	0.20 [-0.12,0.52]	0.21 [-0.12,0.53]
Rural Residence	0.07 [-0.13,0.26]	0.06 [-0.13,0.26]	0.10 [-0.09,0.29]
Family Income (Logged)	0.09 [0.04,0.14]***	0.09 [0.04,0.13]***	0.07 [0.02,0.12]**
Childhood SES and Health Status			
Father's Education(years)		0.02 [-0.005,0.05]	0.02 [-0.004,0.07]
Mother's Education(years)		0.04 [0.01,0.06]*	0.05 [0.01,0.07]*
Parents' Education Non-missing		0.22 [-0.66,1.10]	0.20 [-0.68,1.07]
Family Financial Status Low		0.21 [-0.05,0.48]	0.21 [-0.05,0.47]
Childhood Health: Very Good[c]		-0.03 [-0.25,0.20]	0.04 [-0.19,0.26]
Childhood Health: Good[c]		-0.41 [-0.70,-0.13]**	-0.33 [-0.61,-0.04]*
Childhood Health: Fair[c]		-0.40 [-0.85,0.06]	-0.30 [-0.76,0.16]
Childhood Health: Poor[c]		-0.28 [-1.09,0.53]	-0.21 [-1.01,0.59]
Health and Health Behaviors			
Ever Hypertension at age50/51			-0.16 [-0.38,0.07]
Ever Diabetic at age50/51			-0.57 [-0.92,-0.21]**
Ever Heart Attack at age50/51			-0.02 [-0.39,0.35]
Ever Cancer at age50/51			-0.14 [-0.60,0.33]
Ever Stroke at age50/51			0.07 [-0.71,0.85]

BMI			0.01 [-0.01,0.02]
Depression Symptom			-0.11 [-0.15,-0.08]***
Smoke			-0.52 [-0.76,-0.28]***
Drink			0.30 [0.10,0.51]**
Physical Exercise			0.28 [0.08,0.47]**
Constant	10.66 [9.48,11.85]***	10.71 [9.27,12.14]***	10.68 [9.10,12.26]***
Time variance	4.46 [4.05,4.92]***	4.43 [4.02,4.88]***	4.22 [3.83,4.67]***
Error variance	6.72 [6.44,7.01]***	6.72 [6.43,7.01]***	6.71 [6.43,7.00]***
Number of Observation	11,505	11,505	11,505
Number of Respondents	2,859	2,859	2,859

Note: Point estimates of coefficients and 95% confidence intervals in brackets were presented from linear mixed-effects models. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Appendix Table 5. Cox Proportional Hazards Regression to Predict Incident Dementia Risk at Age≥60 from Logged Midlife Food Insecurity Duration, 2006 - 2020

	Model 1	Model 2	Model 3
Midlife Food Insecurity Duration(logged)	1.33 [1.04,1.72]*	1.39 [1.07,1.80]*	1.35 [1.03,1.76]*
Total Cognition Score age50/51	0.79 [0.75,0.84]***	0.79 [0.74,0.84]***	0.80 [0.75,0.85]***
Later-life Food Insecurity	1.24 [0.73,2.10]	1.19 [0.70,2.02]	1.10 [0.65,1.87]
Sociodemographic Characteristics			
Female	1.12 [0.72,1.73]	1.13 [0.71,1.78]	1.04 [0.64,1.70]
High School Graduate[a]	0.49 [0.33,0.75]***	0.48 [0.32,0.73]***	0.51 [0.33,0.78]**
More Than High School[a]	0.42 [0.22,0.83]*	0.42 [0.20,0.80]**	0.40 [0.20,0.86]*
Race (Black)[b]	1.32 [0.82,2.13]	1.39 [0.85,2.28]	1.46 [0.89,2.41]
Race (Other Race)[b]	0.94 [0.48,1.87]	1.01 [0.52,1.95]	0.95 [0.47,1.92]
Live alone	0.42 [0.17,1.04]	0.41 [0.17,1.03]	0.39 [0.15,1.03]
Rural Residence	0.97 [0.64,1.45]	1.00 [0.66,1.49]	1.03 [0.68,1.55]
Family Income (Logged)	0.80 [0.71,0.89]***	0.79 [0.70,0.90]***	0.79 [0.70,0.90]***
Childhood SES and Health Status			
Father's Education(years)		0.97 [0.93,1.08]	0.97 [0.89,1.04]
Mother's Education(years)		0.94 [0.90,1.01]	0.92 [0.82,0.98]
Parents' Education Non-missing		3.30 [0.81,13.0]	3.28 [0.80,12.8]
Family Financial Status Low		0.98 [0.60,1.60]	1.00 [0.61,1.62]
Childhood Health: Very Good[c]		1.17 [0.73,1.86]	1.30 [0.81,2.09]
Childhood Health: Good[c]		1.11 [0.67,1.83]	1.19 [0.72,1.96]
Childhood Health: Fair[c]		1.11 [0.54,2.26]	1.30 [0.63,2.71]
Childhood Health: Poor[c]		1.50 [0.50,4.48]	1.54 [0.47,4.97]
Health and Health Behaviors			
Ever Hypertension at age50/51			0.93 [0.62,1.39]
Ever Diabetic at age50/51			2.10 [1.19,3.71]*
Ever Heart Attack at age50/51			1.68 [0.88,3.23]
Ever Cancer at age50/51			0.62 [0.20,1.97]
Ever Stroke at age50/51			2.16 [0.86,5.46]

BMI			0.97 [0.92,1.01]
Depression Symptom			1.02 [0.94,1.10]
Smoke			1.33 [0.87,2.04]
Drink			0.70 [0.44,1.11]
Physical Exercise			0.93 [0.62,1.38]
Number of Observation	11,168	11,168	11,168
Number of Respondents	2,808	2,808	2,808

Note: Hazard ratios and 95% confidence intervals in brackets were presented from Cox proportional hazard models, with age as the underlying timescale. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

Appendix Table 6. Linear Mixed-Effect Models for the Association Between Midlife Food Insecurity Duration and Cognition Function at Age≥60, 2006 - 2020

	Model 1	Model 2	Model 3
Midlife Food Insecurity Duration(years)	-0.11 [-0.16,-0.06]***	-0.11 [-0.16,-0.06]***	-0.06 [-0.11,-0.01]*
Total Cognition Score at age50/51	0.47 [0.44,0.49]***	0.46 [0.43,0.49]***	0.45 [0.42,0.48]***
Later-life Food Insecurity	-0.01 [-0.26,0.24]	-0.01 [-0.26,0.24]	0.06 [-0.19,0.30]
Sociodemographic Characteristics			
Age	-0.07 [-0.09,-0.06]***	-0.07 [-0.09,-0.06]***	-0.07 [-0.08,-0.05]***
Female	0.49 [0.28,0.70]***	0.50 [0.29,0.71]***	0.57 [0.36,0.78]***
High School Graduate[a]	1.35 [1.07,1.62]***	1.27 [1.00,1.55]***	1.13 [0.86,1.41]***
More Than High School[a]	2.38 [2.08,2.69]***	2.29 [1.98,2.60]***	2.04 [1.73,2.36]***
Race(Black)[b]	-0.94 [-1.21,-0.67]***	-0.92 [-1.20,-0.65]***	-0.82 [-1.09,-0.54]***
Race(Other Race)[b]	-0.63 [-0.98,-0.27]***	-0.57 [-0.92,-0.22]**	-0.57 [-0.92,-0.22]**
Live alone	0.20 [-0.13,0.52]	0.21 [-0.12,0.53]	0.21 [-0.12,0.53]
Rural Residence	0.07 [-0.13,0.26]	0.06 [-0.14,0.26]	0.10 [-0.09,0.30]
Family Income (Logged)	0.09 [0.05,0.13]***	0.09 [0.05,0.13]***	0.07 [0.03,0.11]***
Childhood SES and Health Status			
Father's Education(years)		0.03 [-0.00,0.06]	0.03 [-0.00,0.06]
Mother's Education(years)		0.03 [0.01,0.07]*	0.04 [0.01,0.08]*
Parents' Education Non-missing		0.22 [-0.63,1.07]	0.20 [-0.64,1.04]
Family Financial Status Low		0.21 [-0.04,0.47]	0.21 [-0.04,0.46]
Childhood Health: Very Good[c]		-0.03 [-0.25,0.20]	0.04 [-0.19,0.26]
Childhood Health: Good[c]		-0.41 [-0.69,-0.13]**	-0.32 [-0.60,-0.04]*
Childhood Health: Fair[c]		-0.39 [-0.84,0.05]	-0.30 [-0.74,0.15]
Childhood Health: Poor[c]		-0.28 [-1.06,0.51]	-0.21 [-1.00,0.58]
Health and Health Behaviors			
Ever Hypertension at age50/51			-0.15 [-0.37,0.06]
Ever Diabetic at age50/51			-0.57 [-0.91,-0.22]**
Ever Heart Attack at age50/51			-0.02 [-0.40,0.35]
Ever Cancer at age50/51			-0.14 [-0.57,0.29]

Ever Stroke at age50/51			0.08 [-0.61,0.77]
BMI			0.01 [-0.01,0.02]
Depression Symptom			-0.11 [-0.15,-0.08]***
Smoke			-0.52 [-0.75,-0.29]***
Drink			0.30 [0.10,0.50]**
Physical Exercise			0.28 [0.08,0.47]**
Constant	10.65 [9.59,11.71]***	10.69 [9.34,12.04]***	10.66 [9.20,12.13]***
Time variance	4.41 [4.08,4.77]***	4.38 [4.05,4.74]***	4.17 [3.85,4.52]***
Error variance	6.75 [6.56,6.96]***	6.75 [6.56,6.96]***	6.75 [6.56,6.95]***
Number of Observation	11,505	11,505	11,505
Number of Respondents	2,859	2,859	2,859

Note: Point estimates of coefficients and 95% confidence intervals in brackets were presented from linear mixed-effects models. *p <0.01. **p < 0.05. ***p < 0.001. BMI = Body Mass Index. CESD = Center for Epidemiologic Studies Depression. a.Reference group = less than high school; b. Reference group = White; c. Reference group = Childhood Health: Excellent.

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Chapter III: Family Dynamic of SNAP Participation: Parent and Sibling Influence

Introduction

The Supplemental Nutrition Assistance Program (SNAP), known as the Food Stamp Program before 2008, provides monthly benefits to eligible low-income households to purchase food items. As a means-tested welfare program, approximately 80 percent of SNAP households lived in poverty in fiscal year 2019 (Cronquist, 2021). Research shows that SNAP reduces food insecurity and that, over the long-term, these impacts lead to improved health and economic outcomes (C. M. Heflin et al., 2019; Na et al., 2022), especially for those who receive SNAP as children (Bailey et al., 2023; C. Heflin et al., 2019; Hoynes et al., 2016). The program also functions as an automatic fiscal stabilizer, contributing to its responsiveness in alleviating poverty during economic downturns (Edwards et al., 2016; Grieger, 2018) and during the COVID-19 pandemic (Cronquist & Eiffes, 2021). Of all 15 domestic food and nutrition assistance programs administered by the U.S. Department of Agriculture (USDA), SNAP is the most unrestricted as the program is available to the population of all ages, and it provides benefits that can be used to purchase most foods at authorized retailers (Hoynes & Schanzenbach, 2016). Much literature has shown that the macro economy, SNAP policy, related welfare policy, and demographics are the primary factors affecting SNAP participation (Heflin et al., 2023; Ziliak, 2016). However, the family dynamic underlying the SNAP participation decision, particularly parental and siblings' influences, has received rare attention.

Parents and siblings could affect individuals' SNAP usage for several reasons. Firstly, information sharing among family members could help overcome the barrier (Burstein et al., 2009). Research indicated that awareness and accurate information regarding the program are critical to participation. Among SNAP-eligible populations, their nonparticipation has been mostly attributed to administrative burden, confusion about eligibility requirements, stigma relative to the program, and mobility and cognitive decline, especially among older adults (Finkelstein & Notowidigdo, 2018; Gundersen & Ziliak, 2015; Meyer & Abdul-Malak, 2020; Zuo & Heflin, 2023). In addition, observing or just knowing family members being on SNAP could also potentially change people's attitudes related to one's independence or reduce the sense of stigma attached to participating in a means-tested welfare program (Burris et al., 2019; Burstein et al., 2009; Campbell et al., 2015). Finally, family members with SNAP experience could directly offer help to overcome the administrative hassles and difficulties with the application and re-application process.

In this study, I use longitudinal data from the nationally representative Panel Study of Income Dynamics (PSID) to examine the individual-level SNAP utilization from 1975 to 2019. Given the substantial surge in SNAP participation rates after 2003 and the profound impact of family background on individuals' economic prospects, this paper focuses on assessing the extent of family members' SNAP participation influences. Specifically, I study the relationship between parents' and siblings' previous and current SNAP participation on the likelihood of people's SNAP uptake with sibling dyads as analytical units. This study significantly advances the existing literature by adopting a comprehensive approach that combines both the intergenerational and intragenerational perspectives in examining welfare participation across the lifespan of two generations. The specific implications of SNAP benefit receipt in one generation to SNAP participation in the subsequent generation remain largely unexplored. Additionally, the transmission of participation behavior amongst siblings is an area that is yet to be comprehensively addressed. To the best of my knowledge, this research is the first to integrate these two dimensions concurrently, thereby offering a distinctive framework to disentangle parental and sibling influences.

This paper unfolds as the following sections. In the next section, I provide the background of the Supplemental Nutrition Assistance Program (SNAP), followed by a review of the relevant literature offering a survey of the existing research landscape. Next, the paper introduces the conceptual framework that guides this study and its hypotheses. The subsequent part describes the data and methodology employed. Then I present the results and conclude with a discussion of the findings and the conclusion.

Background

The modern food stamp program began with President Kennedy's 1961 initiation of pilot food stamp programs in eight impoverished counties. SNAP's stated purpose is to "alleviate hunger and malnutrition" by "permit[ing] low-income households to obtain a more nutritious diet through normal channels of trade by increasing their purchasing power… (Food and Nutrition Act of 2008). Program revisions in 1971 replaced the state-by-state rules with national eligibility standards, and the coverage expanded steadily until all counties were covered in 1974. Following implementation in 1979, the reforms resulted in more eligible households participating in the program. The 1996 Welfare Reform Act brought about several changes, including giving states greater administrative control and limiting eligibility for non-disabled adults without dependents. Beginning with regulatory changes with the 2002 Farm Bill, the USDA has allowed states to implement policies to improve access to benefits. To fight stigma, the 2008 Farm Bill changed the name of the Federal program to the Supplemental Nutrition Assistance Program or SNAP and institutionalized priorities, including strengthening integrity, simplifying administration, maintaining state flexibility, and improving access and expanding eligibility (USDA, 2014).

The 2014 Farm Bill essentially preserved the fundamental eligibility criteria outlined in the Food and Nutrition Act of 2008, setting gross and net income limits, a resource cap, and several other non-financial eligibility requirements. Non-categorically eligible households, bearing those with older or disabled family members, must meet two income criteria: gross income and net income. In terms of monthly gross income, it must not exceed 130% of the Federal Poverty Line (FPL) from the previous fiscal year. However, households with elderly or disabled members are exempt from the gross income standard. Regarding the monthly net income, it must not exceed 100% of FPL from the prior fiscal year for non-categorically eligible households. Another determinant of SNAP eligibility is the test of a household's assets. SNAP benefits are calculated based on the households' net monthly income, the benefit reduction rate, and the maximum SNAP benefit for the household size and location (Hoynes & Schanzenbach, 2016).

In 2019, about 36% of SNAP households had gross incomes at or below half of the poverty guidelines, and they received 54% of all benefits. (Cronquist, 2021). A significant majority of SNAP households (81%) consisted of a child, an older adult, or an individual with a disability, and these households received 86% of all benefits. Likewise, most SNAP participants were either children (43%), older adults (16%), or disabled non-older adults(11%). A significant proportion of all participants(57%) and nearly two-thirds (64%) of all non-older adult participants were female. School-age children accounted for more than two-thirds (70%) of all children. The average monthly SNAP benefit for households with children was $387, reflecting their larger average household size. Single-adult households represented a majority (62%) of SNAP households with children. Meanwhile, households with older adults received an average monthly benefit of $120.

Related Literature

Previous research has established that Food Stamp use and SNAP participation rates varied considerably among subgroups of eligible individuals (Gray & Cunningham, 2016). Related studies also involve examining inequality of food insecurity (FI) and poverty rates across demographic subgroups. Results imply that there are racial and gender differences in these aspects, and thus differential needs for food assistance (Goldberg, 2010; Kim & Frongillo, 2009). Female respondents, racial minority groups, and disabled individuals were more likely to receive SNAP benefits (Fuller-Thomson et al., 2008; Jung et al., 2017). Using the PSID data, (Rank & Hirschl, 2005) illustrates that race and education strongly influence the life course probabilities of using food stamps.

Parent-children and Sibling Correlations of Socioeconomic Outcomes

The impact of family background on offspring economic outcomes is one of the most central concerns of stratification and social mobility research. Parent-children association and sibling correlations of SES attainments are the two primary ways to describe the extent of family influences. In the early references, sibling correlations are regarded as an "omnibus measure" measure of the effect of anything in terms of family background shared by siblings-not just parental characteristics, but also community characteristics such as school quality and status of neighbors (Solon et al., 1988).

There has been extensive international evidence on the transmission of advantages and disadvantages between and within generations by looking at the extent of intergenerational mobility (or immobility) and sibling correlations (Cheng & Song, 2019; Conley & Glauber, 2008; Duncan et al., 2018; Gouskova et al., 2010; Laditka & Laditka, 2018; Lundberg, 2020; Mayer, 2010; Mazumder, 2008, 2011, 2018; Solon et al., 1991). The consensus is that family background is more important for an individual's economic outcomes in the U.S. than in other industrialized countries.

There are four different approaches adopted by the studies of how individuals' economic outcomes during adulthood are related to their family background (Björklund & Jäntti, 2020). The two most well-known approaches are intergenerational mobility and intergenerational effect analyses. The former approach addresses the question of to what extent the outcomes for children are similar to those for their parents (d'Addio, 2007). In contrast, the latter asks how an intervention that changes parental outcomes causally affects their children's outcomes. These two strands of literature cover a variety of dimensions (e.g., income, education, occupations, and earnings), showing the high importance of parental economic situations to their children's later economic outcomes, especially in the U.S. In literature comparing intergenerational correlations (IGCs) or intergenerational elasticities (IGEs) across countries, it is widely accepted that intergenerational mobility in the U.S. ranked bottom among industrialized nations (Corak, 2006; Vogel, 2006; Yuksel, 2009).

Intergenerational correlations may also measure factors beyond parental influence because of correlations with generations. As an alternative approach to learning the role of family (and neighborhood) background, sibling correlations are a broader measure of the role of family background than the intergenerational correlation. Although intergenerational and intragenerational types of social mobility are closely related, and both matter for the life chances available to individuals and their families, the sibling correlation approach has been adopted more in the sociology literature addressing social mobility but has been rare in the economic literature (Schnitzlein, 2014). The prior economic literature on sibling correlations showed that parental income and correlated factors explain less than half of the total impact of family and community characteristics on adult children's economic outcomes (Björklund et al., 2010; Mazumder, 2008). The findings of cross-country comparisons from the limited studies on the sibling correlations in economic outcomes are overall in line with the patterns of intergenerational mobility. By calculating sibling correlations in permanent earnings between the U.S. and the Nordic countries (Björklund et al., 2002) and (Björklund et al., 2004), the correlation is much higher in the U.S. Based on analyzing the sibling correlation in permanent earnings, the results presented by Schnitzlein (2014) indicate higher importance of family and community background and, thus, a lower level of equality of opportunity in Germany and the USA compared to Denmark (Schnitzlein, 2014).

Examples of studies on sibling correlations in socioeconomic outcomes include (Levine & Mazumder, 2007), which examine the between-brother correlation in earnings, family income, and wages from two cohorts of the National Longitudinal Surveys. The results show that young brothers who entered the labor market in the 1980s and early 1990s had higher outcome correlations than those who joined in the 1970s. The authors concluded that family factors that brothers shared have become increasingly important in determining their economic outcomes in the U.S. In addition, nearly half of the variations in educational attainment among American men and their brothers can be linked to their shared family background factors (Kuo & Hauser, 1996). Previous studies, utilizing the PSID and the National Longitudinal Survey of Youth (NLSY) data, have indicated significant sibling similarities in economic status. The correlations in earnings were estimated to be between 0.34-0.49 for brothers and 0.28-0.34 for sisters (Mazumder, 2008; Solon et al., 1991). Conley and colleagues examined the correlation between siblings' earnings, education, and family income, finding no discernible difference between brothers and sisters(Conley & Glauber, 2008). However, their results did indicate that adult siblings from disadvantaged backgrounds tend to differ more from one another than those from advantaged background. This disparity was attributed to a variety of factors including variation in ability, difference in parental investment, and broader societal influences that lead to larger variances in outcomes for disadvantaged families. Additionally, existing literature has explored variations in sibling correlations across different racial groups. Using NLSY data, Heflin & Pattillo (2006) discovered that impoverished African Americans are less likely than their White counterparts to have a middle-class sibling. This suggested that differences in kin network composition are a factor in racial stratification.

Intergenerational and Intragenerational Transmission in Welfare Participation

While evidence of intergenerational mobility and the transmission of economic outcomes between and within generations extends to areas including welfare usage, current research on this topic is limited. Existing studies suggest that welfare receipt tend to persist across generations, and the degree of persistence is influenced by factors such as education, income, race, migration status, and specific program design elements. Although some research has identified a causal effect of parental welfare participation on children's welfare participation, revealing a positive intergenerational transmission in welfare benefit receipt (Antel, 1992; Beaulieu et al., 2005; Gottschalk, 1996; Hartley et al., 2022; Levine & Zimmerman, 1996; Pepper, 2000), most of these studies have focused specifically on the impact of mothers' participation in the Aid to Families with Dependent Children (AFDC) program on their daughters' AFDS participation as adults. For example, a recent study assembled an extended panel of mother-daughter pairs using the 1968-2013 PSID survey to assess the impact of a daughter's childhood exposure to her mother's welfare participation on her likelihood to participate as an adult (Hartley et al., 2022). The study revealed that a mother's participation in AFDC/ Temporary Assistance for Needy

Families (TANF) program increased her daughter's odds of participating as an adult by approximately 25 percentage points. Across a range of models, despite welfare reform starting in 1992 reducing this transmission by at least 50%, the intergenerational correlation remains unchanged after reform as the authors considered the broader safety net that includes the SNAP and the Supplemental Security Income (SSI). Contrarily, a study conducted by Edmark and Hanspers (2015) in Sweden, utilizing register-based information, estimated the intergenerational correlation in welfare benefit receipt. While the results indicated a robust positive correlation, they did not support a causal effect of parents' welfare benefit receipt on their children's future welfare use. Regarding the mechanism underlying the intergenerational correlation in welfare participation, prior research suggests it can arise through possible unobserved correlations in labor market productivity between parents and their adult children, perhaps due to latent shared cognitive or noncognitive skills or shared preferences for welfare relative to work (Solon et al. 1988; Pepper 2000).

Even though siblings are vital players in family dynamics, how adult siblings influence each other has been surprisingly overlooked by both economists and sociologists. Previous research that carefully considered the role of siblings in welfare participation is limited. Echoing arguments in a recent article (Smith, 2020), I highlight a research gap in the existing literature by examining the possible intragenerational processes whereby siblings directly influence one another. Prior literature in economic and social stratification usually examines sibling correlation to assess intergenerational persistence/mobility with parents or grandparents being front and center of the analyses. The academic inquiry typically focuses on how childhood exposure and parental family SES are associated with their later life SES, with core family or parent-child dyads as analytical units, while studying how siblings influence each other is rare. One reason for this neglect may be the lack of longitudinal and nationally representative data at the sibling level.

Mechanisms Underlying the Parental and Siblings' Role on SNAP Participation

While scant literature directly explores the effects of parents and siblings in welfare program participation, the theoretical framework informing the present study has been drawn from related extant scholarship. There are generally four potential mechanisms explaining correlated SNAP participation among family members:

First, the environment in which children are raised, including both the home and broader social context, plays a crucial role in shaping their beliefs, attitudes, and values (Lopez et al., 2021). It is in these settings that individuals' social norms regarding welfare benefits receipt may be partially formed. Once established in childhood, these norms can often remain constant throughout a person's lifetime. This, in turn, could lead to a convergence in siblings' attitudes toward welfare participation as they grow older.

Following this logic, my first hypothesis is as follows:

Hypothesis 1: There is an association between an individual's early life experience of SNAP usage and the likelihood of SNAP participation in adulthood, after accounting for childhood family socioeconomic status (early exposure hypothesis).

Second, parents' and children's program participation can be linked because parents' cognitive and non-cognitive abilities influence offspring's education and other resources available in ways that combine to influence their future life chances (Demange et al., 2022). Low economic mobility between generations implies that children of low-income parents are likely to have low incomes in adulthood, and both generations participate in means-tested programs solely because of their shared poverty status.

Third, family members' program participation can be linked with each other to shared environmental or policy factors. Extended families provide an ecological system within which individuals are embedded, but people are also affected by outside environmental or policy factors. Contemporaneous social norms transition towards welfare use can affect all family members' participation equally. For example, family members living in the same state or community share the same environment or policy, affecting their SNAP eligibility and participation opportunities.

Moreover, the involvement of family members in a program can be related as they have a direct impact on each other's results. The phenomenon of social and behavioral contagion, where dependence on welfare proliferates across a social network, could be a potential reason for the persistence of welfare dependence among those with low income. Behavioral contagion involves the spread of certain behaviors across a group and it is characterized by an individual's tendency to replicate the behaviors of others they are near or have interacted with (Chartrand & Bargh, 1999; Christakis & Fowler, 2013). The attitudes about welfare participation can be formed or affected by observing or learning about the involvement of other members in one's social group. This may potentially reduce the stigma associated with using welfare benefits. However, the process of solidifying the intangible elements, such as norms and values related to welfare usage is not well comprehended and is hard to quantify.

In terms of the possible association between parental participation and the focal individual's participation, my hypothesis is as follows:

Hypothesis 2: Association exists between an individual's SNAP participation and their parents' past and current SNAP use, even after considering childhood SNAP exposure (parental association hypothesis).

I furtherly hypothesize the possible influence of the sibling's current SNAP participation on the focal individual's participation decision:

Hypothesis 3: There is an association between sibling SNAP use and the likelihood of SNAP participation for a focal individual, after controlling for childhood SNAP exposure and parental SNAP participation (sibling's contemporaneous association hypothesis).

Learning effects from siblings' SNAP experience may not immediately manifest due to the potentially lengthy SNAP application process, which sometimes necessitates household asset reallocation or even the need to find a job to comply with the work-related prerequisites of SNAP eligibility review. Consequently, it's plausible that the information gained from siblings' SNAP participation in the distant past could positively influence the present-day decision to participate. Equally, siblings on SNAP as recently as within the past year or two may positively influence the current decision to participate. Therefore, I provide two hypotheses about the sibling's delayed effect regarding the long and short time frames when the effects might emerge.

Hypothesis 4a: There is an association between the likelihood of SNAP participation in the focal sample and siblings' past ever participation (sibling's cumulative long-term delay effect hypothesis).

Hypothesis 4b: There is an association between SNAP participation in the focal sample and sibling SNAP participation in the recent past, specifically within the last one to two years (sibling's short-term delay effect hypothesis).

The seemingly simple indicator of parent-children and sibling correlations carries complex meaning. Researchers have given caveats on not using overall correlations to make global assessments of the degree of openness in American society since the answer appears to depend on the race-class group under study (Conley, 2008). In the US, income, wealth, and economic security are highly stratified by gender and race. Given that the risk of food insecurity and SNAP participation rates are historically higher for female than male and for blacks than for whites (Coleman-Jensen et al., 2022; Ziliak & Gundersen, 2022), the above mechanisms can systematically be stratified by gender and race. Because of the heightened need to be on SNAP among females and Black individuals compared to their male and White counterparts, it is plausible that these two subgroups tend to engage in more frequent information exchanges regarding SNAP with their siblings. Furthermore, they may be more susceptible to the influence of their siblings' SNAP participation. Stemming from this conjecture, I propose the following two hypotheses:

Hypothesis 5: The association between siblings' SNAP participation and the likelihood of SNAP participation is stronger for females than for males (gender heterogeneity hypothesis).

Hypothesis 6: The association between siblings' SNAP participation and the likelihood of SNAP participation is stronger for Black individuals than for White individuals (race heterogeneity hypothesis).

Method

Sample

The Panel Study of Income Dynamics (PSID) began in 1968 with a representative sample of over 18,000 individuals living in 5,000 families. These families have subsequently been reinterviewed each year through 1997 and biennially thereafter. The PSID has been pivotal in shedding light on numerous facets of intergenerational mobility and family dynamics over the life course, encompassing occupation, wealth, education, consumption, health, and group variations segmented by gender, race, and geographic region (Mazumder, 2018; Wiemers & Park, 2021; Wolf, 2018). The main sample person-sibling pairs can be obtained from the PSID because the survey follows children from the original PSID families after they leave home in subsequent years, classifying them as a new PSID family. Consequently, the PSID sample includes numerous sibling groups tracked for 35 years.

I exploited data from the PSID spanning 1975-2019 to measure sibling correlations in SNAP participation. The sample is restricted to those who were children in PSID households in 1968 and those born into PSID samples as children. The data starts from the 1975 wave because it is the year when all counties were mandated to offer Food Stamp Program (FSP) by the 1973 Amendments to the Food Stamp Act, with all U.S. counties administering FSP starting from 1974 (Hoynes et al., 2016). To exclude adult children living with their parents (non-split-off children), I further restricted the working sample and their parents to those who are household heads or spouses of the household heads. The final analytical sample comprises 82,154 observations nested in 14,811 sibling dyads from 4,221 parental families.

To generate sibling dyads, I paired each of the individual focal children with each of their older siblings. Considering the potential influence of birth order on sibling dynamics, I constructed the sibling pairs explicitly acknowledging this factor. Prior research on sibling relationships suggests that siblings, especially older siblings, are formative in one's development. As individuals go through adolescence, they often adopt the attitudes and tastes of their older siblings (McHale et al. 2001). Youths' narratives frequently center around how they are similar to and different from their siblings (Davies, 2014). About 82 percent of children live with at least one sibling, a percentage greater than the percentage living with a father figure, and younger siblings often use their older siblings as models for behavior (McHale et al., 2012).

The sample includes only siblings who share at least one biological parent, and the siblings were identified using the Family Identification Mapping System, allowing for the analysis of intragenerational ties. The younger siblings constituted the primary sample, and their older siblings were identified as the paired units within the sibling dyads. For two-child families, there is only one possible sibling match. In families with more than two siblings, this matching approach excludes doublets (i.e., a match of the identical two siblings, once treating sibling one as the first dyad member and once treating sibling two as the first dyad member) to ensure that the sample contains unique sibling dyads.

Measures

SNAP participation is defined as a dichotomous measure indicating income receipt from the SNAP program at any time in the prior calendar years 1975-2019. The question for SNAP (food stamp) participation in the PSID survey is "Did you (or anyone else in your family) receive food stamp benefits at any time last year?". The information was collected every year from 1968-1997 and collected on a biennial basis beginning in 1999. Following previous literature in welfare transmission, which adopted adolescence and teenage years as the critical exposure period, the focal respondent's early-life SNAP exposure is measured during the ages of 12-18 (Duncan & Wei-Jun, 1995; Hartley et al., 2022). The current and previous SNAP participation of the paired siblings, as well as the current and previous SNAP participation of either parent, are the most important explanatory variables and are measured as dichotomous variables.

Beyond parental and siblings' SNAP participation, I control for focal respondents' individual and family sociodemographic characteristics, including age in years, gender (1=

female; 0 = male), education (three dichotomous variables indicating *less than high school diploma*, *high school diploma*, and *some college* with *college graduate* as reference group), and race (White, Black, other). The models also include whether the focal individuals were employed, had a disability, and whether they were married. Siblings of similar ages are more likely to be in the same life stages and may have similar needs, opportunities, and challenges (Page, 2004), thus, I controlled the age difference between siblings. Several family-level variables describe the family composition and economic situation of the focal respondents. These comprise the number of siblings, number of children, number of family members, and if both parents died (1 = yes; 0 = No). Family income is calculated by dividing the total of all forms of earned and unearned income by the number of family members. The natural log of the value is then taken, resulting in the log of average per capita family income. Early-life characteristics were measured using variables reflecting whether the parent were poor during the respondent's childhood or whether the mother's and father's education was less than high school. These covariates control for time-constant factors and factors that change over time that observable variables can capture.

Statistical Analysis

Factors influencing the correlations in SNAP participation between parents and children, as well as between siblings, can be categorized into: (i) time-constant factors, including genetic heritability, personal capability, and value norms formed during childhood, and (ii) time-variant factors, some of which depend on the frequency of interactions within family networks. For example, the prevailing attitudes within a social network and evolving social norms during adulthood can shape individuals' attitudes toward welfare use. Additionally, information sharing and changing environmental and policy conditions can enhance an individual's awareness of the program. One key strength of adopting sibling dyad analysis lies in its capacity to effectively account for the previously mentioned unobserved time-invariant factors. In all my model analyses, I've incorporated controls for both state and time-fixed effects. State fixed effects account for inherent differences across states influencing economic prospects, while time effects adjust for overarching economic and policy shifts impacting all sample members in a specific year.

To test the above Hypotheses, I estimated two types of three-level mixed effects logistic models to assess the potential intergenerational and intragenerational transmission of SNAP participation from 1975 to 2019. The first is the *cumulative exposure (ever before) model* to investigate the general effect of siblings' past SNAP use on focal respondent's participation:

$$SNAP_{ijst} = \beta_0 + \beta_1 SNAP_{ijst}^{sib} + \beta_2 SNAP_{ijs,\forall T<t}^{sib} + \beta_3 SNAP_{jst}^{parents} + \beta_4 SNAP_{js,\forall T<t}^{parents} + \beta_5 SNAP_{ij}^{childhood} + \beta_6 X_{ijst} + \mu_s + \rho_t + \varepsilon_{ijst} \quad (1)$$

I further estimated the short-term delayed (lag) model to investigate the short-term delayed effects of sibling SNAP use in the past one or two years on the focal respondent's current participation.

$$SNAP_{ijst} = \beta_0 + \beta_1 SNAP_{ijst}^{sib} + \beta_2 SNAP_{ijs,t-1,2}^{sib} + \beta_3 SNAP_{jst}^{parents} + \beta_4 SNAP_{js,\forall T<t}^{parents} + \beta_5 SNAP_{ij}^{childhood} + \beta_6 X_{ijst} + \mu_s + \rho_t + \varepsilon_{ijst} \quad (2)$$

Where

- $SNAP_{ijst}$ is an indicator variable that takes a value of 1 if the focal sibling i of family j residing in state s at time period t participates in SNAP and 0 otherwise;
- $SNAP_{ijst}^{sib}$ takes a value of 1 if the paired sibling residing in state s at time period t participates in SNAP and 0 otherwise; $SNAP_{jst}^{parents}$ is the corresponding dummy variable indicating parents' SNAP participation who reside in state s at time t;

- $SNAP^{sib}_{ijs,\forall T<t}$ takes a value of 1 if the paired adult sibling is ever on SNAP in any prior period j = 1, …, t − 1 and 0 otherwise. In other words, this term is "switched on" continuously upon the sibling's participation and remains so for every subsequent observation. Similarly, $SNAP^{parents}_{js,\forall T<t}$ is the corresponding dummy variable indicating either of the parents ever participated in SNAP at any time before time t;
- $SNAP^{childhood}_{ij}$ takes a value of 1 if the focal sibling is ever on SNAP during his/her age 12-18 and 0 otherwise;
- $SNAP^{sib}_{ijs,t-1,2}$ is a binary variable taking a value of 1 if the paired adult sibling participated in SNAP in the previous 1 or 2 years and 0 otherwise;
- X_{ijst} is a vector of observed demographic and SES characteristics of the main sample person i; such as age, sex, education, marital status, family composition, and income;
- μ_s and ρ_t are the state and time-fixed effects, respectively.
- ε_{ijst} is the error term.

β_1 is the contemporaneous effect of the sibling's participation on the focal sibling's participation, which will be significantly positive if the sibling's contemporaneous association hypothesis holds true. However, β_1 may merely reflect that two siblings uptake SNAP simultaneously, perhaps responding to contemporaneous macro-level socioeconomic environments such as a depressed economy or political or policy factors.

Parents' and siblings' "ever-on" metric captures an extensive temporal window, thereby mitigating potential measurement errors (Hartley et al., 2022). If the sibling's cumulative long-term delay effect hypothesis holds, β_2 in equation (1) will be positive, which represents the effect of a sibling's previous ever participation on the focal individual's SNAP uptake. β_2

equation (2) picks up the short-term effect of sibling participation in the last year or two. Equally, if the parents' effect hypothesis holds, either of β_3 and β_4 in both equations will be positive will be positive.

If the early exposure hypothesis holds, β_5 is expected to be positive. Either or both β_3 and β_4 will be positive if the parental influence hypothesis holds.

Lastly, to assess the two hypotheses about the heterogeneity across gender and family race, the above models are reanalyzed, focusing on four distinct subgroups: females, males, Whites, and Blacks.

Results

Table 1 displays basic descriptives for the total analytical sample and a breakdown for the SNAP enrollees. Because PSID oversampled lower-income populations (PSID, 2021), I weighed the statistics using individual-level weights. Of the 82,154 adult focal individuals who are identified as household heads or their spouses, 8.08% reported receiving SNAP (food stamp) benefits in the last year, while the figures for their parents and paired siblings stood at 7.00% and 8.88%, respectively. About one in five either parents (22.24%) and siblings (21.43%) of these focal respondents ever participated in SNAP at some point during their adult life, while only 8.50% of siblings did so in the last one or two years. Notably, 13.56% of the analytical samples had either of their parents ever used SNAP during the time when they were 12-18 years old.

As to the sociodemographic characteristics, the average age of my focal samples is 36.14 years, with an average age gap of 4.35 years between sibling pairs. Around half of the analytical samples are female (50.75%) and share the same gender (brother-brother or sister-sister) as their paired sibling (51.36%). Regarding education achievements, approximately 11.08% did not complete high school, while 36.35% hold only a high school diploma. One-fifth (19.27%) have some college education, and nearly a third (31.99%) are college graduates. Around 30.26% are married. The mean log-transformed per capita family income is 9.70. Approximately a quarter (25.21%) recalled financial hardships in their childhood, with 19.18% and 13.89%) having fathers and mothers, respectively, who did not complete high school. A majority of the weighted samples identify as White (79.63%) and are employed (83.58%), with about 12.13% reporting a disability. In terms of family composition, analytical samples have an average of 2.07 siblings, 0.96 children, and 2.79 total family members. Around two-fifths (40.33%) reported that both of their parents are deceased.

Noteworthy differences emerge between SNAP participants and total sample across most characteristics, except for gender similarity with paired siblings. SNAP participants, when contrasted with the broader samples, tend to have higher rates of early-life SNAP exposures and greater SNAP participation among parents and siblings. SNAP participants are more often female, younger, non-Whites, and less educated. They are also more likely to be unmarried, unemployed, have a lower household income per capita and be disabled. Additionally, they generally have more siblings, children, and total family members and often come from lower socio-economic backgrounds in their childhood.

Table 2 presents the estimates of three-level logistic regression models predicting the effects of early-life SNAP exposure and parents' and adult-paired siblings' SNAP participation on the focal sibling's participation. The models are designed to evaluate the hypotheses delineated earlier and sequentially incorporate variables related to early SNAP exposure, parental engagement, and sibling involvement into the model. The analysis begins with an examination of the relationship between early SNAP exposure and subsequent adult SNAP participation among focal respondents. Subsequent models incrementally introduce family members' SNAP participation to examine its correlation with respondents' SNAP usage. Specifically, Model 2 introduces parental participation; Model 3 incorporates current sibling participation; Model 4 includes prior sibling participation; and Model 5 integrates sibling participation with a temporal lag.

As expected in Hypothesis 1, all five models consistently indicate the positive association between early-life SNAP exposure and SNAP participation in adulthood. Results in the two fully controlled Model 4 and Model 5 suggest that the experience of SNAP uptake in the ages of 12-18 is associated with an estimated 71.6% and 75.4% increase in the odds of SNAP participation, respectively. The results in Model 2 to Model 5 support Hypotheses 2, indicating a consistent resemblance between adult children and their parents in their SNAP participation. Specifically, the result presented in Model 4 shows that among the adult focal samples, those with parents who have participated in SNAP are approximately 6.280 times more likely to enroll in SNAP compared to their counterparts whose parents have never engaged in SNAP. In addition, if parents have previously participated in SNAP, the odds of the focal respondent's uptake of SNAP increase to about 1.980 times than when the parents have never participated in SNAP, assuming all other variables in the model remain constant. In Model 5, which replaced siblings' ever participation with lagged participation, these coefficients decrease slightly to 4.752 and 1.724, but remain statistically significant.

In Model 3 of Table 2, there exists a notable positive correlation (OR=1.140, P <0.01) between the present SNAP participation of siblings, independent of sociodemographic characteristics, early-life SES, SNAP exposure, and parent participation. This significant positive correlation supports Hypotheses 3, which pertains to the contemporaneous association of siblings. Furthermore, when furtherly controlling for a sibling's 1- or 2- year-lagged participation, the odds ratio slightly adjusts to OR=1.185 (P<0.01). However, upon substituting the sibling's 1- or 2- year-lagged participation with "ever-participation" in Model 4, the correlation remains positive, but turns insignificant (OR=1.030, P >0.05).

Both Model 4 and Model 5 explore the lagged effects -- long-term and short-term respectively -- of a sibling's SNAP use on an individual's current likelihood of SNAP participation, thus lending support to Hypotheses 4a and 4b. Specifically, Model 4 indicates that, compared with individuals whose adult siblings have never previously utilized SNAP up to time t, there is a 26.7% increased probability of SNAP participation for adults who have siblings who participated in SNAP historically (P<0.001). In contrast, Model 5 reveals that compared to those with adult siblings who abstained from SNAP use in the previous 1 or 2 years, there exists an 18.3% heightened likelihood of SNAP engagement for adults whose siblings did uptake the program within that lagged timeframe (P<0.01).

The analyses presented above were separately conducted for both genders with gender-specific outcomes shown in Table 3 and Table 4. The influence pattern of family members on SNAP participation broadly aligns with what is observed in the full-sample analyses (see Table 2). In juxtaposing the outcomes for females and males, as outlined in Table 3 and 4, I found minor differences in the magnitude of the coefficients. The sole divergence lies in the short-term delayed effect of siblings (see Model 5). Specifically, the fully adjusted Model 5 in Table 3 indicates that there is approximately a 21.2% increased likelihood of a female participating in SNAP if her sibling had done so in the preceding 1 to 2 years (p<0.01). Conversely, Model 5 in Table 4 underscores that while this effect persists in a positive direction for males, it is not statistically significant (OR=1.127, P>0.05). Such findings imply that Hypothesis 4b is solely applicable to females.

Table 5 and Table 6 present the outcomes of multilevel Logistic regression results estimating SNAP participation separately for Whites and Blacks. The findings suggest that the correlates of participation between siblings do not operate symmetrically for Whites and Blacks. Specifically, the sibling delay effect is observed exclusively in Blacks but is absent among White counterparts. For Whites, the long-term cumulative effect (OR=1.188, P>0.05) and short-term delayed effect (OR=1.248, P>0.05) of siblings' SNAP participation are both positive, albeit insignificant (see Table 5). Conversely, within the Blacks, individuals with siblings who have previously been on SNAP exhibit 1.294 times (P<0.01) higher likelihood of also participating in the program (refer to Model 4 in Table 6). In addition, if the sibling's participation occurred within the previous one or two years, the propensity to uptake the program increases by approximately 1.225 times (P<0.01), as shown in Model 5 of Table 6.

Contrary to our initial expectations, Hypothesis 1, which postulates the impact of early exposure, finds support only in the findings among the White samples, and not in the Blacks. For Whites, individuals with a history of SNAP usage between the ages of 12 and 18 exhibit a 2.629 times (P<0.001) greater likelihood to use SNAP in adulthood, as shown in Model 4 of Table 5. Nevertheless, among Blacks, the significance of early-life SNAP exposure dissipates upon incorporating parental and sibling participation factors, as evidenced across Models 2 to 5 in Table 6.

Discussion

This study adopts a nuanced familial paradigm in conceptualizing an individual's social network, thereby foregrounding an exploration into the influence of parental and sibling interrelationships on the inclination towards welfare program participation. The results suggest that SNAP participation is not only associated with exposure during their critical years at ages

12-18 but also correlates with the SNAP participation of parents and siblings. By employing the sibling dyads approach, this study examines the sibling correlations in SNAP participation, factoring in a myriad of both measurable and unmeasurable family background attributes (e.g., time-invariant early-life shared environment and shared genes) and the time-variant dynamics between parent-child, inter-sibling, and external environmental factors. Moreover, the research delves into the nuanced difference in outcomes based on gender and family racial backgrounds, thereby enriching our understanding of the mechanisms behind SNAP transmission within familial contexts.

My first *hypothesis (H1), denoting the early exposure* premise, finds only partial support. Among White samples, there is a significant positive correlation between early exposure to SNAP and subsequent adult participation. However, for Black samples, this significance dissipates once controlling for the in-time familial effects on SNAP. Such discrepancy may shed light on the existing mixed literature regarding the direction of the intergenerational correlation in welfare program participation. Conley & Glauber (2008) suggests that resource scarcity in disadvantaged households may lead to parenting strategies that accentuate sibling differences by directing family resources to the better-endowed siblings. Contrarily, Becker et al. (1986) provides an alternative argument. This classic literature contends that capital constraints impede low-income parents from optimal investment in their children's human capital. This suggests possible higher degrees of resemblance at lower incomes since "high-ability children from poor families may receive the same low level of education as a sibling with lower academic ability, compressing their earnings compared with similarly different siblings from a prosperous family" (Mazumder & Levine, 2003). Given SNAP's means-tested nature, my findings, especially among Black participants, resonate with Conley & Glauber's proposition of strategic parental investment. This study suggests that, among Black families, incorporating parental and siblings' current and prior SNAP participation during individuals' adulthood muted the intergenerational correlations of participation observed in the early-life SNAP exposure model. These results align with the works of Chetty et al. (2020) and Bhattacharya and Mazumder (2011), which highlight the limited upward mobility of Black individuals situated at the bottom of the income distribution, in comparison to their White counterparts.

Both my full-sample and subgroup analyses validate previous research positing the profound influence of both present and historical parental SNAP uptake on an individual's contemporaneous SNAP participation, hence affirming my *parental influence hypothesis (H2)*. This is further contextualized by qualitative studies, such as those by DeParle (2004) and Halpern-Meekin et al. (2015), which suggest mothers play a pivotal role in informing their adult daughters that certain program benefits are no longer worth the cost of participation (e.g., TANF) while others are (e.g., SNAP) (Halpern-Meekin et al., 2015).

Our findings initially indicate a positive correlation between individuals' SNAP participation and their siblings' concurrent SNAP uptake, supporting *Hypothesis 3*. This association dissipates when accounting for any historical SNAP involvements of siblings. A plausible explanation for this null effect on sibling's contemporaneous SNAP participation might be the delayed sibling's influence on the SNAP usage decisions, potentially driven by prior exposure to the sibling's previous participation information, familial resource reallocation, adaptive strategies to deal with food insecurity, or word-of-mouth transmission with the family.

Evidence from sibling's effects highlights the heterogeneity across gender and race. The *gender heterogeneity hypothesis (H5)* is partially supported because the *sibling's cumulative long-term delay effect hypothesis (H4a)* holds for both genders, but the *sibling's short-term delay* *effect hypothesis (H4b)* holds only among females but does not hold among males. The results imply that while both genders' program participation are associated with siblings' past SNAP involvement, it takes a shorter time for sibling's influence to manifest in females than in males. The gender differences could stem from females' disadvantaged socio-economic conditions or from a noted reluctance among nonelderly males toward receiving public assistance due to administrative hassles and personal distaste (Geiger et al., 2014).

This study indicated that both siblings' ever use of SNAP and sibling's use in the previous one to two years are associated with the increased probability of SNAP uptake among Blacks, but neither of the associations holds significance among Whites. For race-based differences, Black individuals are influenced by both parental and sibling. In contrast, White individuals' program participation is influenced by their own childhood experiences and by their parents in their adult life.

This research underscores the significance of extended family backgrounds and parental influences on children's SNAP participation. The findings resonate with prior literature regarding a robust intergenerational resemblance in SNAP participation. Households are more inclined toward SNAP if their siblings have engaged with the program, with the association especially salient among women and Blacks. The plausible explanation may be that individuals whose parents and siblings participate in a welfare program may view using a social program as socially acceptable. Previous literature suggests that direct interpersonal relationships strongly influence financial behavior, with information sharing across family generations potentially perpetuating reliance on welfare programs (Shiller, 2000; Kiichi Tokuoka, 2017).

Since the 1990s, the U.S. government has sought to reform the welfare benefit systems to reduce caseloads and increase employment, anchored in the belief that dependence on welfare is passed down from parent to child, creating a “culture of welfare” across generations (Haskins, 2007). This research broadens scholars’ knowledge of the trending of welfare participation. It may also separate the roles of family culture and norms from the broader culture and norms in one’s welfare use.

While this paper does not seek to identify definitive causal channels, using statistical models that include covariates suggests a few potential areas for policy makers to consider. The results are consistent with a large body of literature emphasizing early family environments’ impact on future outcomes (Björklund et al., 2010; Mazumder, 2008). More importantly, it highlights the influence of a contemporary family environment on social welfare usage. Surveys show that many siblings are in regular contact with each other across their life courses. Siblings are still featured highly as their ‘closest relatives’ and ‘prime confidantes,’ and connection between most of them, particularly sisters, is frequent (Buchanan & Rotkirch, 2021). Even in adulthood, individuals tend to maintain solid ties to their siblings: national data show that 60 percent of adults consider at least one sibling among their closest friends, and 30 percent would call a sibling first in an emergency (White & Riedmann, 1992).

Transmission of welfare usage between and across generations can be crucial, mainly when uptake rates are low. Effective communication tools can facilitate this, making understanding family dynamics essential for projecting the trend of caseloads and inform policy interventions of government assistance. Despite its modest benefit, a qualitative study showed respondents often indicated that SNAP is a “lifesaver” (Edin et al., 2013). Researchers also suggested that SNAP should be considered a critical healthcare intervention for low-income Americans (Gundersen & Ziliak, 2015). However, some vulnerable groups have limited SNAP eligibility, and some qualified individuals face barriers to SNAP participation. This is especially true among seniors (Gundersen & Ziliak, 2015). Acquiring knowledge of the welfare system aids recipients in need, as Currie (2006) postulated. This study underlines the need for future theoretical and empirical research on optimal SNAP redesign incorporating knowledge spillovers across and within generations.

Contribution and Limitation

This study investigates the relationships among parents, children, and siblings in SNAP benefit receipts within families and the mechanisms explaining the correlation by distinguishing between time-constant factors from time-variant factors and between parental effects from sibling effects. To the best of my knowledge, no prior research examined the extent to which the intergenerational transmission in welfare participation could be a spurious by-product of the correlation across intragenerational. Overlooking an individual's most foundational context –the family system in studying SES outcomes is theoretically problematic on multiple accounts. The omission of siblings' effect can lead to methodological errors (e.g., omitted variables bias) (Noah, 2015). Several existing studies have tested and supported social learning or heritage of welfare usage between parents and children (de Haan & Schreiner, 2018; Hartley et al., 2017). This research fills the research gap by emphasizing the significance of familial background, focusing on both intra and inter-sibling welfare program participation across life stages.

There are some limitations to this study. Three forms of bias may occur in the estimates. One source of bias may come from potential misclassification bias in survey responses (Bollinger & David, 2001; Kreider et al., 2012). In transfer programs, the primary nonclassical measurement error is "false negatives", where respondents claim they did not participate in a program when they actually did. Meyer, Mok, and Sullivan (2020) noted an increasing trend in misreporting across all major U.S. household surveys, including the PSID (Meyer et al., 2020).

Based on validation studies of the Food Stamp Program and TANF, most misclassifications are false negatives (Bollinger & David, 2001; Meyer et al., 2020). When false positives occur, the issue often misreports the correct source of actual transfer income or mistakes in the timing of receipt; thus, aggregate measures of welfare participation over time or across survey questions should diminish the relevance of this error type given our independent variable definition. Misclassification of welfare participation may affect both the dependent and independent variables for respondents and siblings. To counteract this, I used a long-time history to identify past participation in SNAP, which should also reduce measurement error compared to a contemporaneous measure of the participation.

Second, the so-called life-cycle bias and the “window problem” may distort intergenerational economic status estimates because usually, only snapshots of siblings are observed, not their entire life cycles (Nybom et al., 2016; Page, 2004; Steven & Solon, 2006). In the welfare context, this bias may either exacerbate or attenuate estimates depending on dominance of individuals during long-term welfare spells in the window of observations. To counter this, this study uses long time periods for each respondent-sibling pairs in the PSID, observing the full welfare life cycles. In addition, controlling the sibling’s age difference in all the models also mitigates this distortion.

The third limitation pertains to the data structure of PSID. The data set for the current analysis contains only siblings who were recorded as a son or a daughter in the survey. This implies that the spouse’s siblings are not included in the sample. Thus, about half of the siblings and their potential impacts cannot be identified in this study. Another related limitation to consider is that this study focuses solely on the influence of older siblings over younger ones, without examining the potential impact in the reverse direction.

Conclusion

This study investigates the relationship between individuals' family network and their SNAP participation. The evidence reveal a significant link between individuals' SNAP engagement and early exposure to program during the critical developmental years via their parents. The strong influence of parental SNAP participation is also affirmed, but the observed sibling's influence is nuanced and vary across gender and race. Female appear to respond more promptly to their siblings' recent SNAP participation compared to male counterparts. Both parental and sibling factors significantly associated with the SNAP participation among the Black population, whereas White individuals' program participation are more associated with their parents' utilization and their own early-life SNAP experience.

Table 1. Descriptive Statistics of the Analytical Sample (PSID waves 1975-2019)

	Total Sample Mean(SD)	SNAP Enrollees Mean(SD)	p-value
SNAP Participation			
Focal Respondent Current Participation at Time t, %	8.08(0.001)	---	---
Focal Respondent Participation During Age 12-18, %	13.56(0.001)	45.45(0.007)	<0.001
Focal Respondent Participation During Age 12-18 Missing, %	27.71(0.002)	17.81(0.005)	<0.001
Either Parent Participated at Time t, %	7.00(0.002)	35.80(0.007)	<0.001
Either Parent Ever Participated During Focal Respondent's Adulthood, %	22.24(0.002)	63.43(0.007)	<0.001
Paired Sibling Participated at Time t, %	8.88(0.001)	27.62(0.006)	<0.001
Paired Sibling Ever Participated Before Time t, %	21.43(0.002)	52.48(0.007)	<0.001
Paired Sibling's 1- or 2-year-lagged Participation, %	8.50(0.001)	26.29(0.007)	<0.001
Sociodemographic Characteristics			
Age, y	36.14(0.060)	31.86(0.194)	<0.001
Paired Sibling's Age Difference, y	4.35(0.021)	4.87(0.065)	<0.001
Female, %	50.75(0.002)	63.91(0.007)	<0.001
Paired Sibling Same Sex, %	51.36(0.002)	50.29(0.007)	0.134
Race			
White, %	79.63(0.002)	48.13(0.007)	<0.001
Black, %	11.65(0.001)	31.35(0.006)	<0.001
Other Race, %	8.72(0.001)	20.52(0.006)	<0.001
Education			
Less than High School, %	11.08(0.001)	36.91(0.007)	<0.001
High School Graduate, %	36.35(0.002)	40.80(0.007)	<0.001
Some College, %	19.27(0.002)	14.06(0.005)	<0.001
College graduate, %	31.99(0.002)	6.55(0.004)	<0.001
Married, %	30.26(0.002)	17.60(0.006)	<0.001
Employed, %	83.58(0.002)	42.85(0.007)	<0.001
Disabled, %	12.13(0.002)	31.51(0.007)	<0.001
Family Income per capita (Logged $)	9.70(0.007)	8.28(0.017)	<0.001
Number of Siblings	2.07(0.008)	2.19(0.019)	<0.001
Number of Children	0.96(0.010)	1.61(0.021)	<0.001

Family Size	2.79(0.010)	3.27(0.024)	<0.001
Both Parents Died, %	40.33(0.002)	28.47(0.007)	<0.001
Childhood SES Disadvantage			
Parent Poor, %	25.21(0.002)	39.39(0.007)	<0.001
Father’s Education Less Than High School,%	19.18(0.002)	26.89(0.006)	<0.001
Father's Education Missing,%	8.56(0.001)	19.54(0.006)	<0.001
Mother’s Education Less Than High School, %	13.89(0.001)	26.05(0.006)	<0.001
Mother's Education Missing,%	6.76(0.001)	13.74(0.005)	<0.001
Number of observations	82,154	12,559	
Number of sibling dyads	14,811	4,431	
Number of parental households	4,221	1,926	

Note: Weighted by PSID individual weights. SD = Standard Deviation. a: Number of observations among total sample= 66,337; Number of observations among SNAP enrollee= 9,385

Table 2. Multilevel Logistic regression models predicting sibling's SNAP participation among adult sibling dyads, Full sample, PSID 1975-2019

	(1) Early Life SNAP Exposure	(2) Parents' Participation	(3) Sibling's Current Participation	(4) Sibling's Ever Participation Before Time t	(5) Sibling's 1- or 2 year-lagged Participation
Fixed Effects					
SNAP Participation					
Participation During Age 12-18	3.342***	1.795***	1.760***	1.716***	1.754***
	(16.40)	(7.69)	(7.40)	(7.05)	(6.50)
Participation During Age 12-18 Missing	1.674***	1.202	1.192	1.183	1.219
	(5.29)	(1.91)	(1.83)	(1.74)	(1.83)
Parent Participated at Time t		6.287***	6.268***	6.280***	4.752***
		(21.77)	(21.74)	(21.79)	(17.14)
Either Parent Ever Participated During Focal Respendent's Adulthood		2.055***	2.034***	1.980***	1.724***
		(7.65)	(7.55)	(7.22)	(5.30)
Sibling Participated at Time t			1.140**	1.030	1.185**
			(2.79)	(0.54)	(3.02)
Sibling Ever Participated Before Time t				1.267***	
				(3.56)	
Sibling's 1- or 2-year-lagged Participation					1.183**
					(2.95)
Sociodemographic Characteristics					
Age	0.966***	0.975***	0.976***	0.975***	0.978***
	(-9.11)	(-6.58)	(-6.37)	(-6.47)	(-5.10)
Sibling's Age Difference	1.002	1.001	1.001	1.004	0.997
	(0.28)	(0.08)	(0.18)	(0.54)	(-0.31)
Female	1.914***	2.026***	2.027***	2.023***	2.142***
	(9.40)	(10.07)	(10.08)	(10.05)	(9.01)
Sibling Same Sex	0.956	0.956	0.952	0.950	0.978
	(-0.89)	(-0.88)	(-0.94)	(-1.00)	(-0.34)

Race(Black)	3.151***	2.201***	2.172***	2.129***	2.559***
	(12.97)	(8.49)	(8.36)	(8.20)	(9.50)
Race(Other Race)	2.877***	2.087***	2.064***	2.016***	2.445***
	(10.24)	(7.05)	(6.95)	(6.76)	(7.78)
Less than High School	3.776***	3.593***	3.574***	3.537***	3.568***
	(12.01)	(11.49)	(11.46)	(11.38)	(9.96)
High School Graduate	2.571***	2.635***	2.624***	2.601***	2.596***
	(9.66)	(9.86)	(9.82)	(9.74)	(8.58)
Some College	2.162***	2.278***	2.272***	2.258***	2.305***
	(7.78)	(8.23)	(8.20)	(8.14)	(7.47)
Married	1.185	1.342**	1.343**	1.338**	1.351**
	(1.74)	(2.95)	(2.95)	(2.92)	(2.60)
Employed	0.219***	0.221***	0.221***	0.221***	0.229***
	(-31.36)	(-30.17)	(-30.15)	(-30.16)	(-26.43)
Disabled	1.949***	1.882***	1.881***	1.877***	1.858***
	(11.54)	(10.50)	(10.49)	(10.46)	(9.13)
Number of Siblings	0.980	0.962*	0.962*	0.963*	0.953*
	(-1.39)	(-2.53)	(-2.57)	(-2.52)	(-2.31)
Number of Children	1.894***	1.954***	1.953***	1.947***	1.988***
	(17.33)	(17.58)	(17.57)	(17.51)	(15.68)
Family Size	0.898**	0.861***	0.861***	0.862***	0.820***
	(-3.25)	(-4.41)	(-4.42)	(-4.38)	(-5.22)
Both Parents Died	0.932	1.031	1.037	1.048	1.055
	(-0.99)	(0.41)	(0.48)	(0.62)	(0.68)
Family Income per capita(Logged)	0.578***	0.586***	0.586***	0.587***	0.567***
	(-17.13)	(-17.14)	(-17.15)	(-17.14)	(-15.75)
Childhood SES Disadvantage					
Parent Poor	0.926	0.946	0.945	0.942	0.902
	(-0.94)	(-1.25)	(-1.18)	(-1.14)	(-1.06)
Father’s Education Less Than High School	1.246**	1.184*	1.181*	1.173	1.186*
	(2.73)	(2.06)	(2.02)	(1.95)	(2.03)
Father’s Education Missing	1.282*	1.183	1.179	1.174	1.083
	(2.57)	(1.70)	(1.66)	(1.63)	(0.88)

Mother's Education Less Than High School	1.235*	1.113	1.111	1.103	1.203*
	(2.49)	(1.23)	(1.21)	(1.13)	(2.21)
Mother's Education Missing	1.179	1.076	1.078	1.077	1.148
	(1.52)	(0.66)	(0.68)	(0.68)	(1.20)
Random Effects					
Intercept variance for families	2.347***	2.164***	2.106***	2.019***	1.345***
	(9.73)	(9.27)	(9.04)	(8.68)	(3.76)
Intercept variance for sibling dyads	7.527***	7.377***	7.465***	7.606***	13.21***
	(16.03)	(16.95)	(17.02)	(17.05)	(14.04)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	82,154	82,154	82,154	82,154	65,987
Number of sibling dyads	14,811	14,811	14,811	14,811	6,599
Number of parental households	4,221	4,221	4,221	4,221	3,681
Log pseudolikelihood	-19,005	-17,822	-17,818	-17,810	-13,710

Note: The coefficients reported are in the log odds metric (exponentiated coefficients). t- value in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 3. Multilevel Logistic regression models predicting sibling's SNAP participation among adult sibling dyads: Females only, PSID 1975-2019

	(1) Early Life SNAP Exposure	(2) Parents' Participation	(3) Sibling's Current Participation	(4) Sibling's Ever Participation Before Time t	(5) Sibling's 1- or 2 year-lagged Participation
Fixed Effects					
SNAP Participation					
Participation During Age 12-18	2.940***	1.676***	1.647***	1.611***	1.502***
	(11.33)	(5.13)	(4.91)	(4.68)	(3.65)
Participation During Age 12-18 Missing	1.852***	1.362*	1.351*	1.338*	1.347*
	(5.09)	(2.52)	(2.45)	(2.38)	(2.17)
Parent Participated at Time t		5.300***	5.287***	5.301***	4.414***
		(16.98)	(16.95)	(16.99)	(14.27)
Either Parent Ever Participated During Focal Respondent's Adulthood		1.925***	1.910***	1.871***	1.692***
		(5.62)	(5.56)	(5.37)	(4.13)
Sibling Participated at Time t			1.121	1.029	1.190*
			(1.89)	(0.41)	(2.50)
Sibling Ever Participated Before Time t				1.221*	
				(2.47)	
Sibling's 1- or 2-year-lagged Participation					1.212**
					(2.77)
Sociodemographic Characteristics					
Age	0.971***	0.978***	0.979***	0.979***	0.980***
	(-6.51)	(-4.65)	(-4.51)	(-4.58)	(-3.62)
Sibling's Age Difference	0.998	0.994	0.995	0.997	1.000
	(-0.26)	(-0.62)	(-0.56)	(-0.37)	(0.01)
Sibling Same Sex	0.944	0.941	0.930	0.915	0.966
	(-0.89)	(-0.93)	(-1.10)	(-1.35)	(-0.42)
Race(Black)	3.655***	2.559***	2.530***	2.482***	2.656***
	(11.68)	(8.13)	(8.03)	(7.90)	(7.95)

Race(Other Race)	2.507***	1.798***	1.783***	1.750***	2.130***
	(6.92)	(4.30)	(4.23)	(4.09)	(5.12)
Less than High School	3.419***	3.372***	3.356***	3.323***	3.307***
	(9.21)	(8.91)	(8.87)	(8.83)	(7.95)
High School Graduate	2.224***	2.306***	2.298***	2.281***	2.170***
	(6.92)	(7.10)	(7.07)	(7.02)	(5.98)
Some College	1.880***	2.001***	1.996***	1.984***	1.874***
	(5.44)	(5.88)	(5.86)	(5.81)	(4.92)
Married	0.919	0.975	0.976	0.981	0.645
	(-0.15)	(-0.04)	(-0.04)	(-0.03)	(-0.68)
Employed	0.223***	0.221***	0.221***	0.221***	0.223***
	(-23.71)	(-23.29)	(-23.29)	(-23.28)	(-21.25)
Disabled	1.614***	1.507***	1.506***	1.503***	1.492***
	(7.01)	(5.87)	(5.86)	(5.85)	(5.03)
Number of Siblings	0.984	0.968	0.968	0.970	0.967
	(-0.94)	(-1.73)	(-1.75)	(-1.69)	(-1.34)
Number of Children	2.001***	2.099***	2.098***	2.092***	2.139***
	(15.41)	(16.11)	(16.10)	(16.06)	(14.29)
Family Size	0.764***	0.727***	0.727***	0.728***	0.698***
	(-6.89)	(-8.02)	(-8.02)	(-7.99)	(-8.02)
Both Parents Died	0.870	0.954	0.958	0.963	0.940
	(-1.58)	(-0.52)	(-0.47)	(-0.41)	(-0.65)
Family Income per capita(Logged)	0.491***	0.500***	0.500***	0.500***	0.484***
	(-13.65)	(-13.55)	(-13.55)	(-13.54)	(-12.13)
Childhood SES Disadvantage					
Parent Poor	0.947	0.872	0.872	0.869	0.930
	(-0.70)	(-1.76)	(-1.76)	(-1.80)	(-0.83)
Father's Education Less Than High School	1.135	1.126	1.125	1.122	1.109
	(1.24)	(1.11)	(1.10)	(1.07)	(1.07)
Father's Education Missing	1.265*	1.167	1.167	1.166	1.026
	(2.13)	(1.33)	(1.32)	(1.32)	(0.23)
Mother's Education Less Than High School	1.153	1.050	1.047	1.041	1.099
	(1.37)	(0.45)	(0.42)	(0.37)	(0.90)

Mother's Education Missing	1.095	1.027	1.029	1.024	1.078
	(0.69)	(0.19)	(0.21)	(0.17)	(0.55)
Random Effects					
Intercept variance for families	2.023***	2.173***	2.134***	2.087***	1.156
	(6.55)	(6.74)	(6.61)	(6.50)	(1.48)
Intercept variance for sibling dyads	5.499***	5.366***	5.412***	5.460***	9.196***
	(10.71)	(11.12)	(11.17)	(11.28)	(10.18)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	44,194	44,194	44,194	44,194	35,942
Number of sibling dyads	7,565	7,565	7,565	7,565	3,463
Number of parental households	2,815	2,815	2,815	2,815	2,423
Log pseudolikelihood	-11,363	-10,744	-10,742	-10,738	-8,442

Note: The coefficients reported are in the log odds metric (exponentiated coefficients). t- value in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 4. Multilevel Logistic regression models predicting sibling's SNAP participation among adult sibling dyads: Males only, PSID 1975-2019

	(1) Early Life SNAP Exposure	(2) Parents' Participation	(3) Sibling's Current Participation	(4) Sibling's Ever Participation Before Time t	(5) Sibling's 1- or 2 year-lagged Participation
Fixed Effects					
SNAP Participation					
Participation During Age 12-18	3.961***	1.843***	1.792***	1.733***	1.998***
	(11.72)	(5.04)	(4.81)	(4.54)	(5.00)
Participation During Age 12-18 Missing	1.641**	1.070	1.059	1.046	1.048
	(3.13)	(0.43)	(0.36)	(0.28)	(0.27)
Parent Participated at Time t		8.709***	8.665***	8.675***	5.540***
		(15.18)	(15.16)	(15.16)	(10.88)
Either Parent Ever Participated During Focal Respondent's Adulthood		2.027***	1.995***	1.914***	1.646**
		(5.22)	(5.10)	(4.75)	(3.26)
Sibling Participated at Time t			1.224**	1.053	1.196*
			(2.75)	(0.58)	(2.00)
Sibling Ever Participated Before Time t				1.406**	
				(3.13)	
Sibling's 1- or 2-year-lagged Participation					1.127
					(1.24)
Sociodemographic Characteristics					
Age	0.960***	0.971***	0.972***	0.972***	0.976**
	(-6.61)	(-4.66)	(-4.48)	(-4.52)	(-3.16)
Sibling's Age Difference	1.009	1.009	1.010	1.014	0.994
	(0.86)	(0.89)	(1.02)	(1.45)	(-0.44)
Sibling Same Sex	0.910	0.936	0.951	0.975	0.930
	(-1.18)	(-0.82)	(-0.61)	(-0.30)	(-0.69)
Race(Black)	2.457***	1.814***	1.777***	1.736***	2.206***
	(6.54)	(4.09)	(3.97)	(3.84)	(4.97)

Race(Other Race)	2.873***	2.169***	2.128***	2.056***	2.389***
	(6.72)	(4.95)	(4.83)	(4.65)	(4.78)
Less than High School	4.847***	4.083***	4.045***	3.984***	4.657***
	(8.09)	(7.42)	(7.38)	(7.33)	(6.69)
High School Graduate	3.409***	3.317***	3.294***	3.240***	3.783***
	(6.82)	(6.82)	(6.79)	(6.72)	(6.38)
Some College	2.679***	2.709***	2.699***	2.680***	3.456***
	(5.35)	(5.50)	(5.49)	(5.46)	(5.70)
Married	0.914	1.028	1.027	1.020	0.930
	(-0.77)	(0.23)	(0.22)	(0.16)	(-0.51)
Employed	0.229***	0.245***	0.246***	0.246***	0.262***
	(-19.37)	(-17.96)	(-17.92)	(-17.90)	(-14.54)
Disabled	2.540***	2.615***	2.617***	2.606***	2.636***
	(8.77)	(8.82)	(8.83)	(8.78)	(7.67)
Number of Siblings	0.964	0.935**	0.935**	0.937**	0.912**
	(-1.57)	(-2.90)	(-2.91)	(-2.84)	(-2.75)
Number of Children	1.551***	1.495***	1.492***	1.487***	1.487***
	(7.28)	(6.40)	(6.37)	(6.31)	(5.17)
Family Size	1.232***	1.233***	1.235***	1.237***	1.215**
	(3.86)	(3.73)	(3.74)	(3.78)	(2.85)
Both Parents Died	1.041	1.177	1.189	1.216	1.230
	(0.37)	(1.35)	(1.44)	(1.62)	(1.59)
Family Income per capita(Logged)	0.664***	0.675***	0.675***	0.676***	0.651***
	(-11.08)	(-10.81)	(-10.83)	(-10.84)	(-10.14)
Childhood SES Disadvantage					
Parent Poor	0.961	0.855	0.852	0.849	0.939
	(-0.39)	(-1.49)	(-1.53)	(-1.56)	(-0.52)
Father’s Education Less Than High School	1.205	1.110	1.103	1.091	1.107
	(1.49)	(0.84)	(0.79)	(0.70)	(0.84)
Father’s Education Missing	1.214	1.114	1.102	1.087	1.150
	(1.17)	(0.66)	(0.60)	(0.52)	(0.94)
Mother’s Education Less Than High School	1.342*	1.194	1.194	1.184	1.261
	(2.27)	(1.35)	(1.36)	(1.30)	(1.80)

Mother's Education Missing	1.352	1.214	1.216	1.223	1.259
	(1.67)	(1.07)	(1.09)	(1.13)	(1.16)
Random Effects					
Intercept variance for families	4.317***	3.360***	3.202***	2.942***	1.232
	(7.49)	(6.73)	(6.58)	(6.28)	(1.57)
Intercept variance for sibling dyads	6.459***	6.141***	6.264***	6.517***	20.37***
	(7.97)	(8.23)	(8.34)	(8.40)	(8.17)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	37,960	37,960	37,960	37,960	30,045
Number of sibling dyads	7,233	7,233	7,233	7,233	3,133
Number of parental households	2,742	2,742	2,742	2,742	2,276
Log pseudolikelihood	-7,437	-6,861	-6,857	-6,851	-5,109

Note: The coefficients reported are in the log odds metric (exponentiated coefficients). t- value in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 5. Multilevel Logistic regression models predicting sibling's SNAP participation among adult sibling dyads: Whites Only, PSID 1975-2019

	(1) Early Life SNAP Exposure	(2) Parents' Participation	(3) Sibling's Current Participation	(4) Sibling's Ever Participation Before Time t	(5) Sibling's 1- or 2 year-lagged Participation
Fixed Effects					
SNAP Participation					
Participation During Age 12-18	4.761***	2.776***	2.665***	2.629***	2.424***
	(9.30)	(6.09)	(5.85)	(5.74)	(4.74)
Participation During Age 12-18 Missing	1.320	1.145	1.129	1.131	1.232
	(1.50)	(0.75)	(0.68)	(0.69)	(1.04)
Parent Participated at Time t		2.259***	2.265***	2.275***	1.692**
		(4.46)	(4.47)	(4.52)	(2.68)
Either Parent Ever Participated During Focal Respondent's Adulthood		2.303***	2.267***	2.216***	2.107***
		(4.40)	(4.34)	(4.23)	(3.55)
Sibling Participated at Time t			1.326**	1.233	1.348*
			(2.59)	(1.66)	(2.30)
Sibling Ever Participated Before Time t				1.188	
				(1.11)	
Sibling's 1- or 2-year-lagged Participation					1.248
					(1.54)
Sociodemographic Characteristics					
Age	0.961***	0.963***	0.964***	0.964***	0.963***
	(-5.00)	(-4.82)	(-4.70)	(-4.73)	(-4.16)
Sibling's Age Difference	1.021	1.015	1.015	1.017	1.000
	(1.27)	(0.94)	(0.97)	(1.07)	(0.01)
Female	1.889***	1.965***	1.958***	1.951***	1.829**
	(3.84)	(4.09)	(4.08)	(4.06)	(3.02)
Sibling Same Sex	1.019	1.001	0.993	0.990	1.043
	(0.18)	(0.01)	(-0.07)	(-0.10)	(0.34)

Less than High School	5.297***	4.850***	4.808***	4.772***	5.328***
	(7.98)	(7.61)	(7.59)	(7.56)	(7.09)
High School Graduate	3.431***	3.255***	3.234***	3.210***	3.271***
	(7.27)	(6.97)	(6.95)	(6.89)	(6.16)
Some College	2.764***	2.784***	2.764***	2.744***	2.689***
	(5.75)	(5.79)	(5.76)	(5.72)	(5.01)
Married	1.620*	1.737**	1.737**	1.728**	1.593*
	(2.53)	(2.91)	(2.92)	(2.90)	(2.09)
Employed	0.190***	0.189***	0.189***	0.189***	0.185***
	(-16.95)	(-16.60)	(-16.61)	(-16.62)	(-15.33)
Disabled	1.995***	1.947***	1.950***	1.945***	1.812***
	(5.99)	(5.84)	(5.85)	(5.82)	(4.57)
Number of Siblings	0.976	0.958	0.957	0.957	0.949
	(-0.64)	(-1.14)	(-1.18)	(-1.18)	(-1.03)
Number of Children	2.404***	2.418***	2.428***	2.418***	2.603***
	(8.39)	(8.29)	(8.32)	(8.27)	(7.84)
Family Size	0.678***	0.667***	0.664***	0.665***	0.606***
	(-4.25)	(-4.38)	(-4.42)	(-4.41)	(-4.68)
Both Parents Died	0.937	0.971	0.975	0.980	0.985
	(-0.50)	(-0.23)	(-0.19)	(-0.15)	(-0.11)
Family Income per capita(Logged)	0.519***	0.522***	0.522***	0.522***	0.497***
	(-10.98)	(-11.19)	(-11.23)	(-11.25)	(-10.44)
Childhood SES Disadvantage					
Parent Poor	1.035	0.993	0.991	0.982	0.994
	(0.27)	(-0.06)	(-0.07)	(-0.15)	(-0.04)
Father’s Education Less Than High School	1.177	1.109	1.098	1.092	1.114
	(0.91)	(0.59)	(0.54)	(0.51)	(0.55)
Father’s Education Missing	1.690*	1.470	1.445	1.432	1.320
	(2.26)	(1.65)	(1.59)	(1.56)	(1.17)
Mother’s Education Less Than High School	1.433*	1.239	1.232	1.219	1.210
	(2.01)	(1.19)	(1.17)	(1.11)	(1.05)
Mother’s Education Missing	1.609	1.417	1.425	1.428	1.713*
	(1.88)	(1.34)	(1.38)	(1.40)	(2.24)

Random Effects					
Intercept variance for families	2.801***	2.826***	2.652***	2.520***	1.693*
	(4.60)	(4.68)	(4.54)	(4.31)	(2.56)
Intercept variance for sibling dyads	13.44***	11.41***	11.56***	11.78***	23.48***
	(7.86)	(7.95)	(8.16)	(8.20)	(7.37)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	42,758	42,758	42,758	42,758	36,218
Number of sibling dyads	5,806	5,806	5,806	5,806	3,116
Number of parental households	2,003	2,003	2,003	2,003	1,841
Log pseudolikelihood	-5,019	-4,950	-4,947	-4,947	-4,022

Note: The coefficients reported are in the log odds metric (exponentiated coefficients). t- value in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 6. Multilevel Logistic regression models predicting sibling's SNAP participation among adult sibling dyads: Blacks only, PSID 1975-2019

	(1) Early Life SNAP Exposure	(2) Parents' Participation	(3) Sibling's Current Participation	(4) Sibling's Ever Participation Before Time t	(5) Sibling's 1- or 2 year-lagged Participation
Fixed Effects					
SNAP Participation					
Participation During Age 12-18	1.553***	1.120	1.103	1.076	1.149
	(4.59)	(1.11)	(0.96)	(0.72)	(1.16)
Participation During Age 12-18 Missing	1.216	1.012	1.004	0.993	1.102
	(1.47)	(0.09)	(0.03)	(-0.06)	(0.66)
Parent Participated at Time t		2.493***	2.485***	2.486***	2.030***
		(10.98)	(10.95)	(10.96)	(7.80)
Either Parent Ever Participated During Focal Respondent's Adulthood		1.621***	1.603***	1.574***	1.569***
		(4.17)	(4.09)	(3.92)	(3.48)
Sibling Participated at Time t			1.150*	1.033	1.168*
			(2.49)	(0.48)	(2.31)
Sibling Ever Participated Before Time t				1.294**	
				(3.15)	
Sibling's 1- or 2-year-lagged Participation					1.225**
					(2.84)
Sociodemographic Characteristics					
Age	0.972***	0.975***	0.976***	0.975***	0.977***
	(-5.18)	(-4.53)	(-4.33)	(-4.45)	(-3.68)
Sibling's Age Difference	0.992	0.993	0.994	0.997	1.000
	(-0.95)	(-0.85)	(-0.71)	(-0.32)	(0.02)
Female	2.771***	2.770***	2.770***	2.759***	2.948***
	(9.78)	(9.85)	(9.86)	(9.84)	(9.10)
Sibling Same Sex	0.965	0.970	0.966	0.961	0.983
	(-0.51)	(-0.44)	(-0.50)	(-0.57)	(-0.19)

Less than High School	3.485***	3.326***	3.303***	3.260***	3.004***
	(7.61)	(7.39)	(7.35)	(7.28)	(5.97)
High School Graduate	2.302***	2.330***	2.316***	2.295***	2.068***
	(5.73)	(5.85)	(5.80)	(5.75)	(4.55)
Some College	1.954***	1.974***	1.964***	1.952***	1.940***
	(4.54)	(4.64)	(4.60)	(4.55)	(4.06)
Married	1.255	1.340*	1.339*	1.336*	1.459*
	(1.67)	(2.14)	(2.14)	(2.12)	(2.38)
Employed	0.245***	0.247***	0.247***	0.247***	0.257***
	(-22.42)	(-22.23)	(-22.21)	(-22.22)	(-19.47)
Disabled	1.999***	1.936***	1.935***	1.936***	1.894***
	(8.44)	(7.95)	(7.94)	(7.94)	(7.01)
Number of Siblings	0.997	0.986	0.986	0.988	0.988
	(-0.17)	(-0.80)	(-0.82)	(-0.72)	(-0.51)
Number of Children	1.918***	1.958***	1.958***	1.954***	1.937***
	(13.35)	(13.92)	(13.92)	(13.91)	(11.98)
Family Size	0.908*	0.888**	0.888**	0.889**	0.860**
	(-2.24)	(-2.77)	(-2.76)	(-2.75)	(-3.14)
Both Parents Died	0.943	1.012	1.018	1.025	1.008
	(-0.59)	(0.13)	(0.18)	(0.25)	(0.08)
Family Income per capita(Logged)	0.620***	0.626***	0.626***	0.626***	0.606***
	(-11.62)	(-11.66)	(-11.65)	(-11.64)	(-10.63)
Childhood SES Disadvantage					
Parent Poor	0.973	0.933	0.935	0.941	0.993
	(-1.11)	(-1.14)	(-1.04)	(-1.15)	(-1.20)
Father's Education Less Than High School	1.128	1.098	1.094	1.090	
	(1.13)	(0.86)	(0.83)	(0.80)	
Father's Education Missing	1.315*	1.266	1.261	1.258	1.123
	(2.28)	(1.94)	(1.91)	(1.90)	(1.10)
Mother's Education Less Than High School	1.107	1.063	1.060	1.052	1.177
	(0.91)	(0.54)	(0.51)	(0.45)	(1.45)
Mother's Education Missing	0.911	0.883	0.885	0.879	0.958
	(-0.71)	(-0.95)	(-0.94)	(-0.99)	(-0.30)

Random Effects					
Intercept variance for families	1.677***	1.591***	1.552***	1.502***	1.153
	(5.10)	(4.96)	(4.80)	(4.64)	(1.78)
Intercept variance for sibling dyads	5.825***	5.872***	5.907***	5.978***	8.899***
	(11.61)	(11.98)	(12.03)	(12.09)	(10.11)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	28,407	28,407	28,407	28,407	22,359
Number of sibling dyads	5,542	5,542	5,542	5,542	2,173
Number of parental households	1,200	1,200	1,200	1,200	1,078
Log pseudolikelihood	-9,848	-9,659	-9,656	-9,650	-7,441

Note: The coefficients reported are in the log odds metric (exponentiated coefficients). t- value in parentheses. * p<0.05, ** p<0.01, *** p<0.001

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PEER-REVIEWED PUBLICATIONS

Journal Articles

Zuo, Dongmei., Colleen Heflin. (2023). "Cognitive Impairment and Supplemental Nutrition Assistance Program Take-up Among the Eligible Older Americans." *The Journals of Gerontology, Series B: Social Sciences*, 78(1): 99-110.

Heflin, Colleen., Jun Li, **Dongmei Zuo**.(2023). "Changing patterns of SNAP take-up and Participation and the Role of Out-of-pocket Medical Expenses Among Older Adults." *Applied Economic Perspectives, and Policy*, *45*(1): 336-349.

Jun Li, **Dongmei Zuo, &** Heflin, Colleen. (2023) " Adoption Of Standard Medical Deduction Increased SNAP Enrollment And Benefits In 21 Participating States." *Health Affairs*, 42(8): 1173-1181.

Silverstein, Merril., **Dongmei Zuo.** (2021). “Grandparents Caring for Grandchildren in Rural China: Consequences for Emotional and Cognitive Health in Later Life.” *Aging & Mental Health*, 25(11):2042-2052.

Silverstein, Merril., **Dongmei Zuo**, Jinpu Wang, Vern Bengtson. (2019). “Intergenerational Religious Participation in Adolescence and Provision of Assistance to Older Mothers.” *Journal of Marriage and Family*, 81: 1206-1220.

Lu, Nan., Vivian Lou, **Dongmei Zuo**, Iris Chi. (2015). “Intergenerational Relationships and Self-Rated Health Trajectories Among Older Adults in Rural China: Does Gender Matter?” *Research on Aging*, 14: 1-23.

Zuo, Dongmei., Shuzhuo Li, Weiyu Mao, Iris Chi. (2014). “End-of-life Family Caregiving for Older Parents in China’s Rural Anhui Province.” *Canadian Journal on Aging*, 33, 448–461.

Zuo, Dongmei., Wu, Zheng, Shuzhuo Li. (2011). “Age and Intergenerational Exchange Among Older Parents in Rural China.” *International Journal of Social Welfare*, 20: S30-S46.

Li, Shuzhuo., Jie Xu, **Dongmei Zuo,** Weihong Zeng. (2017). “Livelihood and Wellbeing of Rural Elderly and Family Support Policy: A Sustainable Livelihood Framework.” *Modern Economic Science*, 39(4), 1-10. **[In Chinese]**

Han, Zhaocai., Shuzhuo Li, **Dongmei Zuo.** (2017). “Measurement of the Elder’s Death Anxiety in Rural China: Based on the Validation of DAQ scale.” *Population Journal,* 4: 82-92. **[In Chinese]**

Zuo, Dongmei., Shuzhuo Li, Zheng Wu. (2012). “Age trajectories of Intergenerational Economic Exchanges in Elderly Family of Rural China: Perspective of Adult Children.” *Modern Economic Science* 5: 26-34. **[In Chinese]**

Gao, Jianxin., Shuzhuo Li, **Dongmei Zuo.** (2012). “Effects of Emigration for Work on Children’s Division of Intergenerational Supports to the Rural Elderly Parents.” *South China Population* 27 (2): 74-80. **[In Chinese]**

Zuo, Dongmei., Shuzhuo Li. (2011). “The Impact of Labor Migration on Healthy Well-being of Elderly Left Behind in Rural China: Studies Based on Surveys in Inflow and Outflow Places.” *Journal of Public Management* 8 (2): 93-100. **[In Chinese]**

Zuo, Dongmei., Shuzhuo Li, Lu Song. (2011). “Factors Affecting Elder’s Willingness to Living in Nursing Homes in Rural China.” *Population Journal* 1: 24-31. **[In Chinese]**

Zuo, Dongmei., Lu Song. (2011). “The Conceptual Framework Built of Factors Affecting Community Elder People’s Attitudes on Nursing Homes: Qualitative Analysis Based on Grounded Theory.” *Northwest Population Journal* 32 (1): 43-47 **[In Chinese]**

Song, Lu., **Dongmei Zuo.** (2010). “Gender Differences in Medical Expenditure of the Rural Elderly and Its Effect Factors: Evidence from Chaohu.” *Chinese Rural Economy* 5: 74-85. **[In Chinese]**

Gao, Jianxin., **Dongmei Zuo.** (2009). “The effect of Adult Children’s Education to Satisfaction of Life of Elder Parents in Rural China.” *Journal of Chinese Gerontology* 12: 302-305 **[In Chinese]**

Gao, Jianxin., **Dongmei Zuo.** (2009). “Impact of Children’s Division on Economic Support That Rural Elderly Parents received.” *Population and Development.* 6: 16-22 **[In Chinese]**

Zuo, Dongmei., Jing Wu, Ping Wang. (2008). “Studies on the Usage and Demand of the Community-based Elderly Care Services in Typical Communities in Xi'an City.” *Northwest Population Journal* 29 (3): 60-62,68 **[In Chinese]**

Wang, Ping., **Dongmei Zuo.** (2007). “The Longitudinal Study of Living Arrangement of the Elderly in Rural China.” *Chinese Rural Economy* 6: 28-38. **[In Chinese]**

Book Chapter

Li, Shuzhuo., Marcus Feldman, **Dongmei Zuo.** (2010). Gender, Migration, and the Well-being of the Elderly in Rural China, in *Aging Asia: The Economic and Social Implications of Rapid Demographic Change in China, Japan, and South Korea*, Eggleston K, Tuljapurkar S, ed., University Press: Stanford, CA. pp. 63-75.

Dongmei Zuo. (2007). Research Methods in Social Medicine (Chapter 3), in *Social Medicine (2nd ed.)*, Geng Q, ed., Shaanxi Science and Technology Press, 2007. **[In Chinese]**

Research Brief

Heflin, Colleen., **Dongmei Zuo,** Alphonso, Gabriella. (2022). "Limited Cognitive Ability May Reduce SNAP Participation among Older Adults." *Population Health Research Brief Series*. 197.

GRANTS

Role: *Principal Investigator*

2013-2016 **Chinese National Natural Science Foundation Grant**, "Study on the Mechanisms of Intergenerational Exchange in Elderly Extended Family and Health Outcomes." (71273205), Funded: $86,000. (PI:Dongmei Zuo)

2011-2012 **Bureau of Statistics of Shaanxi Province, "China's Sixth Nationwide Census Data Analysis" Grant**, "Situation of Aging Population and Old-age security in Shaanxi Province." (S2012WZ007), Funded: $3,210. (PI:Dongmei Zuo)

2009-2011 **Chinese National Natural Science Foundation Grant**, "Age Pattern of Intergenerational Exchanges among Older People in Rural China." (70803039), Funded: $26,730. (PI:Dongmei Zuo)

Role: *Co-Investigator*

2012-2013 **Stanford Center for Demography and Economics of Health and Aging,** "Intergenerational Support and the Experience of the Elderly at the End of Life: An Extension of a Longitudinal Study in Rural China." Funding: $30,000 (PI: Marcus W. Feldman; Co-PI: Shuzhuo Li & Dongmei Zuo).

Syracuse University Grant

2023 Summer Dissertation Fellowship; Funder: Graduate School: Amount: $4,500

2022, 2020 Travel Fund from Social Science Department, Aging Studies Institute, and Graduate Student Office

TEACHING EXPERIENCE

Syracuse University

Fall 2022 Teaching Assistant, SOC 101: Introduction to Sociology, Department of Sociology
Spring 2022 Teaching Assistant, HST 214: Modern Africa, Department of History (undergraduate)
Nov.16, 2021 Guest Lecturer, SOC364: Aging Society, Department of Sociology
Spring 2018 Teaching Assistant, SOC/WGS 364 & 664: Aging Society, Department of Sociology

Xi'an Jiaotong University

2004-2012, 2014-2015 Statistics and Stata/SPSS Application
2014 Demography
2003, 2004 Labor Relations

PRESENTATIONS (*Denotes Presenter)

Selected Academic Conference

Zuo, Dongmei *. (2022). "A Lack of Food for Thought: Midlife Food Insecurity and Cognitive Impairment Risk among Older Americans." Oral presentation at 2022 Population Association of America (PAA) Annual Meeting, Atlanta, GA., April 6-9.

Heflin, Colleen.*, Jun Li, **Dongmei Zuo**. (2022). "Increasing Access to SNAP for Older Adults Through the Standard Medical Deduction". Oral presentation at 2022 Annual meeting of the Association of Public Policy and Management (APPAM), Washington, D.C., Nov 17-19.

Heflin, Colleen., Jun Li, **Dongmei Zuo ***. (2022). "Increasing Access to SNAP for Older Adults Through the Standard Medical Deduction". Poster session of 2022 Population Association of America (PAA) Annual Meeting, Atlanta, GA., April 6-9.

Heflin, Colleen.*****, Jun Li, **Dongmei Zuo.** (2021). "Changing Patterns of Eligibility and Take Up in SNAP and the Role of Out-of-pocket Medical Expenses." Understanding Food-Related Hardships Among Older Americans USDA Food and Nutrition Service Reporting Conference. May 28, 2021. (online)

Zuo, Dongmei.*****, Colleen Heflin. (2020). "Cognitive Impairment and SNAP Participation Among the Eligible Older Americans" [Poster Presentation]. Annual meeting of the Association of Public Policy and Management (APPAM), October 11-13. (online)

Zuo, Dongmei. *, Colleen Heflin. (2020). "How does cognitive impairment affect SNAP participation among the eligible aged?" [Presentation Session]. 2020 Population Association of America (PAA) Annual Meeting, Washington, DC., April 22-25. (Conference canceled because of COVID)

Zuo, Dongmei.*, Colleen Heflin. (2020) ."Age Patterns of joint participation in Social Security Old Age, SSI and SNAP for American Seniors" [Poster Session]. 2020 Population Association of America (PAA) Annual Meeting, Washington, DC., April 22-25. (Conference canceled because of COVID)

Zuo, Dongmei. *, Merril Silverstein. (2019) ." Pattern of Health-Related Behaviors and Resources as Predictor of Medical Care and Mortality Risk Among Older Adults. " [Poster Session]. The Gerontological Society of America Annual Meeting, Austin, TX, November 13-17.

Zuo, Dongmei. *, Merril Silverstein. (2018). "Caring for Grandchildren in Rural China-Protective or Harmful to Mental and Cognitive Health?" Paper presented at the Gerontological Society of America Annual Meeting, Boston, MA., November 15.

Zuo, Dongmei., Shuzhuo Li*****. (2013). "Sons and Daughters: Adult Children's Care for the Elder Parents at the End of Life in Rural China" Paper presented at XXVII International Union for the Scientific Study of Population (IUSSP) International Population Conference. Aug. 26-31, Busan, Korea.

Zuo, Dongmei. *, Zheng Wu, Shuzhuo Li. (2010). "Age and Intergenerational Exchanges (IE) of the Elderly in Rural China " Paper presented at the 1st Asian Population Association Conference. 16-20 November, New Delhi, India.

Zuo, Dongmei. *, Shuzhuo Li. (2007). "Factors Affecting Rural Elderly's Willingness to Enter the New Type Elder Homes in Rural China." Paper presented at *the 8th Asia/Oceania Regional Congress of Gerontology and Geriatrics.* 22-25 October, Beijing, China.

Invited

Zuo, Dongmei. *, Shuzhuo Li, Marcus Feldman. (2013). "Adult Children's Care for the Elder Parents at the End of Life in Rural China: Study based on a long-term longitudinal Survey" Paper Presentation at

“Shorenstein Asia-Pacific Research Center, Asia Health Policy Program (AHPP) Seminar” at Stanford University. May 30, Stanford.

Zuo, Dongmei.*****, Shuzhuo Li. (2013). “The well-being of Rural Older People in Anhui Province: A12-year Longitudinal Survey”. May 28, Oral Presentation in the Roybal Institute for Aging and Davids School of Gerontology, University of Southern California, Los Angeles.

Zuo, Dongmei.*, Shuzhuo Li. (2010). “Trajectories of Intergenerational Exchanges in Rural China: Age and Cohort Effect.” Paper presented at the conference of Intergenerational Family Support for Chinese Older Adults: New perspective on Chinese Culture and Society. May 6-8, Los Angels, USA.

PROFESSIONAL SERVICE

Journal Reviewer

Journal of Gerontology: Social Sciences, The Gerontologist, Aging and Mental Health, Journal of Aging and Health, BMC Nursing, BMC Geriatrics, BMC Supplements, Rural Sociology, Asian Population Studies, European Journal of Ageing, Journal of Ethnic & Cultural Diversity in Social Work

Research Funding Agencies Reviewer

- 2014, 2015, 2016: National Natural Science Foundation of China

LANGUAGES

English, Chinese