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Preclinical Dementia and Economic Well-Being Trajectories of Racially Diverse Older Adults

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Abstract

Objectives: This study examined the magnitude, changes, and racial/ethnic disparities in the economic costs of the 16-year preclinical phase of dementia—a period of cognitive decline without significant impact on daily activities. **Methods:** The study utilized two dementia algorithms to classify individuals with incident dementia in the Health and Retirement Study. These cases were compared to matched controls in terms of poverty status, labor force participation, and unsecured debts. **Results:** Older adults classified with dementia were more likely to drop out of the labor force and become poor than similar older adults without dementia. Racial/ethnic disparities in poverty persisted during the preclinical period, with non-Hispanic Black older adults more likely to leave the labor force and Hispanic older adults more likely to have unsecured debt. **Discussion:** Findings highlight the economic costs during prodromal phase of dementia, emphasizing need for early interventions to reduce financial strain across diverse older adults.

Keywords

economic well-being, Alzheimer's disease and related dementias, health and retirement study, racial/ethnic disparities, preclinical

Introduction

Alzheimer's disease and related dementias (ADRD) can have significant implications for people's lives, including their financial standing and potential earnings. Historically, economic characteristics have been examined in the years following dementia diagnosis. However, increased attention has been paid to the *preclinical* phase of dementia (i.e., the years of cognitive decline that immediately precede meeting criteria for clinical dementia), as it represents an extended period characterized by cognitive and other behavioral declines that could be targeted for early intervention. This study documents the magnitude and changes in the economic costs in the 16 years prior to dementia classification among individuals aged 68 and older in the Health and Retirement Study (HRS; Sonnega et al., 2014). Participants classified as having incident dementia according to Langa-Weir (LW) or modified Hurd dementia algorithms are compared to matched controls. Specifically, we focus on economic indicators of poverty, labor force participation, and unsecured debt. We pay particular attention to how changes in economic well-being prior to dementia classification vary across race/ethnicity and how results differ depending on dementia classification approach.

The Financial Costs of Dementia

Dementia is an umbrella term that refers to conditions in which individuals experience a decline in thinking or memory severe enough to interfere with their ability to independently carry out daily activities. Individuals experience at least some degree of cognitive and functional changes in the years prior to clinical diagnosis (Gaugler et al., 2013). Indeed, the underlying neuropathological processes and cognitive decline

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associated with ADRD may begin more than a decade prior to a clinical diagnosis (Amieva et al., 2005; Jack Jr. et al., 2018). For example, a study of community-dwelling adults aged 65 years or older showed a decline in cognitive functioning 10–12 years prior to incident dementia and a decline in daily functioning 5 years prior (Amieva et al., 2008). Another study found subjective memory complaints begin up to 16 years prior to a diagnosis of dementia (Verlinden et al., 2016).

The estimated annual medical and caregiving costs for those living with dementia in the United States is approximately $600 billion with $271 billion being unpaid care by family and friends; by 2050, the costs may increase to upwards of $1 trillion (Alzheimer's Disease Facts & Figures, 2022). On an individual level, those living with dementia at age 65 spend $38,000 more in out-of-pocket medical expenses than those without (Aranda et al., 2021). Another study found upwards of $56,000 in attributable yearly costs for those living with dementia (Hurd et al., 2013). As the disease progresses with continued cognitive and functional changes, the associated costs at the patient- and country-level also increase (e.g., health care resource utilization, informal care; Colucci et al., 2014). These costs are apparent even in early stages of Alzheimer's disease, making it important to evaluate trajectories of financial burden prior to diagnosis (Robinson et al., 2020). As individuals begin to experience these early cognitive changes, small costs begin to accumulate (e.g., lost earnings, health care expenditures), potentially becoming a large portion of the financial burden related to ADRD (El-Hayek et al., 2019). Thus, it is important to examine economic well-being during the years leading up to ADRD diagnosis to avoid underestimating the true costs associated with the disease.

Fewer studies have investigated financial costs accrued during the preclinical phase. In a sample of older adults from northern Manhattan, those who develop dementia have higher expenditures involving Medicare, home health and skilled nursing care, and medical equipment in the few years prior to incident dementia compared to matched controls (Zhu et al., 2015). Similarly, a national sample of older adults experienced an increase in Medicare expenditures one year before diagnosis, with those who went on to develop ADRD spending 42% more than propensity matched controls (Lin et al., 2016).

In the current study, we use three outcomes to define economic well-being: being in poverty as measured by the federal poverty level, having unsecured debt-to-assets ratio of at least 80%, and exiting labor force. Therefore, we take a holistic approach to the study of economic well-being during the preclinical phase of ADRD by focusing on the pervasive costs that might accrue during a much longer period. For example, unsecured debts, which include debt from medical bills, credit card balances, and other debt not backed up by a collateral (see Bugliari et al., 2020), may accrue early in the preclinical phase as individuals begin to utilize health care resources. As individuals begin to have difficulty with activities of daily living, their labor force participation (i.e., ability to work) may be impacted, forcing retirement or impeding their ability to continue working past normal retirement age if they want or need to do so. This may create an unstable economic situation for individuals with no or limited source of income, especially if simultaneously saddled with increasing unsecured debts. The compounding effect of these burdens, alongside potentially declining ability to manage money and increasing health-related costs as cognitive functioning declines, may increase the likelihood of individuals becoming poor.

Racial/Ethnic Disparities in Economic Well-Being

Significant racial/ethnic inequities exist in economic well-being, with non-Hispanic Black and Hispanic families having less overall accumulated wealth than White families. This inequity grows with increasing age, such that the largest differences in wealth are seen in older families (Bhutta et al., 2020) and contributes to disparities in financial resources available for retirement (Choi et al., 2017). This is particularly troublesome in the context of dementia, a disease that is associated with older age and which has higher prevalence rates in non-Hispanic Black and Hispanic individuals than White individuals (Mayeda et al., 2016; Tang et al., 2001). Furthermore, non-Hispanic Black and Hispanic individuals live longer than White individuals following diagnosis, potentially leading to additional familial and economic strain (Chen et al., 2022).

The most basic measure of economic well-being is *poverty*. Racial disparities in poverty still persist today (U.S. Census Bureau, 2022). Poverty is a critical concept because previous research shows that various chronic health conditions are linked with poverty (Callander et al., 2013), poverty reduces cognitive capacity (Mani et al., 2013), and the history of experience of economic hardship is associated with abnormal brain changes (Butterworth et al., 2012). There are many different ways of measuring poverty, ranging from official and supplemental measures that focus narrowly on economic variables (Mudrazija & Butrica, 2023a) to more comprehensive measures of multidimensional poverty that account for quality of life and social participation, among others (Stites, 2022). We focus on the official measure of poverty available in the HRS that compares household income to the U.S. Census poverty thresholds for relevant time periods. While not without shortcomings, it is important as a metric used to determine eligibility for various social programs.

There are racial/ethnic differences in other metrics of economic well-being that may be relevant to the preclinical dementia phase. For example, non-Hispanic Black older adults have more difficulty paying medical bills and have higher medical debt compared to their non-Hispanic White peers (Wiltshire et al., 2016), resulting in greater *unsecured debt*. This type of debt has no collateral and is inherently

riskier than the secured debt, such as mortgage loans (Mudrazija & Butrica, 2023b). Older adult *participation in the labor force* may also be sensitive to early cognitive decline. Labor force participation differs across race/ethnicity, but importantly reasons for continued work vary dramatically across individuals. For some, continued work after age 65 is a result of financial need; others might simply enjoy working and keep doing so despite having the accumulated wealth necessary to retire. Disparities in outcomes between those who stay in the workforce versus those who leave it are not always straightforward. For example, White older adults who continue working after age 65 tend to have better overall health and place higher value on work compared to those who leave the workforce, and Black older adults who continue working are more likely to own a home (Choi et al., 2017). Ultimately, leaving the workforce is not simply a matter of desire or need to work, as described by Flippen and Tienda (2000). Hispanic and non-Hispanic Black older adults may be more likely to experience involuntary exit from the labor force, perhaps due to health factors that make participation in physically demanding jobs more challenging, and the addition of age discrimination to underlying racial/ethnic discrimination (Burr & Mutchler, 2007; Choi et al., 2017; Flippen & Tienda, 2000). This makes them more vulnerable to economic hardship as they cannot rely on work to help them supplement their income and pay for unplanned health-related expenses. To date, racial/ethnic disparities in economic well-being in the preclinical dementia phase have not been adequately investigated.

Dementia Classifications

Because the gold standard classification of dementia through an extensive neuropsychological battery and medical examination is costly and time consuming, additional methods for classification are needed for large-scale studies. Two methods used with the HRS dataset are the Langa-Weir classification (LW)—relying on a single cutoff for cognitive scores or proxy rated outcomes—and the Hurd classification—relying on ordered probit models to determine dementia classification. Both algorithms are based on the Aging, Demographics, and Memory Study (ADAMS) subsample of HRS participants aged 70 and older. The ADAMS was a benchmark study that included comprehensive dementia assessments to establish dementia cutoffs for the abbreviated cognitive measures used in the core longitudinal HRS. The LW algorithm applies a sample-wide dementia cutpoint to objective cognitive performance measured cross-sectionally. For participants who did not complete objective cognitive tests, LW relies on a combination of memory ratings by proxies, interviewer-determined cognition, and proxy-reported limitations in instrumental activities of daily living (IADLs). The Hurd algorithm is a regression-based algorithm that determines cognitive status based on ordered probit models to predict ADAMS cognitive functioning status fit separately for self- and proxy-respondents. Compared to LW, the Hurd algorithm incorporates additional cognitive measures, self-rated IADLs, prior wave information, as well as limited demographic factors (Hurd et al., 2013).

Importantly, the method of classification used to identify dementia has implications for diagnostic accuracy across race/ethnicity. Commonly used algorithms for dementia classification in the HRS are less accurate for minorities compared to non-Hispanic Whites due largely to discrepancies in specificity (Gianattasio et al., 2019). Specifically, the LW classification leads to an *overdiagnosis* of non-Hispanic Black and Hispanic individuals with dementia, which may reflect the application of a single cognitive cutoff across racial/ethnic groups. In contrast, alternative regression-based approaches that incorporate race and ethnicity-specific predicted probability thresholds, such as the Hurd algorithm modified by Gianattasio and colleagues (2020), lead to more similar consistency in dementia accuracy across racial/ethnic groups. Because these algorithms use different approaches for classifying who has dementia (and when they develop it), their implementation likely has implications for quantifying the magnitude of economic costs accrued during the preclinical phase of ADRD. Specifically, some racial/ethnic minority participants may be erroneously classified as having dementia (or having dementia earlier) based on the LW algorithm, as compared with the modified Hurd algorithm.

The Current Study

This study extends the literature on economic well-being in dementia into the preclinical phase by evaluating outcomes of poverty, unsecured debt, and labor force participation up to 16 years prior to incident dementia classification. We also investigate potential racial/ethnic differences in economic well-being during the preclinical phase, as well as the implications of different algorithms in the identification of dementia. Importantly, we do not aim to establish a causal link between preclinical dementia and economic well-being, but rather to document any differences in economic outcomes by subsequent cognitive status, which could be a foundation for a future study of possible mechanisms linking cognitive health and economic outcomes.

We hypothesize that those who are ultimately classified with dementia will be at a greater risk of falling into poverty, accumulating high levels of unsecured debt, and exiting the labor force in the years prior to their dementia classification as compared with matched controls. Across racial/ethnic groups, we expect that non-Hispanic Black older adults will be at a greater risk of falling into poverty, experience greater unsecured debt burden, and have higher rates of exiting labor force in the years preceding a dementia classification. We also expect that Hispanic older adults will be at a higher risk of falling into poverty preceding dementia

classification, but we have no clear expectation regarding their debt burden and labor force participation given evidence of their more constrained access to the financial system, which may prevent Hispanic older adults from accumulating much debt. For the impact of algorithmic classification, we expect somewhat weaker associations between preclinical dementia and economic burden of non-Hispanic Blacks and Hispanics in models using the LW algorithm due to the documented misclassification of cognitively normal non-Hispanic Black and Hispanic individuals as having dementia.

Data and Methods

Data

Data come from the HRS, a nationally representative biennial longitudinal survey of Americans over the age of 50 that began in 1992. Additional cohorts were added to the study in 1998, 2004, and 2010 to keep the sample representative of the target age group. We limit our analysis to those who were at least age 68 at entry into the risk set for each economic outcome of interest[1] and who were interviewed in 1998, when the full age spectrum of older adults became available in the HRS, or later. Furthermore, we conduct propensity score matching to determine which among the HRS respondents who are not classified as having dementia have similar sociodemographic profiles to those with dementia and keep in our analytic sample those with dementia and their matches without dementia.[2] Finally, since we conduct survival analysis of three economic outcomes of interest using two dementia classification algorithms, there are six distinct analytic samples. As a result of all these analytic decisions, our final analytic samples are as follows: becoming poor (4537 persons and 22,198 person-years for LW and 7716 persons and 25,978 person-years for modified Hurd algorithm), dropping out of labor force (820 persons and 2403 person-years for LW and 1414 persons and 2885 person-years for modified Hurd), and crossing the 80% threshold of unsecured debt to assets (4543 persons and 24,280 person-years for LW and 7739 persons and 28,391 person-years for modified Hurd).

Variables

The three outcome variables are becoming poor (i.e., having household income below 100% of federal poverty line), dropping out of labor force,[3] and crossing the 80% threshold[4] of unsecured debt-to-assets ratio. Key predictors include being classified as having dementia by the LW or modified Hurd algorithm, versus being in the matched control sample.

The models control for a series of sociodemographic variables, including birth year, age (in years),[5] sex, race and ethnicity (non-Hispanic White, non-Hispanic Black, and Hispanic), relationship status (married/partnered, divorced/separated, widowed, and never married), and educational attainment (less than high school, high school/GED, some college, and college degree or higher). Additionally, they include multiple health-focused covariates: fair or poor self-rated health, two or more mental health issues (e.g., feeling depressed; out of 8 possible), two or more doctor-diagnosed health conditions (e.g., diabetes; out of 8 possible), and any ADL limitation (e.g., difficulty bathing/showering; out of 5 possible).

Analytic Approach

For each of the three outcomes of interest, we begin by depicting trends in the risk of its occurrence in the ADRD preclinical stage for those subsequently classified as having dementia and their matched peers without dementia. Next, we estimate a series of Cox proportional hazards models, a semi-parametric continuous-time multivariate hazard model commonly used in analyzing multivariate survival data, to examine the factors related to older adults' becoming poor, dropping out of the labor force, and crossing the 80% threshold of unsecured debt-to-assets. In the Cox models, we specify a continuous-time cause-specific hazard rate (i.e., a subdistribution hazard rate, $h_r(t)$) that represents the instantaneous probability of an event (E) such as falling into poverty (p) occurring in an interval of time [t, Δt], given that the event has not previously occurred

$$h_r(t) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \Pr[t \le T < t + \Delta t, E = p \,|\, T \ge t]$$

Waves preceding dementia diagnoses define our analytical unit of time. The models include respondents ages 68 and older who participated in at least two consecutive survey waves and are nonpoor and thus have the potential to become poor starting at age 70. We follow the same logic for the other two outcome variables.

Taking a stepwise approach, the first model included just incident dementia versus matched control. The second model introduced sociodemographic control variables, followed by a third model that included health control variables. The final model added interaction of the incident dementia indicator and the race/ethnicity variables. We next fit the same set of model specifications to the sample defined based on the modified Hurd algorithm for dementia classification. In supplementary analyses, we examined the graphs of cumulative hazard of the outcome by dementia classification for each racial/ethnic group to facilitate the description of racial/ethnic differences (see Supplemental materials).

Results

Poverty

Figure 1 shows the trends in three economic well-being outcomes in the preclinical stage for older adults classified as having dementia and a matched sample of those never

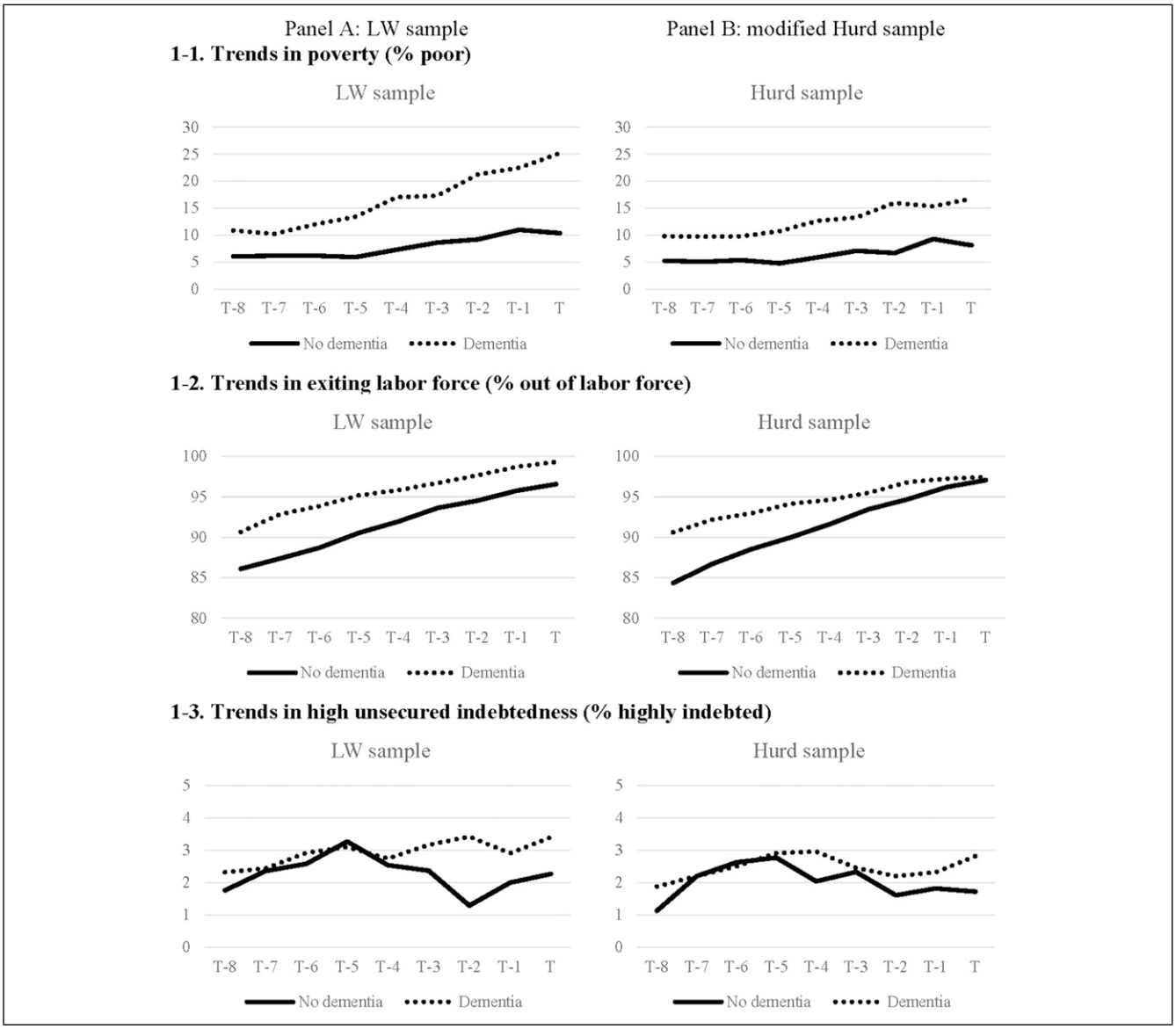

Figure 1. Trends in three economic well-being indicators in the preclinical stage of dementia with classifications based on LW (panel A) and modified Hurd (panel B) algorithms. Note: T denotes time when classified as having dementia, and T-1, T-2, etc, denote periods that are one wave (or two years), two waves (four years) etc. preceding the time of being classified as having dementia.

classified as having dementia using LW (panel A) and modified Hurd (panel B) algorithmic measures of dementia. Poverty is higher among those ultimately classified with dementia years before the classification, and the difference grows ever larger as the time of classification approaches (Figures 1–1). This difference is more pronounced in the LW model than in the modified Hurd model.

As presented in Table 1, results of survival analyses show a consistently higher risk of becoming poor in the preclinical stage for those who are ultimately classified as having dementia than their peers who never cross dementia threshold. For example, in the fully specified model (Model 4), the risk of becoming poor is 61% higher for those with dementia using the LW sample and 79% higher using the modified Hurd sample. Both non-Hispanic Blacks and Hispanics have markedly higher risk of becoming poor during the preclinical phase than non-Hispanic Whites, yet the magnitude of this difference does not vary by dementia status.

Labor Force Participation

As shown in Figures 1–2, older adults with dementia exit labor force much earlier during the preclinical stage than their peers without dementia in both LW and modified Hurd models. As diagnosis nears, the proportion of older adult

Table 1. Risk of Becoming Poor in the Preclinical Stage for Adults Aged 68 and Older Using LW and Modified Hurd Algorithms of Dementia.

	LW Sample				Hurd Sample			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Dementia	1.86***	1.65***	1.58***	1.61***	2.10***	1.70***	1.61***	1.79***
Birth year		0.93*	0.93*	0.93*		0.95+	0.95+	0.95+
Age		0.94+	0.94+	0.94+		0.97	0.97	0.97
Woman		1.61***	1.60***	1.62***		1.70***	1.69***	1.69***
Race/ethnicity (ref. Non-Hispanic White)								
Non-Hispanic Black		2.78***	2.71***	2.43***		3.08***	2.96***	3.49***
Hispanic		3.07***	2.89***	3.47***		3.46***	3.22***	3.82***
Education (ref. less than high school)								
High school/GED		0.52***	0.53***	0.53***		0.47***	0.49***	0.49***
Some college		0.46***	0.48***	0.48***		0.35***	0.37***	0.37***
College degree or higher		0.33***	0.35***	0.35***		0.29***	0.31***	0.31***
Relationship status (ref. married/partnered)								
Divorced/separated		3.44***	3.42***	3.46***		3.79***	3.75***	3.72***
Widowed		2.61***	2.54***	2.55***		2.88***	2.81***	2.83***
Never married		4.11***	3.87***	4.00***		5.34***	5.09***	5.13***
Fair/poor self-rated health			1.16*	1.17*			1.24**	1.24**
Two or more mental health issues			1.15*	1.15*			1.14+	1.14*
Two or more health conditions			0.93	0.94			0.9	0.91
Any ADL limitation			1.18*	1.17*			1.20*	1.20*
Dementia*Race/ethnicity								
Dementia*NH Black				1.18				0.78
Dementia*Hispanic				0.73				0.75
N	22,198				25,978			

Note. LW sample includes 4537 older adults of whom 1061 became poor, while modified Hurd sample includes 7716 older adults, of whom 1550 fell into poverty. $p < .001$ ***, $p < .01$ **, $p < .05$ *, $p > .05$ +.

without dementia who exit labor force approaches, though never quite reaches, that of older adults with dementia.

Inferential results show a significant relationship between dementia classification and exiting the labor force, with a higher magnitude in the LW model than the modified Hurd model (Table 2). Being Hispanic is associated with higher risk of exiting the labor force, as is being non-Hispanic Black and having dementia, both with a higher magnitude for the LW model.

High Indebtedness

As shown in Figures 1–3, only a small proportion (roughly about 2–3%) of older adults hold unsecured debt in excess of 80% of their assets at any point in the preclinical period. However, at the time of being classified with dementia and in a couple of waves preceding it, there is a notable difference of higher indebtedness for those classified as having dementia in both, that is, LW (about 1–2 percentage points) and modified Hurd models (0.5–1 percentage point).

Survival analysis, however, shows that, once covariates are accounted for, there seems to be no significant independent association of dementia group and unsecured level of indebtedness (Table 3). The only exception is the substantially increased risk of high indebtedness for Hispanic older adults classified as having dementia using the modified Hurd algorithm. Otherwise, being a minority older adult is associated with a higher risk of becoming indebted: in the LW model, this includes both non-Hispanic Blacks and Hispanics; for the modified Hurd model, this includes only non-Hispanic Blacks.

Discussion

Cognitive decline is associated with substantial adverse economic impact for older adults. In this paper, we extended this research to the prodromal period of dementia and examined whether and when the divergence in economic well-being for older adults with and without incident dementia begins to emerge. We found that older adults ultimately classified with dementia, via LW or modified Hurd criteria, are at higher risk of dropping out of the labor force and becoming poor than otherwise similar older adults who are not classified with dementia. The estimated difference for high burden of unsecured debt, however, was not statistically significant at conventional levels in most model

Table 2. Risk of Exiting Labor Force in the Preclinical Stage for Adults Aged 68 and Older Using LW and Modified Hurd Algorithms of Dementia.

	LW Sample				Hurd Sample			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Dementia	1.37***	1.43***	1.39***	1.25**	1.22***	1.20**	1.16*	1.08
Birth year		0.81***	0.80***	0.79***		0.85***	0.85***	0.84***
Age		0.82***	0.81***	0.80***		0.88***	0.87***	0.86***
Woman		1.13	1.13	1.15*		1.23**	1.23**	1.24**
Race/ethnicity (ref. Non-Hispanic White)								
Non-Hispanic Black		0.83	0.84	0.55*		1.01	1	0.79
Hispanic		1.55***	1.49***	1.58**		1.38+	1.36+	1.24
Education (ref. less than high school)								
High school/GED		1.03	1.05	1.03		0.96	0.99	0.99
Some college		0.94	0.97	0.94		0.88	0.91	0.91
College degree or higher		0.93	1.01	1.01		0.79*	0.85+	0.85+
Relationship status (ref. married/partnered)								
Divorced/separated		0.78+	0.78+	0.80+		0.84	0.83+	0.83+
Widowed		1.13+	1.06	1.09		1.04	0.97	0.98
Never married		0.73	0.69+	0.72		0.61+	0.57*	0.58*
Fair/poor self-rated health			1.14+	1.13+			1.12+	1.12
Two or more mental health issues			1.28***	1.25***			1.35***	1.33***
Two or more health conditions			1.09	1.1			1.07	1.08
Any ADL limitation			1.12	1.12			1.06	1.06
Dementia*Race/ethnicity				1				
Dementia*NH Black				2.19**				1.62*
Dementia*Hispanic				0.94				1.27
N	2403				2885			

Note. LW sample includes 820 older adults of whom 731 exits labor force, while modified Hurd sample includes 1414 older adults, of whom 1262 exits labor force. $p < .001$ ***, $p < .01$ **, $p < .05$ *, $p < .10$ +.

specifications. It is worth noting that even 16 years prior to dementia classification, those who were eventually classified as having dementia had more precarious and compromised economic well-being compared to those not classified as having dementia. Of course, individuals with lower socioeconomic standing are already at a higher risk of a dementia diagnosis. Our results are consistent with this observation but extend our understanding by suggesting that cognitive decline could have compounding effects on socioeconomic standing.

We further examined whether economic well-being trajectories in the prodromal period differed for non-Hispanic Black and Hispanic older adults relative to their non-Hispanic White peers. The results were mixed. On one hand, non-Hispanic Black or Hispanic participants were more likely to fall into poverty and, for non-Hispanic Blacks, were more likely to have greater unsecured debt. On the other hand, most interaction effects between race/ethnicity and dementia status did not reach statistical significance, thereby suggesting that being in the preclinical stage of ADRD in and of itself may not disadvantage minorities more than non-Hispanic Whites. An exception is the risk of dropping out of labor force, which is considerably higher for non-Hispanic Black adults diagnosed with dementia relative to their White peers.

We relied on two algorithmic classifications of ADRD, LW and modified Hurd, to assess the sensitivity of assigning the HRS respondents of different racial/ethnic background to dementia or non-dementia status. The results suggest a general congruence between the two algorithms but also reveal some relevant differences. In particular, the estimated hazards of various adverse socioeconomic outcomes for non-Hispanic Blacks and Hispanics are consistently higher using the LW algorithm. Furthermore, the estimated differences between those diagnosed with dementia and those without dementia using the LW algorithm are particularly pronounced for non-Hispanic Blacks. Because the LW algorithm does not take into account any demographic variables, it is possible that dementia status as determined by LW is influenced by racial disparities in life course social factors that influence cognitive level, regardless of dementia status. In other words, the LW dementia classification may be a stronger *proxy* for long-standing socioeconomic characteristics, leading to inflated correlations between dementia status and socioeconomic outcomes.

Table 3. Risk of High Burden of Unsecured Debt in the Preclinical Stage for Adults Aged 68 and Older Using LW and Modified Hurd Algorithms of Dementia.

	LW Sample				Hurd Sample			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Dementia	1.41*	1.25	1.2	1.06	1.22	1.11	1.06	0.84
Birth year		1.02	1.02	1.01		1.01	1.01	1.01
Age		0.98	0.98	0.98		0.97	0.96	0.96
Woman		0.83	0.83	0.83		0.85	0.85	0.85
Race/ethnicity (ref. Non-Hispanic White)								
Non-Hispanic Black		2.34***	2.26***	1.90+		2.02***	1.93***	1.47
Hispanic		1.73*	1.64*	1.44		1.38	1.34	0.73
Education (ref. less than high school)								
High school/GED		0.56***	0.59**	0.59**		0.49***	0.52***	0.52***
Some college		0.65+	0.72	0.73		0.60*	0.65+	0.65+
College degree or higher		0.32***	0.37**	0.37**		0.24***	0.27***	0.26***
Relationship status (ref. married/partnered)								
Divorced/separated		3.23***	3.12***	3.12***		3.68***	3.55***	3.55***
Widowed		1.85***	1.72**	1.72**		2.20***	2.07***	2.07***
Never married		2.21*	2.09+	2.06+		1.83	1.75	1.66
Fair/poor self-rated health			1.17	1.17			1.05	1.05
Two or more mental health issues			1.52*	1.51*			1.25	1.24
Two or more health conditions			1.46+	1.46+			1.68**	1.67**
Any ADL limitation			1.15	1.15			1.40*	1.41*
Dementia*Race/ethnicity								
Dementia*NH Black				1.36				1.66
Dementia*Hispanic				1.29				2.93*
N	24,280				28,391			

Note. LW sample includes 4543 older adults of whom 280 became highly indebted with unsecured debt, while modified Hurd sample includes 7739 older adults, of whom 369 became highly indebted. $p < .001$ ***, $p < .01$ **, $p < .05$ *, $p < .10$ +.

Implications for Studying Racial/Ethnic Disparities in Economic Well-Being During the Preclinical Phase of Dementia

The current study highlights that the economic hardship for people with dementia may begin long before their functioning surpasses a dementia threshold. In work to date, researchers have focused on the economic disparities experienced by people *after* they have been diagnosed with dementia (Samuel et al., 2020) or in the time immediately preceding diagnosis (Lin et al., 2016; Zhu et al., 2015). The fact that the costs are seen up to 16 years prior to dementia classification suggests that the economic precarity experienced by individuals with dementia could be present much sooner in the disease cycle than researchers and clinicians have likely appreciated to date. Thus, early detection and intervention efforts may contribute importantly to reducing the economic difficulties prior to dementia onset.

Although racial/ethnic disparities exist across the lifespan in many domains, these are cumulative effects, such that they increase in magnitude across the lifespan (Bhutta et al., 2020). We also see these long-standing economic disparities extend into the preclinical phase of ADRD, where they could have substantial impact on receiving a formal diagnosis, accessing high-quality dementia care, and buffering dementia-related expenses. Thus, even in the absence of interactions between dementia status and racial/ethnic group (i.e., race/ethnicity did not differentially predict *increases* in poverty), there were nevertheless disparities such that race/ethnicity was associated with poverty risk throughout the preclinical period. In other words, the disparities between racial/ethnic groups were static, which has implications for dementia diagnosis and care. The disparities seen at the start of the preclinical phase likely have large implications for how individuals navigate the disease progression, with greater economic uncertainty having effects on many contextual circumstances (e.g., housing stability, food availability, leisure, accessibility of health care, and family environments).

There was also evidence for stronger negative association between preclinical dementia and economic well-being among minority older adults. Specifically, declines in workforce participation were disproportionately evident for older non-Hispanic Black participants. Minority older adults are more likely to experience involuntary job loss, and much of their drop in workforce participation can be attributable to health challenges that are more likely to accumulate in these groups (Burr & Mutchler, 2007; Choi et al., 2017; Flippen & Tienda, 2000). Over time, older Black adults are at higher risk

of work disability, which has implications for their workforce participation, debt, and poverty risk (Brown & Warner, 2008). In addition, increases in unsecured debt were disproportionately evident for older Hispanic participants, suggesting that preclinical dementia may present unique challenges for this group. For example, Hispanic immigrants may be more likely to be underinsured and may experience greater economic penalties for labor force exit related to preclinical dementia.

Implications of Utilizing Algorithms for Dementia Classification

How researchers classify dementia in the absence of a formal diagnosis can have implications for quantifying disparities during both the preclinical and clinical phases of dementia. Dementia classification can inadvertently capture characteristics that do not reflect an underlying neurodegenerative process. For instance, some algorithm-based approaches are based on suboptimal training data that might not fully capture a representative sample of minority older adults. Likewise, classification paradigms might use more or fewer assessments of cognitive health, producing more or less stable estimates of cognitive functioning. Altogether, these considerations and others might alter the likelihood that any one participant is (mis)classified as having dementia.

In the current study, many of the outcomes and disparities were comparable across the two classification methods although the magnitude of these disparities sometimes differed. For instance, disparities were often larger when the LW classification was used than when the modified Hurd classification was used. It might be that the LW algorithm might be more likely to capture racial/ethnic *disadvantages* (i.e., over-classifying racial/ethnic minorities as having ADRD due to racial disparities in life course social factors) rather than an underlying neurodegenerative process among Hispanic and non-Hispanic Black participants (Gianattasio et al., 2019). Particularly when modeling changes in economic well-being during the preclinical phase, appropriately considering racial/ethnic disadvantage stemming from factors other than neurodegeneration (e.g., racial/ethnic disparities in school quality) is especially important. Knowing how individuals are classified as having dementia can help appropriately contextualize and interpret observed economic disparities. Appropriately classifying people most at risk for economic precarity during this preclinical phase has many implications for intervention efforts, such as where (and when) resources can be most effectively deployed to reduce the economic impact of cognitive decline.

Limitations/Future Directions

There are several limitations to this study. First, because our outcomes were dichotomous, detailed information related to these economic outcomes were not examined in this study. For example, data on the ratio of household income to poverty may be more suitable to reveal gradient financial pressure for families just above or beneath the poverty line. Similarly, outcomes related to employment may require circumstantial context and history (e.g., reasons for not working, transition into other jobs, cognitive and physical demand of the job) to better understand the extent of the economic burden. Future research will benefit from incorporating such information to examine the nuanced financial impact and diverging trajectories stemming from various levels of resources and choices made by the individuals. Second, we determined the onset of dementia based on cut-offs of cognitive performance measures, but this may not necessarily mean that the respondent received a physician's diagnosis at that wave. An individual's financial prospects and decision-making may differ depending on the diagnosis status and getting access to Medicare and other health services that they become eligible for after a formal diagnosis. Thus, future research should corroborate the current findings with clinical diagnosis data. However, it should be noted that clinical diagnoses often underestimate ADRD prevalence among racial/ethnic minorities due to disparities in access to high-quality healthcare.

Furthermore, although we examined the relationship between economic outcomes and race and ethnicity, the analysis could be improved by stratifying it by more discrete racial/ethnic groups, given differences in exposures to risk factors such as education, nativity, immigration, and health for various populations, and arguably in particular subgroups of Hispanic older adults, including Mexicans, Cubans, Puerto Ricans, and others (Díaz-Venegas et al., 2016; Garcia et al., 2018, 2018b). Unfortunately, limited sample size and the subsequent lack of reliability of the estimates preclude such analyses here but represent a potentially fruitful direction for future research with more appropriate data.[6]

Finally, while tracking economic trajectories years before the occurrence of dementia is an important aspect of this study, this also raises the prospect of possible reverse causation whereby economic hardship may precede and precipitate cognitive decline, for example, through worse healthcare access and quality. It is also possible that the economic wellbeing-dementia relationship may be inherently bidirectional. And although our study does not make any causal claims with respect to this relationship, it is important to emphasize that we cannot determine the directionality of the causal link.

Conclusion and Implications

The current study demonstrated that people with dementia face elevated level of economic hardship years before the actual onset of dementia. Compared to individuals who do not develop dementia, those eventually classified with dementia had higher risk of becoming poor and dropping out of the

labor force up to 16 years prior to classification. The racial/ethnic disparities in economic well-being were persistent across the dementia progression, with additional racial/ethnic disparities evident in accelerated job loss among non-Hispanic Black older adults and possibly higher indebtedness among Hispanic older adults, compared to White older adults. These findings highlight the importance of evaluating economic costs in the extensive prodromal phase of dementia and suggest the possibility that early interventions could help reduce the financial strain stemming from cognitive decline. On the healthcare system level, such interventions could include establishing close coordination between older adults' family members and clinicians such as physicians or social workers. Doing so would help develop plans and outline steps needed to maintain the physical and financial well-being of older adults. Adopting such a collaboration might mitigate some negative economic implications of early dementia. On the individual and family level, one potentially important intervention would be to provide financial literacy training to older adults and their families about steps they can take to improve their money management and extend the period of financial self-sufficiency for older adults with cognitive decline. Finally, on the workforce level, existing employment programs could be adjusted to help identify appropriate and available jobs to support continued labor force participation for older adults with early signs of cognitive decline who want, or need, to continue working. Altogether, the current study highlights that those ultimately classified with dementia experience declines in economic well-being in the years prior to classification and the level of this economic disadvantage is larger for minority older adults.

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Supplemental Material

Supplemental material for this article is available online.

Notes

1. Since ADAMS uses age 70 as a cutoff for dementia assessment, we use age 68 as the sample entry age cutoff, as these individuals would be at least age 70 at their first follow-up interview, that is, at the first period when they could be classified as having dementia (i.e., to ensure at least one potential pre-dementia assessment of economic outcomes).
2. We employ nearest-neighbor matching and match the five most similar individuals *not* classified with dementia during our study window (i.e., nearest neighbors) to each individual who *is* classified with dementia at some point after their wave of entry into the study or after age 68, whichever happens at a more advanced age. We allowed for replacement, that is, the same individuals without dementia can be used as matches to those with dementia as many times as appropriate. As a result, we use weights that adjust for the number of times that each match is used. To calculate propensity scores, we employ logistic regressions controlling for race and ethnicity, sex, education level, total number of waves, and birth year. We conduct matching separately for individuals determined to have dementia using LW and Hurd algorithms. Further details about propensity score matching results are available on request from the authors.
3. This refers to any labor force status other than full- and part-time work and unemployment.
4. While there is not one universally accepted level of debt that distinguishes high from low financial risk, we choose 80% cutoff as an indicator of approaching potentially unsustainably high levels of debt. For reference, mortgage lenders often use 80% of property value as the upper end of the loan they are willing to extend to minimize the risk of default. Since we are focused on unsecured debt only, our cutoff is less conservative, but is based on the notion that only unsecured debt exhibits a clear negative association with health, include cognitive health (Mudrazija & Butrica, 2021).
5. Because of the cohort-sequential design of HRS, there was sufficient variability to enable us modeling both birth year and age in the same model. This is important because birth year is distinct from chronological age. For example, 70-year-old persons born in 1928 and first interviewed in 1998 could have very different experience from 70 year olds born in 1948 and first interviewed in 2018 (when the first group/cohort already reached age 90). We are, therefore, interested in distinguishing life cycle pattern in economic well-being (i.e., age effect) from possible shifts in that pattern attributable to different experiences of people born at different points in time as they move across time (i.e., cohort effect). Admittedly, we are also making a strong simplifying assumption that over the observed period there were no external factors (i.e., period effects) that would have fundamentally changed the relationship of cognitive health and economic well-being outcomes of interest, allowing us to identify the model. For more information on the age-period-cohort issue and related theoretical and practical considerations, readers can refer to Bell (2020) and Yang and Land (2013).

6. For example, in the model examining leaving the labor force, Hispanic subsample includes only 57 individuals. Further subdividing this already small subsample size would result in unreliable estimates, even for Mexican-origin older adults, who represent the largest group within the HRS Hispanic sample.

References

Alzheimer's Disease Facts and Figures. (2022). https://www.alz.org/media/Documents/alzheimers-facts-and-figures.pdf

Amieva, H., Jacqmin-Gadda, H., Orgogozo, J. M., Le Carret, N., Helmer, C., Letenneur, L., Barberger-Gateau, P., Fabrigoule, C., & Dartigues, J. F. (2005). The 9 year cognitive decline before dementia of the Alzheimer type: A prospective population-based study. *Brain: A Journal of Neurology*, *128*(Pt 5), 1093–1101. https://doi.org/10.1093/brain/awh451

Amieva, H., Le Goff, M., Millet, X., Orgogozo, J. M., Pérès, K., Barberger-Gateau, P., Jacqmin-Gadda, H., & Dartigues, J. F. (2008). Prodromal Alzheimer's disease: Successive emergence of the clinical symptoms. *Annals of Neurology*, *64*(5), 492–498. https://doi.org/10.1002/ana.21509

Aranda, M. P., Kremer, I. N., Hinton, L., Zissimopoulos, J., Whitmer, R. A., Hummel, C. H., Trejo, L., & Fabius, C. (2021). Impact of dementia: Health disparities, population trends, care interventions, and economic costs. *Journal of the American Geriatrics Society*, *69*(7), 1774–1783. https://doi.org/10.1111/jgs.17345

Bell, A. (2020). Age period cohort analysis: A review of what we should and shouldn't do. *Annals of Human Biology*, *47*(2), 208–217. https://doi.org/10.1080/03014460.2019.1707872

Bhutta, N., Chang, A. C., Dettling, L. J., & Hsu, J. W. (2020). *Disparities in wealth by race and ethnicity in the 2019 survey of consumer finances*. Board of Governors of the Federal Reserve System. FEDS Notes. https://doi.org/10.17016/2380-7172.2797

Brown, T. H., & Warner, D. F. (2008). Divergent pathways? Racial/ethnic differences in older women's labor force withdrawal. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *63*(3), S122–S134. https://doi.org/10.1093/geronb/63.3.s122

Bugliari, D., Carroll, J., Hayden, O., Hayes, J., Hurd, M., Karabatakis, A., & Emanuel, N. (2020). *RAND HRS longitudinal file 2016 (V2) documentation*. RAND Center for the Study of Aging.

Burr, J. A., & Mutchler, J. E. (2007). Residential independence among older persons: Community and individual factors. *Population Research and Policy Review*, *26*(1), 85–101. https://doi.org/10.1007/s11113-007-9022-0

Butterworth, P., Cherbuin, N., Sachdev, P., & Anstey, K. J. (2012). The association between financial hardship and amygdala and hippocampal volumes: Results from the PATH through life project. *Social Cognitive and Affective Neuroscience*, *7*(5), 548–556. https://doi.org/10.1093/scan/nsr027.

Callander, E. J., Schofield, D. J., & Shrestha, R. N. (2013). Chronic health conditions and poverty: A cross-sectional study using a multidimensional poverty measure. *BMJ Open*, *3*(11), Article e003397. https://doi.org/10.1136/bmjopen-2013-003397

Chen, Y., Crimmins, E., Ferido, P., & Zissimopoulos, J. M. (2022). Racial/ethnic disparities in length of life after dementia diagnosis: An 18-year follow-up study of Medicare beneficiaries. *Lancet regional health. Americas*, *8*, 100179. https://doi.org/10.1016/j.lana.2021.100179.

Choi, E., Tang, F., & Copeland, V. C. (2017). Racial/ethnic inequality among older workers: Focusing on Whites, Blacks, and Latinos within the cumulative advantage/disadvantage framework. *Journal of Social Service Research*, *43*(1), 18–36. https://doi.org/10.1080/01488376.2016.1235068

Colucci, L., Bosco, M., Fasanaro, A. M., Gaeta, G. L., Ricci, G., & Amenta, F. (2014). Alzheimer's disease costs: What we know and what we should take into account. *Journal of Alzheimer's Disease: JAD*, *42*(4), 1311–1324. https://doi.org/10.3233/JAD-131556

Díaz-Venegas, C., Downer, B., Langa, K. M., & Wong, R. (2016). Racial and ethnic differences in cognitive function among older adults in the USA. *International Journal of Geriatric Psychiatry*, *31*(9), 1004–1012. https://doi.org/10.1002/gps.4410

El-Hayek, Y. H., Wiley, R. E., Khoury, C. P., Daya, R. P., Ballard, C., Evans, A. R., Karran, M., Molinuevo, J. L., Norton, M., & Atri, A. (2019). Tip of the iceberg: Assessing the global socioeconomic costs of Alzheimer's disease and related dementias and strategic implications for stakeholders. *Journal of Alzheimer's Disease: JAD*, *70*(2), 323–341. https://doi.org/10.3233/JAD-190426

Flippen, C., & Tienda, M. (2000). Pathways to retirement: Patterns of labor force participation and labor market exit among the pre-retirement population by race, Hispanic origin, and sex. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *55*(1), S14-S27, https://doi.org/10.1093/geronb/55.1.s14

Garcia, M. A., Saenz, J. L., Downer, B., Chiu, C. T., Rote, S., & Wong, R. (2018a). Age of migration differentials in life expectancy with cognitive impairment: 20-year findings from the hispanic-EPESE. *The Gerontologist*, *58*(5), 894–903. https://doi.org/10.1093/geront/gnx062

Garcia, M. A., Saenz, J., Downer, B., & Wong, R. (2018b). The role of education in the association between race/ethnicity/nativity, cognitive impairment, and dementia among older adults in the United States. *Demographic Research*, *38*, 155–168. https://doi.org/10.4054/DemRes.2018.38.6.

Gaugler, J. E., Hovater, M., Roth, D. L., Johnston, J. A., Kane, R. L., & Sarsour, K. (2013). Analysis of cognitive, functional, health service use, and cost trajectories prior to and following memory loss. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *68*(4), 562–567. https://doi.org/10.1093/geronb/gbs078

Gianattasio, K. Z., Ciarleglio, A., & Power, M. C. (2020). Development of algorithmic dementia ascertainment for racial/ethnic disparities research in the US Health and Retirement Study. *Epidemiology*, *31*(1), 126–133. https://doi.org/10.1097/EDE.0000000000001101

Gianattasio, K. Z., Wu, Q., Glymour, M. M., & Power, M. C. (2019). Comparison of methods for algorithmic classification of dementia status in the health and retirement study. *Epidemiology*, *30*(2), 291–302. https://doi.org/10.1097/EDE.0000000000000945

Hurd, M. D., Martorell, P., Delavande, A., Mullen, K. J., & Langa, K. M. (2013). Monetary costs of dementia in the United States. *New England Journal of Medicine*, *368*(14), 1326–1334. https://doi.org/10.1056/NEJMsa1204629

Jack, C. R. Jr., Bennett, D. A., Blennow, K., Carrillo, M. C., Dunn, B., Haeberlein, S. B., Holtzman, D. M., Jagust, W., Jessen, F.,

Karlawish, J., Liu, E., Molinuevo, J. L., Montine, T., Phelps, C., Rankin, K. P., Rowe, C. C., Scheltens, P., Siemers, E., Snyder, H. M., & Silverberg, N. (2018). NIA-AA research framework: Toward a biological definition of Alzheimer's disease. *Alzheimer's and Dementia: The Journal of the Alzheimer's Association*, *14*(4), 535–562. https://doi.org/10.1016/j.jalz.2018.02.018

Lin, P.-J., Zhong, Y., Fillit, H. M., Chen, E., & Neumann, P. J. (2016). Medicare expenditures of individuals with Alzheimer's disease and related dementias or mild cognitive impairment before and after diagnosis. *Journal of the American Geriatrics Society*, *64*(8), 1549–1557. https://doi.org/10.1111/jgs.14227

Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. *Science*, *341*(6149), 976–980. https://doi.org/10.1126/science.1238041

Mayeda, E. R., Glymour, M. M., Quesenberry, C. P., & Whitmer, R. A. (2016). Inequalities in dementia incidence between six racial and ethnic groups over 14 years. *Alzheimer's and Dementia: The Journal of the Alzheimer's Association*, *12*(3), 216–224. https://doi.org/10.1016/j.jalz.2015.12.007

Mudrazija, S., & Butrica, B. A. (2023a). The dynamic nature of poverty and food insecurity among older adults: Evidence from the health and retirement study. *Applied Economic Perspectives and Policy*, *45*(1), 262–279. https://doi.org/10.1002/aepp.13329

Mudrazija, S., & Butrica, B. A. (2023b). How does debt shape health outcomes for older Americans? *Social Science & Medicine*, *329*, 116010. https://doi.org/10.1016/j.socscimed.2023.116010.

Robinson, R. L., Rentz, D. M., Andrews, J. S., Zagar, A., Kim, Y., Bruemmer, V., Schwartz, R. L., Ye, W., & Fillit, H. M. (2020). Costs of early stage Alzheimer's disease in the United States: Cross-sectional analysis of a prospective cohort study (GERAS-US). *Journal of Alzheimer's Disease: JAD*, *75*(2), 437–450. https://doi.org/10.3233/JAD-191212

Samuel, L. J., Szanton, S. L., Wolff, J. L., Ornstein, K. A., Parker, L. J., & Gitlin, L. N. (2020). Socioeconomic disparities in six-year incident dementia in a nationally representative cohort of US older adults: An examination of financial resources. *BMC Geriatrics*, *20*(1), 156–159. https://doi.org/10.1186/s12877-020-01553-4

Sonnega, A., Faul, J. D., Ofstedal, M. B., Langa, K. M., Phillips, J. W. R., & Weir, D. R. (2014). Cohort profile: The health and retirement study (HRS). *International Journal of Epidemiology*, *43*(2), 576–585. https://doi.org/10.1093/ije/dyu067

Stites, S. D. (2022). The association of poverty with well-being and dementia outcomes—it's not all about the money. *JAMA Network Open*, *5*(3), Article e224171. https://doi.org/10.1001/jamanetworkopen.2022.4171

Tang, M. X., Cross, P., Andrews, H., Jacobs, D. M., Small, S., Bell, K., Merchant, C., Lantigua, R., Costa, R., Stern, Y., & Mayeux, R. (2001). Incidence of AD in African-Americans, Caribbean Hispanics, and Caucasians in northern Manhattan. *Neurology*, *56*(1), 49–56. https://doi.org/10.1212/wnl.56.1.49

U.S. Census Bureau. (2022). *Poverty in the United States: 2021*. U.S. Government Publishing Office.

Verlinden, V. J., van der Geest, J. N., de Bruijn, R. F., Hofman, A., Koudstaal, P. J., & Ikram, M. A. (2016). Trajectories of decline in cognition and daily functioning in preclinical dementia. *Alzheimer's and Dementia: The Journal of the Alzheimer's Association*, *12*(2), 144–153. https://doi.org/10.1016/j.jalz.2015.08.001

Wiltshire, J. C., Elder, K., Kiefe, C., & Allison, J. J. (2016). Medical debt and related financial consequences among older African American and White adults. *American Journal of Public Health*, *106*(6), 1086–1091. https://doi.org/10.2105/AJPH.2016.303137

Yang, Y., & Land, K. C. (2013). *Age-period-cohort analysis: New models, methods, and empirical applications*. CRC Press.

Zhu, C. W., Cosentino, S., Ornstein, K., Gu, Y., Scarmeas, N., Andrews, H., & Stern, Y. (2015). Medicare utilization and expenditures around incident dementia in a multiethnic cohort. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *70*(11), 1448–1453. https://doi.org/10.1093/gerona/glv124