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# From Normal Cognition to Severe Dementia: Measurement, Validation, and Consequences for Care Arrangements and Health

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**Abstract**

Dementia imposes substantial demands on families, health systems, and public programs, and those demands depend on disease severity, not only on whether dementia is present. Capturing the progression of dementia is therefore central to research on its consequences, yet most studies of severity rely on clinical or convenience samples. We address this gap by extending the Hudomiet–Hurd–Rohwedder cognition measure to a calibrated severity classification in the Health and Retirement Study (HRS), drawing on the Clinical Dementia Rating collected in the Aging, Demographics, and Memory Study. We apply the classification to HRS respondents age 65 or older across waves 2000–2018. We examine associations between dementia severity and mortality, nursing home residence, paid and unpaid care, health care utilization, out-of-pocket spending, Medicaid coverage, and household wealth. Age-adjusted dementia prevalence declined between 2000 and 2018, with the decline concentrated in moderate and severe stages and with larger declines among Black and Hispanic respondents than among White respondents. Across outcomes, the experience of dementia and its consequences for individuals, families, and the health care system vary substantially by severity. These findings validate the measure and demonstrate that the severity classification we developed for the HRS provides valuable information for health policy, providers, patients, and families to further adapt care to the stage of the condition and for advance planning.

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# 1. Introduction

Dementia is a progressive condition whose cognitive, functional, and behavioral features intensify as the disease advances. The intensity of care needs, the use of informal and formal long-term care,[1] the level of out-of-pocket medical spending,[2] and the financial strain on households all rise with severity.[3] Even where age-adjusted prevalence has declined, the population-level burden of dementia continues to be shaped by how individuals are distributed across stages of the disease and by how they transition through those stages over time.

Despite the relevance of severity for households, providers, and policy-makers, population-representative evidence on dementia severity is limited. Most existing severity estimates come from clinical registries such as the National Alzheimer's Coordinating Center Uniform Data Set,[4, 5] from community studies such as the Chicago Health and Aging Project[6] or the Framingham Heart Study,[7] or from small specialized samples.[5, 8] These sources differ from the U.S. older population in age structure, racial and ethnic composition, geography, and selection into clinical settings, and they typically follow participants for limited periods. As a result, the distribution of severity in the U.S. population age 65 or older, the way that distribution has changed over time, and the way severity maps onto outcomes such as care use, health, spending, and wealth are not well established at the population level.

This study develops a measure of dementia severity on data from the Health and Retirement Study (HRS), a nationally representative longitudinal survey of older Americans, and uses it to describe the distribution of severity in the U.S. population age 65 or older over the period 2000–2018 and to estimate associations between severity and a range of outcomes. We build on the HHR cognition measure (Hudomiet, Hurd, and Rohwedder, 2022),[9] a continuous index of cognition derived from HRS core interview items and calibrated to dementia diagnoses from the Aging and Demographics Memory Study (ADAMS). We extend the HHR framework by using the Clinical Dementia Rating-based severity categories (CDR) from ADAMS to define matching severity categories in the HRS core, producing severity estimates for the full HRS sample of respondents age 65 or older across all waves from 2000 through 2018.

**Research questions**

We address four questions:

1. **Distribution.** What is the distribution of dementia severity in the U.S. population age 65 or older, and how does it vary by age?
2. **Trends and inequalities.** How has the distribution of severity changed between 2000 and 2018 overall and across race and ethnicity?
3. **Transitions and mortality.** How do older adults move between cognitive states from one wave to the next, and how does two-year mortality vary by severity and age?
4. **Consequences.** How is severity associated with nursing home residence, paid and unpaid care in the community, health status, health care utilization, out-of-pocket medical spending, Medicaid coverage, and household wealth?

Statistics by severity also serve to validate the measure: the patterns we document — strong age gradients, transitions consistent with disease progression, sharply elevated mortality at higher severity, and graded associations with care, spending, and wealth — provide internal evidence that the classification captures meaningful variation in disease stage. The measure thus opens a broad range of research opportunities in a population-representative setting and can inform efforts to tailor services and supports to the stage of the condition.

# 2. Data and Methods

## 2.1 The Health and Retirement Study

We use data from the Health and Retirement Study (HRS), a nationally representative, biennial, longitudinal survey of the U.S. population age 51 or older. The HRS began in 1992, and new cohorts of individuals age 51–56 have been added every six years to maintain population representativeness. The survey collects detailed information on health, cognition, family, work, income, and wealth, and is unusually rich in cognitive measures relative to other large social science surveys.

Two features of HRS data collection are central to our analysis. First, respondents are followed into nursing homes, which is necessary for accurate estimates of dementia and severity at older ages. Second, when a respondent is unable or unwilling to complete an interview, the HRS attempts to interview a proxy, typically a spouse or adult child. About half of the sample with dementia is interviewed by proxy. For respondents who attrite, the HRS seeks information on survival status and

date of death. With appropriate weighting, the HRS provides a population-representative sample of older adults and of deaths during the study period.

Our analytic sample comprises HRS respondents age 65 or older in waves 2000 through 2018, yielding 106,632 person-wave observations on 22,506 individuals.

## 2.2 Cognition measures in the HRS core

The HRS core interview includes an extensive set of cognition items. Some items are collected only in self-interviews, others only in proxy interviews, and several are collected in both. Subjectively assessed memory (poor, fair, good, very good, excellent) and the number of limitations in instrumental activities of daily living (using the phone, managing money, taking medications, shopping, preparing meals) are available in both self- and proxy interviews.

In self-interviews, the HRS administers items adapted from the Telephone Interview for Cognitive Status: a 10-word immediate recall test, a 10-word delayed recall test, a serial-7 subtraction test (subtracting 7 five times beginning at 100), backward counting from 20 to 10, the date of the interview, the name of the president, and naming "cactus" and "scissors" from paraphrased descriptions. In proxy interviews, both interviewers and proxy informants report on the cognitive state of the respondent. Interviewers assess whether cognitive limitations were a reason for conducting a proxy interview (no limitation; some limitation; limitations prevented a self-interview). Proxy informants report whether the respondent has ever gotten lost, has ever wandered off, can be left alone for an hour or so, and has seen or heard things that were not there.

## 2.3 ADAMS and the HHR cognition measure

Because the HRS core does not include a clinical dementia diagnosis, 856 HRS respondents age 70 or older underwent a detailed in-home clinical assessment in 2001–2003 as part of the Aging, Demographics, and Memory Study (ADAMS). The assessment lasted 3–4 hours and produced a final diagnosis of (1) dementia, (2) cognitively impaired but not dementia (CIND), or (3) normal cognitive function. ADAMS participants who were not diagnosed with dementia were followed up to three additional times between 2003 and 2009.

In prior work we developed a continuous measure of cognition for HRS respondents — the HHR measure — built from a wide set of HRS core cognitive items together with limitations in activities of daily living, instrumental activities of daily living, and other health variables.[9] The measure is calibrated

to ADAMS diagnoses both for the population overall and for subgroups defined by sex, race, and ethnicity, and it produces estimates of normal cognition, CIND, and dementia for the full HRS sample. We use the HHR measure for HRS respondents age 65 or older in all waves from 2000 through 2018.

## 2.4 Extending the HHR measure to dementia severity

ADAMS also collected the items required to compute the CDR,[10] which assesses dementia severity in six domains: memory; orientation; judgment and problem-solving; community affairs; home and hobbies; and personal care. The ADAMS investigators used the CDR to classify participants into seven severity categories ranging from no dementia through mild impairment, mild dementia, moderate dementia, severe dementia, profound dementia, and terminal dementia.

We extend the HHR measure to severity by selecting cut-points along the continuous HHR scale such that the distribution of HRS respondents across severity categories matches the corresponding distribution in ADAMS, using sampling weights so that the resulting estimates represent the U.S. population age 65 or older. Because the profound and terminal categories contain few observations, we combine profound, terminal, and severe dementia into a single "severe" category for the analyses that follow. The resulting classification has five levels: normal cognition, CIND, mild dementia, moderate dementia, and severe dementia.

## 2.5 Outcomes

We examine the association between dementia severity and a set of outcomes spanning mortality and health, care arrangements and health care services utilization, and economic position:

- **Mortality:** death within two years of the wave-*t* interview.
- **Nursing home residence:** an indicator for living in a nursing home at the wave-*t* interview.
- **Care arrangements in the community:** receipt of any home care, any paid help, and any unpaid help, along with monthly hours of paid and unpaid help.
- **Health status:** self-reported fair or poor health; self-reported prior doctor diagnosis of Alzheimer's disease or other dementias; counts of ADL and IADL limitations.
- **Health care utilization** (elicited as use since the previous interview): any hospital nights and number of hospital nights; any doctor visit and number of doctor visits; any outpatient surgery; any dental visit.

- **Out-of-pocket medical spending:** total annualized out-of-pocket spending and components for nursing home, home health, special facilities, prescription drugs, and dental care, expressed in thousands of 2018 dollars.
- **Medicaid coverage:** an indicator for being covered by Medicaid.
- **Household wealth:** indicators for positive wealth and the natural log of wealth conditional on positive values, separately for primary residence, non-housing wealth, and total wealth.

## 2.6 Statistical models

We begin with descriptive statistics: the distribution of severity overall and by age, age-adjusted trends from 2000 through 2018, trends by race and ethnicity, wave-to-wave transitions across cognitive states, and two-year mortality by age and severity. Descriptive statistics are weighted using HRS person-level weights, including weights for individuals residing in nursing homes.

For most outcomes we estimate individual fixed-effects regressions of the form

$$y_{it} = \alpha_i + \beta' S_{it} + \gamma' X_{it} + \delta_t + \varepsilon_{it},$$

where $y_{it}$ is the outcome for individual $i$ at wave $t$, $S_{it}$ is a set of indicators for severity (with normal cognition as the reference category), $X_{it}$ is a vector of demographic and health controls, $\delta_t$ are wave fixed effects, and $\alpha_i$ is an individual fixed effect. The fixed-effects specification identifies $\beta$ from within-person changes in cognitive status over time and absorbs time-invariant individual heterogeneity, including factors such as education, and early-life conditions.

For nursing home residence, we also report a sequence of pooled OLS specifications that add wave dummies, demographic controls, and health controls in turn, to show how the estimated severity gradient changes as more controls are introduced and how the within-person estimates compare to the between-person estimates. For health care utilization we use OLS rather than fixed effects because the analysis includes comparisons by race and ethnicity, which are time-invariant. Regression analyses are unweighted and use HRS respondents age 65 or older across waves 2000–2018. Standard errors are clustered at the individual level in the OLS regressions.

# 3. Results

## 3.1 Distribution of dementia severity in 2002

Table 1 shows the distribution of the calibrated severity measure in the 2002 HRS among respondents age 71 or older, the age range covered by ADAMS. Because of oversamples and differential nonresponse, weighted and unweighted distributions differ meaningfully, and we present weighted estimates throughout the paper unless noted. In 2002, 65.1% of the population age 71 or older had normal cognition, 20.1% had CIND, and 14.8% had dementia. Among those with dementia, more than half were classified as mild (8.6% of the full population), 2.4% had moderate dementia, 2.6% had severe dementia, and the profound and terminal categories together accounted for 1.2%. Because of small sample sizes in the latter two categories, we combine profound, terminal, and severe dementia into a single "severe" category in the analyses that follow.

*[TABLE 1 ABOUT HERE]*

## 3.2 Distribution by age

Table 2 shows the distribution of cognitive status by age group, pooling HRS waves 2000 through 2018. Age gradients are pronounced. The share with normal cognition declines from 86.8% among those age 65–69 to 26.4% among those age 90 or older. Over the same age range, CIND rises from 11.3% to 32.3%, and dementia rises from 1.8% to 41.3%.

The composition of dementia also shifts with age. Among people living with dementia, the share with mild dementia falls from 83.6% at ages 65–69 to 53.0% at ages 90 or older, while the share with severe dementia rises from 6.6% to 31.5%. The share with moderate dementia is comparatively flat across age groups, ranging between roughly 15% and 17%, except the lower rate of 9.8% among the youngest group (age 65-69). The age gradient in dementia is therefore not only a gradient in prevalence but also a gradient in severity: older age groups have a higher share of people living with dementia, and within that share a larger fraction are at advanced stages.

*[TABLE 2 ABOUT HERE]*

## 3.3 Trends, 2000–2018

Table 3 reports age-adjusted trends in cognitive status from 2000 through 2018. The share of the population age 65 or older with normal cognition was approximately stable, ranging between 69.1% and 71.9%. The share with CIND was also approximately stable, ranging between 17.9% and 21.0%. Both

show a slight increasing trend. Taken together with a decline in any dementia from 12.2% in 2000 to 7.9% in 2018 — a decrease of 4.3 percentage points — these patterns indicate an overall shift toward less severe cognitive impairment. The trends by severity stage reinforce this conclusion: the decline in dementia was concentrated in the more severe stages, with severe dementia falling from 3.2% to 1.5% (−1.7 percentage points), moderate dementia falling from 2.0% to 1.0% (−1.0 percentage points), and mild dementia falling from 7.1% to 5.5% (−1.6 percentage points).

*[TABLE 3 ABOUT HERE]*

Table 4 presents these changes by race and ethnicity. The pattern for White respondents resembles the overall pattern, but with smaller absolute changes: normal cognition rose by 1.3 percentage points, any dementia fell by 3.3 percentage points, and severe dementia fell by 1.4 percentage points. Changes for Black and Hispanic respondents were larger. Among Black respondents, normal cognition rose by 13.9 percentage points, CIND fell by 3.9 percentage points, and any dementia fell by 9.9 percentage points, with declines of 5.1, 1.6, and 3.2 percentage points in mild, moderate, and severe dementia respectively. Among Hispanic respondents, normal cognition rose by 11.1 percentage points and any dementia fell by 7.9 percentage points, with similarly broad-based declines across severity stages. Gaps in dementia between Black and Hispanic respondents on the one hand and White respondents on the other narrowed across all severity stages over the study period.

*[TABLE 4 ABOUT HERE]*

## 3.4 Wave-to-wave transitions

Table 5a reports wave-to-wave transitions in cognitive status. Because HRS waves are roughly two years apart, these are approximately two-year transition probabilities. Among respondents with normal cognition at wave *t*, 91.9% remained in normal cognition at wave *t+1* and 8.1% transitioned to CIND; transitions directly to dementia were rare (less than 0.1%). Among those with CIND, 78.1% remained in CIND, 19.4% transitioned to mild dementia, and small fractions transitioned to moderate or severe dementia. Among those with mild dementia, 62.8% remained in mild dementia, 27.7% transitioned to moderate dementia, and 7.2% transitioned to severe dementia. Among those with moderate dementia, 76.3% transitioned to severe dementia. Reverse transitions to a less impaired state were uncommon and small in magnitude — 2.4% of those with mild dementia transitioned to CIND, and 1.5% of those with moderate dementia transitioned to mild dementia — consistent with the progressive nature of the

disease and the limited scope for measurement-driven backward movement in the calibrated classification.

*[TABLE 5a ABOUT HERE]*

Table 5b shows nursing home residence rates by cognitive transition from wave *t* to wave *t*+1. Panel A reports residence at wave *t*. Among those with normal cognition at *t*, 0.19% lived in a nursing home; among those who transitioned from normal to CIND, the rate was 0.70%. Other transitions show further elevation. For example, among those with mild dementia at *t*, 12% lived in a nursing home overall — 9% among those who remained at mild dementia at *t*+1, but 26% among those who progressed to severe dementia. Thus, conditional on cognitive classification, nursing home residence is associated with an elevated transition to a worse cognitive state. While this association could be causal, operating through a lack of familiar social connections, disruptions to normal life and many others, it could also be the result of selection: within a cognitive classification those with relatively worse cognition who already have elevated transition probabilities may reside in a nursing home for other, unspecified health conditions.

Panel B reports nursing home residence at wave *t*+1 (approximately two years later) for the same transitions. The pattern is similar but uniformly higher. For example, among those with mild dementia at *t*, the rate was 12% at *t* and 25% at *t*+1.

Panel C reports the difference between Panels B and A — the change in nursing home residence associated with each cognitive transition. The fraction of individuals living in nursing homes increased in each transition category, except among those whose cognitive status improved from CIND to normal (decrease of 1.2 percentage point). The increase in nursing home residence tended to be higher in categories associated with larger declines in cognitive status. For example, the increase was 8.4 percentage points among those who stayed in the mild dementia group, while it was 22.2 percentage points among those who transitioned to moderate dementia and 31.4 percentage points among those who transitioned to severe dementia. Some cells show very large changes: the transition from CIND to moderate dementia is associated with a 69 percentage-point increase (from 5% to 73%).

*[TABLE 5b ABOUT HERE]*

## 3.5 Two-year mortality

Table 6 reports two-year mortality rates by age group and cognitive status. Overall, two-year mortality among those age 65 or older was 9.6%. Mortality rises with age within every cognitive status and rises with severity within every age group (except the sparsely populated group aged 65-69 with severe dementia). Among respondents with normal cognition, two-year mortality ranged from 2.6% at ages 65–69 to 22.5% at ages 90 or older. Among respondents with CIND, two-year mortality was already substantially elevated even at younger ages: 10.3% at ages 65–69 (vs. 2.6% for those with normal cognition). At older ages, mortality among people living with dementia was very high, reaching 64.0% among those age 90 or older with severe dementia. The strong gradient of mortality with severity, present at every age, supports the interpretation that the severity classification captures a clinically meaningful dimension of disease progression.

*[TABLE 6 ABOUT HERE]*

## 3.6 Nursing home residence

Table 7 reports models of living in a nursing home, an outcome that captures the most resource-intensive form of long-term care and a major driver of out-of-pocket and public spending at advanced stages of dementia. We present four pooled OLS specifications and one individual fixed-effects specification. The first OLS column includes only the severity indicators. Subsequent columns add wave dummies, demographic controls, and health controls in turn.

The mean of the outcome is 3.7%; that is, 3.7% of the population age 65 or older was living in a nursing home at the time of the HRS interview, pooling waves 2000–2018. The share of respondents with normal cognition who live in a nursing home is close to zero. Without further controls, the probability of living in a nursing home rises from the reference level by 2.7 percentage points for CIND, 15.6 percentage points for mild dementia, 38.1 percentage points for moderate dementia, and 58.9 percentage points for severe dementia. Adding wave dummies leaves the estimates essentially unchanged. Adding demographic controls reduces the severe dementia estimate to 54.7 percentage points, and adding health controls reduces it further to 50.9 percentage points. The fixed-effects estimate of 49.3 percentage points for severe dementia is close to the fully-controlled OLS estimate, indicating that the strong association between severity and nursing home residence reflects within-person changes in cognitive status rather than fixed differences across individuals. Across all specifications, severity is strongly graded with nursing home residence.

*[TABLE 7 ABOUT HERE]*

Figure 1 displays the same gradient graphically using weighted pooled data from waves 2000–2018: the share living in a nursing home rises from 0.3% at normal cognition to 2.9% at CIND, 16.0% at mild dementia, 37.9% at moderate dementia, and 58.9% at severe dementia.

*[FIGURE 1 ABOUT HERE]*

## 3.7 Health status

Table 8 reports fixed-effects regressions of four health outcomes on cognitive status with full demographic and health controls. The objective of these estimations is to find how these health indicators vary as severity progresses. Compared with respondents in normal cognition, those with CIND are 7.8 percentage points more likely to report fair or poor health, and those with severe dementia are 26.9 percentage points more likely to do so. The relationship with self-reported prior doctor diagnosis of Alzheimer's disease or other dementias is steeper: respondents with mild dementia are 28.1 percentage points more likely than those from the reference group to report a prior diagnosis, and respondents with severe dementia are 81.5 percentage points more likely. Adding the constant term (0.199) and the coefficient on severe dementia would predict that all those with severe dementia would have been informed by a doctor of their condition. But among those with mild dementia, about half would have been informed.

The number of ADL and IADL limitations rises sharply with severity. Compared with respondents in normal cognition, those with severe dementia have 3.4 more ADL limitations and 3.8 more IADL limitations, on bases of 0.6 and 0.5 limitations on average, respectively.

*[TABLE 8 ABOUT HERE]*

## 3.8 Care arrangements in the community

Table 9 reports fixed-effects regressions of care arrangements among respondents living in the community. In every category, more severe stages of dementia are associated with a higher probability of receiving help and with more hours of help. Compared with respondents in normal cognition, those with severe dementia are 34.8 percentage points more likely to receive home health care, 43.6 percentage points more likely to receive any paid help, and 57.7 percentage points more likely to receive unpaid help. Compared to those with normal cognitive function, paid hours are 126 hours higher per month and unpaid hours are 236 hours higher per month at severe dementia. Care needs in the

community therefore rise steeply with severity, and the bulk of the additional hours is provided informally.

*[TABLE 9 ABOUT HERE]*

## 3.9 Health care utilization

Table 10 reports OLS regressions of health care utilization on severity, age, sex, race and ethnicity, and an indicator for long recall windows (described below). We use OLS rather than fixed effects because the analysis includes comparisons by race and ethnicity. Health care utilization is elicited in the HRS as use "since last interview." For most respondents this corresponds to a recall period of about two years, the typical interval between HRS waves. For respondents who missed an intervening wave, the recall window is longer. We include an indicator for these cases (wave gap greater than one wave) so that the severity coefficients are not contaminated by mechanical differences in recall length.

Compared with respondents in normal cognition, those with severe dementia are 21.4 percentage points more likely to have any hospital nights and have 5.2 more hospital nights per period. Doctor visits also rise with severity, with 10.0 more visits at severe dementia than at normal cognition. In contrast, more severe dementia is associated with a lower probability of outpatient surgery (−9.1 percentage points at severe dementia) and a lower probability of any dental visit (−19.5 percentage points at severe dementia). The combination of more inpatient and outpatient medical contact with less elective and preventive care is consistent with the acute medical needs that arise at advanced stages of dementia and with the practical difficulty of administering procedures and routine care to people living with severe dementia.

For all the service use categories Black and Hispanic persons had less use than white persons. The difference is particularly large for any dental visit where Black persons were 22 ppts less likely and Hispanic persons 20 ppts less likely.

*[TABLE 10 ABOUT HERE]*

## 3.10 Out-of-pocket medical spending

Table 11 reports fixed-effects regressions of annualized out-of-pocket medical spending on severity, expressed in thousands of 2018 dollars. Total out-of-pocket spending rises with severity, reaching $9,606 more per year at severe dementia than at normal cognition. Almost all of the additional spending is accounted for by nursing home costs, which rise by $9,190 per year at severe dementia. Out-of-pocket spending on home health care ($273), special facilities ($254), and prescription drugs ($−124, not

statistically distinguishable from zero) is small in comparison. Out-of-pocket dental spending falls with severity, by $132 per year at severe dementia, consistent with the lower probability of dental visits documented in Table 10.

*[TABLE 11 ABOUT HERE]*

## 3.11 Medicaid coverage

The top panel of Table 12 reports the share of the population covered by Medicaid by age and dementia severity; the lower panel shows the joint distribution of the population across the same age and severity cells to help interpretation of information in top panel, i.e. whether percentages there apply to a small or large fraction of the population. Overall, 8.9% of the HRS sample age 65 or older was on Medicaid over the study period. Medicaid coverage rises with age overall — from 7.7% at ages 65–69 to 15.2% at ages 90 or older; yet, within each cognitive status category the fraction on Medicaid is decreasing in age. For example, coverage at severe dementia is lower at older ages than at younger ages (56.5% at ages 65–69, 41.9% at ages 90 or older). This pattern is consistent with selection: respondents who survive to advanced old age came disproportionately from higher-wealth backgrounds and are less likely to qualify for Medicaid, and survival to advanced old age is itself more likely among those who remain in better cognitive states.

Across rows, Medicaid coverage rises sharply with severity at every age. Among respondents age 90 or older, Medicaid coverage is 2.8% at normal cognition and 41.9% at severe dementia. The bottom panel shows that respondents with severe dementia make up 2.2% of the population age 65 or older overall but a larger share at older ages: about 15% of respondents age 90 or older have severe dementia.

*[TABLE 12 ABOUT HERE]*

## 3.12 Household wealth

Table 13 reports fixed-effects regressions of household wealth on severity. Each wealth category — primary residence, non-housing wealth, and total wealth — is examined through two outcomes: an indicator for positive wealth, and the natural log of wealth conditional on positive values.

Homeownership declines steeply with severity. Compared with respondents in normal cognition, those with severe dementia are 24.5 percentage points less likely to own a primary residence. The population mean is 75.4%. Conditional on owning a primary residence, the log value declines by 0.046 log points (about 4.5%) at severe dementia, a smaller effect that is not consistently significant. The probability of having positive non-housing wealth declines by 7.4 percentage points at severe dementia; the

population mean is 87.3%. Among those with positive non-housing wealth the decline is larger: 0.412 log points, or about 34% lower non-housing wealth compared to those with normal cognition. Total wealth shows the largest decline conditional on positive wealth: 0.810 log points at severe dementia, or about 56% less than at normal cognition.

The combination of small declines in housing wealth conditional on ownership with large declines in non-housing wealth conditional on positive holdings suggests that as severity advances, households first draw down financial assets and then transition out of homeownership, consistent with the pattern of nursing home entry documented in Table 7 and the elevated out-of-pocket spending documented in Table 11.

*[TABLE 13 ABOUT HERE]*

# 4. Discussion

The severity classification we developed for the HRS reveals distinct and substantively meaningful differences across stages of dementia that prevalence alone does not reveal. Mortality, nursing home residence, transitions between cognitive states, care arrangements, out-of-pocket spending, and household wealth all vary sharply across stages, and the patterns we document support the broader proposition that the burden of dementia for households, providers, and public programs depends on severity, not only on whether dementia is present.

## 4.1 Severity, age, and the composition of dementia

Severity varies strongly with age, and the composition of dementia shifts with age in ways that matter for service use and cost. Among respondents age 70–74 with dementia, 73% have mild dementia and 10% have severe dementia; among those age 90 or older with dementia, 53% have mild dementia and 32% have severe dementia. As life expectancy continues to rise, a larger share of the older population will be in age groups with the highest severe-dementia shares. Holding age-specific severity profiles constant, this shift implies higher average resource needs per case, even without any change in age-specific prevalence. Analyses of dementia-related service use, spending, and policy costs that rely on prevalence alone therefore risk understating future demand. Taking severity composition into account is necessary both for forecasting and for designing services that match the stage of the condition.

The around-the-clock care needs that emerge at the more advanced stages of dementia are what make the condition so burdensome for families and public programs. The steep severity gradient in nursing

home residence (Table 7, Figure 1), the large increases in paid and unpaid care hours (Table 9), and the concentration of out-of-pocket spending at the most severe stages (Table 11) all reflect this fact.

## 4.2 Trends and inequalities

Between 2000 and 2018, the prevalence of dementia among people age 65 or older fell by 4.3 percentage points (from 12.2% to 7.9%), with the largest absolute decline at the severe end (−1.7 pp), followed by moderate (−1.0 pp) and mild (−1.6 pp) dementia. CIND prevalence rose by 1.6 pp over the same period, and the share with normal cognition was roughly stable. The net pattern is a shift in the cognitive distribution toward less severe impairment. The declines were not evenly distributed across groups: any-dementia prevalence fell by 9.9 pp among Black respondents and 7.9 pp among Hispanic respondents, compared with 3.3 pp among White respondents, narrowing — though by no means closing — long-standing gaps. Improvements in education, cardiovascular health, and other early- and mid-life conditions are plausible contributors, consistent with prior work on cognitive aging trends.[9, 11] Whatever the mechanisms, the disproportionate gains at the severe end and among historically disadvantaged groups are encouraging from a population-health standpoint and have direct implications for the volume and composition of dementia care needed going forward.

## 4.3 Undiagnosed cognitive impairment

A notable finding concerns the extent to which cognitive impairment goes undiagnosed, particularly at milder stages.[12, 13] The fixed-effects estimates in Table 8 show that respondents with mild dementia are just 28.1 percentage points more likely than those with normal cognition to report a prior doctor diagnosis of Alzheimer's disease or other dementias; thus, a meaningful fraction of people living with mild dementia appear never to have received a formal diagnosis. Earlier diagnosis would expand the window for estate planning, advance care planning, family arrangements, and other household-level decisions, and — given the emergence of disease-modifying therapies whose benefits depend on early initiation — increasingly for treatment as well.

## 4.4 Gaps in service use

The utilization results in Table 10 point to gaps in service use that are unlikely to reflect lower need. Compared with the population average, respondents with severe dementia have markedly lower rates of dental visits — about two-thirds of the population average — and lower rates of outpatient surgery. These patterns are consistent with the practical difficulty of administering elective and routine procedures to people living with severe dementia. They also raise questions about whether existing

service-delivery models adequately reach this group and whether more tailored accommodations for health care service delivery are needed.

### 4.5 Spending, Medicaid, and the social cost of dementia

Out-of-pocket medical spending rises with severity, and almost the entire increase at advanced stages is attributable to nursing home costs. Out-of-pocket totals nonetheless understate the social cost of dementia, because a substantial share of long-term care spending is paid by Medicaid. The Medicaid coverage results in Table 12 are consistent with this: severity is strongly associated with Medicaid coverage at every age. Part of that association reflects duration in advanced stages of dementia and the spend-down of private resources during nursing home stays. Averages, however, conceal substantial heterogeneity across households in lifetime nursing home use and out-of-pocket spending , as documented in earlier work.[14]

The wealth results in Table 13 are consistent with this picture. Households appear to draw down financial assets first, with large declines in non-housing wealth conditional on positive holdings, and to transition out of homeownership at the most advanced stages, when nursing home use becomes most prevalent.

### 4.6 Comparison with the literature

Our population-representative estimates of severity composition can be compared with prior studies that used clinical or community samples. In our HRS sample of respondents age 65 or older over 2000–2018, the composition of dementia is 60.8% mild, 17.4% moderate, and 21.8% severe. Estimates from the Framingham Heart Study[7] gave 50.4% mild, 30.3% moderate, and 19.3% severe; estimates from the National Alzheimer's Coordinating Center Uniform Data Set[15] gave 65.8% mild, 22.9% moderate, and 11.3% severe; and estimates from the Chicago Health and Aging Project[6] gave 48% mild, 31% moderate, and 21% severe. The differences between our estimates and prior figures are modest given the differences in sample design, age structure, and clinical setting, and the broad similarity supports the validity of the calibrated HRS-based measure.

## 5. Limitations

Several limitations bear on the interpretation of the results. First, the severity classification is calibrated to ADAMS, which was fielded in 2001–2003. We assume that the mapping from HRS core cognitive items, ADL/IADL limitations, and health variables to CDR-based severity categories is stable over the

study period. Changes in the relationship between these inputs and clinical severity over 2000–2018 — for example, due to changes in diagnostic practice or in the composition of dementia by etiology — could affect the level of severity-specific estimates, although they are less likely to drive within-person fixed-effects associations.

Second, the severity classification places respondents into discrete categories at each wave. This summarizes a continuous disease process and may understate within-category heterogeneity, particularly within the combined "severe" category, which includes the original severe, profound, and terminal stages.

Third, the regression models for utilization, spending, wealth, and Medicaid are descriptive associations rather than causal estimates. The fixed-effects specifications absorb time-invariant individual heterogeneity but do not address reverse causality or time-varying confounding. For example, declines in non-housing wealth that precede observed transitions to severe dementia could reflect unmeasured early functional decline rather than the consequences of severity per se.

Fourth, dementia diagnosis in the HRS is self- or proxy-reported. The undiagnosed-share results in section 4.3 should be interpreted as the share of respondents not reporting a prior doctor diagnosis, which may differ from the share with no diagnosis on record.

Fifth, race and ethnicity comparisons rely on a smaller set of subgroups and do not address mechanisms underlying the narrowing of gaps over the study period.

## 6. Conclusions

Dementia in the HRS is heterogeneous, and severity matters. Mild dementia is the modal form, but the consequences for care, health, and wealth scale steeply with severity, and severe dementia accounts for a disproportionate share of nursing home use, around-the-clock caregiving, and out-of-pocket and Medicaid spending. Population-level trends from 2000 to 2018 show declining prevalence at every severity level and a narrowing of racial and ethnic gaps, but the absolute burden remains large and is concentrated among the oldest old. Continued surveillance of severity — not just any dementia — is essential for projecting care needs, evaluating policy, and understanding how the social cost of dementia is distributed across families, public programs, and providers.

A further implication concerns mild and moderate dementia, where our estimates suggest substantial underdiagnosis relative to clinically assessed prevalence. This is precisely the window in which early intervention is most consequential — whether behavioral (lifestyle, caregiver support, environmental

adaptation), medical (including the new generation of disease-modifying therapies, whose benefits depend on early initiation), or planning-oriented (advance care directives, financial and housing decisions, mobilization of family resources). Closing this gap — through better detection, lower-friction assessment, and clearer pathways from screening to follow-up — is likely to yield outsized returns for individuals, families, and the health and long-term care systems that support them.

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# Tables and Figures

**Table 1. Distribution of HHR-based calibrated severity measure, HRS, 2002, 71+**

| | Unweighted | | Weighted | |
|---|---|---|---|---|
| | N | % | N | % |
| 1. Normal cognition | 4,454 | 63.3% | 4581.0 | 65.1% |
| 2. CIND | 1,468 | 20.9% | 1414.1 | 20.1% |
| 3. Mild dementia | 646 | 9.2% | 608.8 | 8.6% |
| 4. Moderate dementia | 175 | 2.5% | 169.8 | 2.4% |
| 5. Severe dementia | 196 | 2.8% | 181.0 | 2.6% |
| 6. Profound dementia | 46 | 0.7% | 42.0 | 0.6% |
| 7. Terminal dementia | 55 | 0.8% | 42.4 | 0.6% |
| Total | 7,040 | 100.0% | 7039.0 | 100.0% |
| Total dementia | 1118 | 15.9% | 1043.9 | 14.8% |

**Table 2. Distribution of cognition and distribution of dementia severity, by age group. HRS 2000-2018**

| | Population | | | | With dementia | | | |
|---|---|---|---|---|---|---|---|---|
| | Normal | CIND | Dementia | All | Mild | Moderate | Severe | All |
| 65-69 | 86.8 | 11.3 | 1.8 | 100.0 | 83.6 | 9.8 | 6.6 | 100.0 |
| 70-74 | 81.4 | 15.1 | 3.5 | 100.0 | 73.4 | 16.3 | 10.3 | 100.0 |
| 75-79 | 72.7 | 19.8 | 7.5 | 100.0 | 70.3 | 15.0 | 14.7 | 100.0 |
| 80-74 | 60.3 | 25.0 | 14.7 | 100.0 | 63.7 | 15.6 | 20.8 | 100.0 |
| 85-89 | 44.9 | 31.0 | 24.2 | 100.0 | 56.4 | 17.3 | 26.3 | 100.0 |
| 90+ | 26.4 | 32.3 | 41.3 | 100.0 | 53.0 | 15.5 | 31.5 | 100.0 |

**Table 3. Trends in age-adjusted cognitive status in the HRS, 2000-2018, weighted**

| | Normal cognition | CIND | Mild dementia | Moderate dementia | Severe dementia | Any dementia |
|---|---|---|---|---|---|---|
| 2000 | 69.3% | 18.6% | 7.1% | 2.0% | 3.2% | 12.2% |
| 2002 | 70.9% | 17.9% | 6.6% | 1.7% | 2.9% | 11.2% |
| 2004 | 70.5% | 19.2% | 5.8% | 1.8% | 2.6% | 10.2% |
| 2006 | 71.4% | 19.2% | 5.8% | 1.4% | 2.2% | 9.4% |
| 2008 | 71.1% | 19.3% | 6.4% | 1.4% | 1.8% | 9.6% |
| 2010 | 69.9% | 20.3% | 6.3% | 1.6% | 1.9% | 9.8% |
| 2012 | 69.1% | 21.0% | 5.9% | 1.8% | 2.2% | 9.9% |
| 2014 | 69.4% | 20.7% | 6.1% | 1.6% | 2.2% | 9.9% |
| 2016 | 70.3% | 20.6% | 5.9% | 1.3% | 1.9% | 9.1% |
| 2018 | 71.9% | 20.2% | 5.5% | 1.0% | 1.5% | 7.9% |

**Table 4. Changes in cognitive status by race/ethnicity in the HRS, 2000-2018, weighted**

| | | Normal cognition | CIND | Mild dementia | Moderate dementia | Severe dementia | Any dementia |
|---|---|---|---|---|---|---|---|
| All | 2000 | 69.3% | 18.6% | 7.1% | 2.0% | 3.2% | 12.2% |
| | 2018 | 71.9% | 20.2% | 5.5% | 1.0% | 1.5% | 7.9% |
| | Difference | 2.7% | 1.6% | -1.6% | -1.0% | -1.7% | -4.3% |
| White | 2000 | 73.7% | 16.0% | 5.9% | 1.7% | 2.7% | 10.3% |
| | 2018 | 75.0% | 18.0% | 5.0% | 0.8% | 1.3% | 7.0% |
| | Difference | 1.3% | 2.0% | -0.9% | -1.0% | -1.4% | -3.3% |
| Black | 2000 | 49.5% | 29.4% | 12.3% | 3.0% | 5.8% | 21.1% |
| | 2018 | 63.4% | 25.5% | 7.2% | 1.4% | 2.5% | 11.2% |
| | Difference | 13.9% | -3.9% | -5.1% | -1.6% | -3.2% | -9.9% |
| Hispanic | 2000 | 55.3% | 26.9% | 10.6% | 3.2% | 4.0% | 17.8% |
| | 2018 | 66.3% | 23.8% | 6.3% | 1.5% | 2.0% | 9.9% |
| | Difference | 11.1% | -3.1% | -4.3% | -1.7% | -2.0% | -7.9% |

**Table 5a. Transitions in Cognitive Status**

Panel A: Crosstabulation (unweighted counts)

| Cognitive status at wave t | Cognitive status at wave t+1 | | | | | All |
|---|---|---|---|---|---|---|
| | Normal | CIND | Mild dem. | Moderate | Severe | |
| Normal | 56509 | 5363 | 16 | 0 | 0 | 61888 |
| CIND | 369 | 11553 | 2906 | 47 | 5 | 14880 |
| Mild dementia | 0 | 97 | 2476 | 1092 | 280 | 3945 |
| Moderate dementia | 0 | 0 | 12 | 203 | 673 | 888 |
| Severe dementia | 0 | 0 | 0 | 12 | 998 | 1010 |

Panel B: Weighted wave-to-wave transition probabilities

| Cognitive status at wave t | Cognitive status at t+1 | | | | | All |
|---|---|---|---|---|---|---|
| | Normal | CIND | Mild dem. | Moderate | Severe | |
| Normal | 91.91 | 8.06 | 0.03 | 0.00 | 0.00 | 100.00 |
| CIND | 2.22 | 78.06 | 19.37 | 0.31 | 0.03 | 100.00 |
| Mild dementia | 0.00 | 2.37 | 62.76 | 27.70 | 7.17 | 100.00 |
| Moderate dementia | 0.00 | 0.00 | 1.46 | 22.21 | 76.33 | 100.00 |
| Severe dementia | 0.00 | 0.00 | 0.00 | 1.03 | 98.97 | 100.00 |

**Table 5b. Nursing home residence and cognitive status transitions. Weighted**

| Cognitive status at wave t | Cognitive status at wave t+1 | | | | | All |
|---|---|---|---|---|---|---|
| | Normal | CIND | Mild dem. | Moderate | Severe | |
| Panel A: Percentage living in nursing homes at wave t | | | | | | |
| Normal | 0.15 | 0.70 | - | - | - | 0.19 |
| CIND | 1.93 | 1.39 | 4.49 | 4.68 | - | 2.02 |
| Mild dementia | - | 4.44 | 9.01 | 15.84 | 25.75 | 11.99 |
| Moderate dementia | - | - | - | 32.68 | 35.32 | 34.96 |
| Severe dementia | - | - | - | - | 55.34 | 55.21 |
| Panel B: Percentage living in nursing homes at wave t+1 | | | | | | |
| Normal | 0.34 | 3.63 | - | - | - | 0.62 |
| CIND | 0.69 | 3.10 | 16.93 | 73.48 | - | 5.98 |
| Mild dementia | - | 7.60 | 17.41 | 37.01 | 57.15 | 25.46 |
| Moderate dementia | - | - | - | 40.60 | 54.40 | 51.13 |
| Severe dementia | - | - | - | - | 64.19 | 64.06 |
| Panel C: Change in the percentage living in nursing homes between waves t and t+1 | | | | | | |
| Normal | 0.19 | 2.93 | - | - | - | 0.42 |
| CIND | -1.24 | 1.71 | 12.44 | 68.79 | - | 3.96 |
| Mild dementia | - | 3.16 | 8.40 | 21.17 | 31.41 | 13.46 |
| Moderate dementia | - | - | - | 7.91 | 19.08 | 16.17 |
| Severe dementia | - | - | - | - | 8.85 | 8.85 |

**Table 6. Two- year mortality [%], HRS 2000-2018, weighted**

| | Cognitive status at wave t | | | | | |
|---|---|---|---|---|---|---|
| Age at wave t | Normal | CIND | Mild dem. | Moderate | Severe | All |
| 65-69 | 2.6 | 10.3 | 19.5 | 20.9 | 11.9 | 3.8 |
| 70-74 | 3.5 | 10.9 | 20.2 | 34.6 | 36.3 | 5.3 |
| 75-79 | 5.1 | 14.1 | 24.7 | 33.9 | 40.3 | 8.6 |
| 80-74 | 7.3 | 18.3 | 29.5 | 34.8 | 53.3 | 14.1 |
| 85-89 | 11.1 | 23.9 | 33.9 | 42.5 | 54.3 | 22.2 |
| 90+ | 22.5 | 33.3 | 46.5 | 56.3 | 64.0 | 38.8 |
| All 65+ | 4.7 | 16.5 | 30.8 | 40.8 | 54.2 | 9.6 |

**Table 7. OLS and Fixed Effects regression models of living in a nursing home on cognitive status, HRS 2000-2018, unweighted**

| | [1] | [2] | [3] | [4] | [6] |
|---|---|---|---|---|---|
| | OLS | | | | FE |
| | Base | + Wave | + Demog | + Health | ~[4] |
| Normal cognition | ref. | ref. | ref. | ref. | ref. |
| CIND | 0.027 | 0.027 | 0.018 | 0.010 | 0.017 |
| | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.002*** |
| Mild dementia | 0.156 | 0.156 | 0.136 | 0.117 | 0.139 |
| | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.003*** |
| Moderate dementia | 0.381 | 0.381 | 0.353 | 0.325 | 0.340 |
| | 0.013*** | 0.013*** | 0.013*** | 0.013*** | 0.005*** |
| Severe dementia | 0.589 | 0.589 | 0.547 | 0.509 | 0.493 |
| | 0.014*** | 0.014*** | 0.014*** | 0.014*** | 0.005*** |
| Wave dummies | - | Y | Y | Y | Y |
| Demographics | - | - | Y | Y | Y |
| Health | - | - | - | Y | Y |
| Constant | 0.003 | -0.001 | 0.022 | 0.026 | 0.205 |
| | 0.000*** | 0.001 | 0.005*** | 0.006*** | 0.082** |
| R-squared | 0.296 | 0.296 | 0.315 | 0.327 | 0.237 |

* The mean of the outcome variable is 3.7%. The regressions are based on 106,632 person-year observations from 22,506 individuals. The FE models include wave indicators, age, marital status, race/ethnicity, education, birthplace, urban resident, veteran, religion, ever worked, income quartiles, wealth quartiles, self-rated health, self-rated vision, self-rated hearing, 8 diagnosed health conditions, whether back problems, smoking history, alcohol consumption indicators, BMI categories, health care insurance status, ADL and IADL limitations, and missing variable indicators.

**Table 8. Fixed Effects regression models of health status on cognitive status, HRS 2000-2018, unweighted.**

| | [1] | [2] | [3] | [4] |
|---|---|---|---|---|
| | Fair/poor health | Dementia diagnosis | # ADLs | # IADLs |
| Normal cognition | ref. | ref. | ref. | ref. |
| CIND | 0.078 | 0.046 | 0.214 | 0.322 |
| | 0.005*** | 0.002*** | 0.011*** | 0.009*** |
| Mild dementia | 0.130 | 0.281 | 1.038 | 1.598 |
| | 0.008*** | 0.004*** | 0.019*** | 0.015*** |
| Moderate dementia | 0.209 | 0.624 | 2.272 | 3.187 |
| | 0.012*** | 0.006*** | 0.030*** | 0.024*** |
| Severe dementia | 0.269 | 0.815 | 3.440 | 3.766 |
| | 0.013*** | 0.006*** | 0.033*** | 0.027*** |
| Constant | 0.077 | 0.199 | -1.369 | 0.227 |
| | 0.205 | 0.097** | 0.503*** | 0.413 |
| Mean outcome | 0.322 | 0.0639 | 0.592 | 0.500 |
| R-squared | 0.091 | 0.313 | 0.340 | 0.445 |

* All regression models include detailed wave, demographic, and health controls. The regressions are based on 106,632 person-year observations from 22,506 individuals. "Dementia diagnosis" is survey participants' report of prior doctor diagnoses of Alzheimer's disease or other dementias. Table 7 shows the control variables that were used in the FE regressions, but, depending on the outcome, not all were used in each regression

**Table 9. Fixed Effects regression models of care arrangements on cognitive status among people living in the community, HRS 2000-2018, unweighted.**

| | [1] | [2] | [3] | [4] | [5] |
|---|---|---|---|---|---|
| | Home care | Any paid help | Unpaid help | Paid hours | Unpaid hours |
| Normal cognition | ref. | ref. | ref. | ref. | ref. |
| CIND | 0.036 | 0.033 | 0.107 | 4.528 | 14.878 |
| | 0.004*** | 0.002*** | 0.004*** | 0.590*** | 1.150*** |
| Mild dementia | 0.150 | 0.136 | 0.361 | 28.351 | 81.292 |
| | 0.007*** | 0.004*** | 0.006*** | 1.027*** | 2.003*** |
| Moderate dementia | 0.267 | 0.321 | 0.554 | 75.850 | 177.308 |
| | 0.012*** | 0.007*** | 0.012*** | 1.874*** | 3.655*** |
| Severe dementia | 0.348 | 0.436 | 0.577 | 126.063 | 236.484 |
| | 0.015*** | 0.008*** | 0.014*** | 2.223*** | 4.336*** |
| Constant | -0.332 | 0.177 | 0.223 | -48.918 | -111.498 |
| | 0.173* | 0.097* | 0.165 | 26.155* | 51.004** |
| Mean outcome | 0.110 | 0.0396 | 0.157 | 5.479 | 21.47 |
| R-squared | 0.079 | 0.114 | 0.176 | 0.079 | 0.108 |

* All regression models include detailed wave, demographic, and health controls. The regressions are based on 102, 676 person-year observations from 22,022 individuals. Paid and unpaid hours are reported monthly. Table 7 shows the control variables that were used in the FE regressions, but, depending on the outcome, not all were used in each regression

**Table 10. Regression of service use**

| | Any hospital nights 0/1 | Num Nights Hosp | Any doctor visit 0/1 | Num doc visits | Any outpatient surgery 0/1 | Any dental visit 0/1 |
|---|---|---|---|---|---|---|
| Normal | ref | ref | ref | ref | ref | ref |
| CIND | 0.112 | 2.208 | -0.017 | 2.432 | -0.029 | -0.135 |
| | 0.005*** | 0.118*** | 0.003*** | 0.229*** | 0.004*** | 0.006*** |
| Mild | 0.176 | 4.805 | 0.006 | 4.770 | -0.047 | -0.166 |
| | 0.008*** | 0.384*** | 0.003* | 0.392*** | 0.006*** | 0.009*** |
| Moderate | 0.256 | 5.242 | 0.018 | 7.761 | -0.071 | -0.160 |
| | 0.013*** | 0.486*** | 0.005*** | 1.123*** | 0.009*** | 0.013*** |
| Severe | 0.214 | 5.231 | 0.004 | 10.022 | -0.091 | -0.195 |
| | 0.012*** | 0.520*** | 0.006 | 1.023*** | 0.008*** | 0.014*** |
| Age 70-75 | 0.032 | 0.136 | 0.005 | 0.451 | 0.014 | -0.019 |
| | 0.004*** | 0.099 | 0.002** | 0.179** | 0.004*** | 0.004*** |
| Age 75-80 | 0.065 | 0.445 | 0.007 | 0.451 | 0.019 | -0.024 |
| | 0.004*** | 0.120*** | 0.002*** | 0.190** | 0.004*** | 0.005*** |
| Age 80-85 | 0.086 | 0.574 | 0.009 | 0.667 | 0.010 | -0.026 |
| | 0.005*** | 0.139*** | 0.003*** | 0.246*** | 0.005** | 0.006*** |
| Age 85-90 | 0.100 | 0.353 | 0.002 | 0.086 | -0.012 | -0.034 |
| | 0.007*** | 0.181* | 0.003 | 0.315 | 0.005** | 0.008*** |
| Age 90+ | 0.091 | -0.604 | 0.002 | -0.909 | -0.048 | -0.040 |
| | 0.009*** | 0.237** | 0.004 | 0.459** | 0.006*** | 0.011*** |
| Female | -0.017 | -0.335 | 0.013 | 0.319 | -0.021 | 0.025 |
| | 0.004*** | 0.087*** | 0.002*** | 0.171* | 0.003*** | 0.006*** |
| Wave Gap >1wv | 0.098 | 1.987 | 0.001 | 9.319 | 0.038 | 0.050 |
| | 0.008*** | 0.349*** | 0.004 | 0.794*** | 0.007*** | 0.009*** |
| White | ref | ref | ref | ref | ref | ref |
| NH Black | -0.023 | -0.273 | -0.030 | -0.797 | -0.082 | -0.221 |
| | 0.006*** | 0.130** | 0.003*** | 0.271*** | 0.004*** | 0.008*** |
| NH Oth | -0.024 | -0.524 | -0.040 | -1.016 | -0.057 | -0.105 |
| | 0.014* | 0.253** | 0.009*** | 0.497** | 0.010*** | 0.018*** |
| Hispanic | -0.055 | -0.630 | -0.101 | -1.510 | -0.096 | -0.200 |
| | 0.007*** | 0.142*** | 0.005*** | 0.289*** | 0.005*** | 0.009*** |
| Constant | 0.246 | 2.013 | 0.947 | 9.641 | 0.251 | 0.693 |
| | 0.004*** | 0.092*** | 0.002*** | 0.163*** | 0.003*** | 0.005*** |
| Observations | 106,632 | 105,175 | 106,632 | 99,163 | 106,632 | 106,632 |
| R-squared | 0.038 | 0.0184 | 0.018 | 0.0161 | 0.015 | 0.061 |
| Mean Outcome | 0.320 | 2.904 | 0.942 | 11.17 | 0.212 | 0.597 |

**Table 11. Fixed Effects regression models of annualized out-of-pocket medical spending on cognitive status, HRS 2000-2018, unweighted**

| | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| | Total OOP | Nursing home | Home health | Special facility | Drugs | Dental |
| Normal cognition | ref. | ref. | ref. | ref. | ref. | ref. |
| CIND | 0.568 | 0.391 | 0.060 | 0.026 | 0.069 | -0.028 |
| | 0.095*** | 0.067*** | 0.013*** | 0.008*** | 0.060 | 0.012** |
| Mild dementia | 2.457 | 2.053 | 0.177 | 0.094 | -0.015 | -0.059 |
| | 0.158*** | 0.113*** | 0.022*** | 0.014*** | 0.100 | 0.020*** |
| Moderate dementia | 5.892 | 5.575 | 0.238 | 0.176 | 0.113 | -0.087 |
| | 0.253*** | 0.181*** | 0.035*** | 0.022*** | 0.159 | 0.033*** |
| Severe dementia | 9.606 | 9.190 | 0.273 | 0.254 | -0.124 | -0.132 |
| | 0.281*** | 0.202*** | 0.039*** | 0.025*** | 0.177 | 0.037*** |
| Constant | 4.360 | -0.397 | 0.112 | 0.056 | 0.310 | 0.139 |
| | 4.282 | 0.883 | 0.171 | 0.107 | 2.697 | 0.161 |
| Mean outcome | 2.366 | 0.494 | 0.0408 | 0.0253 | 1.034 | 0.337 |
| R-squared | 0.039 | 0.061 | 0.006 | 0.005 | 0.008 | 0.003 |
| Person-wave observations | 106,632 | 95,894 | 95,894 | 95,894 | 106,632 | 95,894 |
| Number of persons | 22,506 | 21,067 | 21,067 | 21,067 | 22,506 | 21,067 |

* All regression models include detailed wave, demographic, and health controls. Spending is expressed in thousands of 2018 dollars. Table 7 shows the control variables that were used in the FE regressions, but, depending on the outcome, not all were used in each regression

**Table 12. Percent on Medicaid and Population Distribution by Age and Cognition, HRS 2000-2018, weighted**

| | *Normal* | *CIND* | *Mild* | *Moderate* | *Severe* | *Total* |
|---|---|---|---|---|---|---|
| *Age* | Percent on Medicaid | | | | | |
| *65-69* | 5.0 | 22.9 | 40.5 | 44.6 | 56.5 | 7.7 |
| *70-74* | 4.8 | 19.5 | 32.7 | 48.5 | 65.3 | 8.2 |
| *75-79* | 4.3 | 16.1 | 26.1 | 33.9 | 51.6 | 8.6 |
| *80-74* | 4.2 | 13.1 | 20.9 | 24.5 | 45.9 | 9.7 |
| *85-89* | 4.1 | 9.1 | 19.3 | 33.6 | 39.8 | 11.2 |
| *90+* | 2.8 | 9.5 | 18.0 | 30.5 | 41.9 | 15.2 |
| *Total* | 4.6 | 16.0 | 24.0 | 32.8 | 44.6 | 8.9 |
| *Age* | Percent of Population by Age and Cognition | | | | | |
| *65-69* | 22.65 | 3.50 | 0.49 | 0.06 | 0.03 | 26.72 |
| *70-74* | 19.04 | 3.88 | 0.69 | 0.15 | 0.08 | 23.83 |
| *75-79* | 14.73 | 4.23 | 1.15 | 0.25 | 0.24 | 20.60 |
| *80-74* | 8.86 | 3.84 | 1.46 | 0.35 | 0.46 | 14.97 |
| *85-89* | 3.77 | 2.72 | 1.28 | 0.41 | 0.65 | 8.83 |
| *90+* | 1.21 | 1.56 | 1.13 | 0.36 | 0.78 | 5.05 |
| *Total* | 70.26 | 19.72 | 6.20 | 1.58 | 2.24 | 100.00 |

**Table 13. Fixed Effects regression models of household wealth on cognitive status, HRS 2000-2018, unweighted**

| | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| | Primary residence | | Non-housing total | | Total | |
| | w>0 | ln(w) | w>0 | ln(w) | w>0 | ln(w) |
| Normal cognition | ref. | ref. | ref. | ref. | ref. | ref. |
| CIND | -0.038 | -0.018 | -0.013 | -0.073 | -0.011 | -0.082 |
| | 0.003*** | 0.008** | 0.003*** | 0.016*** | 0.003*** | 0.012*** |
| Mild dementia | -0.110 | -0.050 | -0.037 | -0.132 | -0.037 | -0.256 |
| | 0.005*** | 0.015*** | 0.006*** | 0.027*** | 0.005*** | 0.021*** |
| Moderate dementia | -0.185 | -0.007 | -0.068 | -0.218 | -0.084 | -0.444 |
| | 0.009*** | 0.027 | 0.009*** | 0.044*** | 0.007*** | 0.035*** |
| Severe dementia | -0.245 | -0.046 | -0.074 | -0.412 | -0.107 | -0.810 |
| | 0.010*** | 0.031 | 0.010*** | 0.049*** | 0.008*** | 0.039*** |
| Constant | 1.010 | 12.030 | 0.625 | 11.013 | 1.074 | 13.478 |
| | 0.148*** | 0.357*** | 0.154*** | 0.220*** | 0.122*** | 0.553*** |
| Mean outcome | 0.754 | 11.82 | 0.873 | 11.22 | 0.921 | 12.11 |
| R-squared | 0.088 | 0.043 | 0.020 | 0.083 | 0.019 | 0.091 |
| Person-wave observations | 106,632 | 80,398 | 106,632 | 93,090 | 106,632 | 98,230 |
| Number of persons | 22,506 | 18,244 | 22,506 | 21,073 | 22,506 | 21,547 |

* All regression models include detailed wave, demographic, and health controls. Table 7 shows the control variables that were used in the FE regressions, but, depending on the outcome, not all were used in each regression

**Figure 1. Percentage living in a nursing home by cognitive status. HRS, 2000-2018, weighted**

