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Future Monetary Costs of Dementia in the United States under Alternative Dementia Prevalence Scenarios

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Abstract

Population aging will likely lead to increases in health care spending and the ability of governments to support entitlement programs such as Medicare and Medicaid. Dementia is a chronic condition that is especially pertinent because of its strong association with old age and because care for dementia is labor intensive and expensive. Indeed, prior research has found that if current dementia prevalence rates persist, population aging will generate very large increases in health care spending for dementia. In this study we considered two alternative assumptions or scenarios about future prevalence. The first adjusts the prevalence projections using recent research that suggests dementia prevalence may be declining. The second uses growth in hypertension, obesity and diabetes, and the relationship between dementia and these conditions to adjust future prevalence rates. We find under the first scenario that if the rates of decline in age-specific dementia rates persist, future costs will be much less than previous estimates, about 40% lower. Under the second scenario, the growth in those conditions makes only small differences in costs.

Keywords

Forecasts of health care costs; dementia

Introduction

A number of recent studies have made clearer the magnitude of the social and economic impact of dementia on older adults, their families, and on government programs in the United States and around the world. An estimated 4.2 million adults in the United States and more than 135 million worldwide had dementia in 2010, based on a meta-analysis of recent epidemiologic studies (Prince et al, 2013). The economic impact of dementia, including unpaid care provided by families, is estimated at \$159 billion to \$215 billion per year in the United States (Hurd et al, 2013), and more than \$600 billion worldwide (Wimo et al, 2013).

Dementia incidence increases significantly at ages above 75, so the expected growth in the worldwide elderly population in the decades ahead (from about 600 million now to 1.5 billion in 2050) may lead to a tripling of dementia cases by 2050, assuming no new interventions to stop or slow the trajectory of cognitive decline (Prince et al, 2013).

The large and growing impact of dementia on individuals and populations has caught the attention of policymakers and governments around the world. For instance, the Congress passed and President Obama signed the National Alzheimer's Project Act (NAPA) into law in 2011 with the goal of improving treatments and preventive efforts for dementia, as well as implementing new strategies for data collection to track the progress of these efforts. In 2013, a G-8 "Dementia Summit" was held in London to bring government representatives together to encourage coordinated efforts for international collaboration and data sharing. Finally, the World Health Organization recently declared dementia to be a "public health priority" which should be on the public health agenda of all countries.

The likely further increase in dementia cases notwithstanding, a number of recent studies have suggested that the age-specific risk of dementia may have decreased in high-income countries over the last 25 years. For example, using data from the National Long-term Care Survey (NLTC), Manton and colleagues (2005) found a significant decline in the prevalence of "severe cognitive impairment" in the United States between 1982 and 1999, from 5.7% to 2.9%. Similarly, a study of the prevalence of cognitive impairment in the U.S. Health and Retirement Study (HRS) found a decline between 1993 and 2002, from 12.2% to 8.7% (Langa et al, 2008).

Findings from the Rotterdam Study, an ongoing population-based prospective cohort study, provides evidence suggesting that better and more aggressive treatment for cardiovascular risk factors may be helping to lead to a downward trend in dementia incidence and prevalence. This study found a decline between 1990 and 2010 in dementia incidence among older adults in the Netherlands, and brain MRIs performed in more recent cohorts showed significantly less brain atrophy and fewer vascular-related brain lesions compared to MRIs performed in the earlier cohorts (Schrijvers et al, 2012).

Recent findings from the UK Cognitive Function and Ageing Study (CFAS) provide additional support for a declining risk of dementia in older adults over the last 20 years (Matthews et al, 2013). CFAS studied adults aged 65 and older in Cambridgeshire, Newcastle, and Nottingham in the early 1990's, and then again around 2010. Importantly, to avoid diagnostic drift and to maximize the validity of the prevalence comparisons across the two time periods, the same standardized algorithmic diagnostic process was used for both time periods. Between 1991 and 2011, the age- and sex-standardized dementia prevalence declined from 8.3% to 6.5% between 1991 and 2011 in these regions in England. This decline translated to a 24% decrease in the expected number of dementia cases in England in 2011. The CFAS authors hypothesized that increased education levels and better primary prevention of cardiovascular risk factors have likely contributed to the declining risk for dementia in England over the past 25 years. However, it is currently unclear whether this optimistic trend in England and other high-income countries will continue in the face of

rising levels of obesity and diabetes, and it is also unclear whether there has been a similar or opposite trend in low- and middle-income countries (Chan et al, 2013; Wu et al, 2013).

Nonetheless, given the large sums of money involved in caring for dementia, the implications of a possible trend toward lower age-adjusted prevalence are of some interest. The purpose of this paper is to redo our earlier dementia cost-of-care estimates (Hurd et al., 2013) using alternative scenarios for trends in dementia prevalence. Because the new study builds on the previous one, we review the methods and results from the earlier paper, adding additional results that were not published, before presenting our new results.

Summary of Prior Study

We used data from the Health and Retirement Study, which draws from a nationally representative sample of the U.S. population age 51 and above. Conducted since 1992, this biennial longitudinal survey of approximately 20,000 persons collects data on a wide range of variables: cognition, including a modified version of the Telephone Interview for Cognitive Status (TICS); cost and use of health care services; health status, including limitations on activities of daily living (ADLs) and instrumental activities of daily living (IADLs); income and wealth; and such demographic variables as marital status, children in the household, and education.

The survey provides for proxy interviews when the respondent is unable or unwilling to be interviewed. The proxy interview covers much the same data but also includes the Informant Questionnaire on Cognitive Decline in the Elderly. Even so, the HRS per se, despite its many strengths for the current purpose, lacks a true assessment for dementia status.

We relied on the Aging, Demographics, and Memory Study (ADAMS), a substudy of the HRS, for the assessment of dementia status. In 2001–2003, ADAMS, working from self-interviews, clinically assessed 856 HRS respondents 71 or older as having normal cognition (63.9% prevalence), being cognitively impaired but not demented (CIND; 22.2%; see Plassman et al., 2008), or being demented (13.9%; Plassman et al., 2007). We first estimated a model based on the ADAMS data.

For self-interviewing respondents, we estimated an ordered probit model of the probability that a self-interviewing respondent would be in each of the three cognition states. The explanatory variables were taken from data collected from that respondent in one of the recent HRS waves (typically from the HRS wave immediately preceding the ADAMS wave, e.g., someone assessed in 2001 would enter the analysis with his or her explanatory variables having their HRS 2000 values). For proxy respondents, we used the TICS item responses from the intended respondent two waves prior to the ADAMS assessment.

Because of measurement error in any given cognitive assessment and because the rate of decline in cognitive functioning might be predictive of the onset of dementia, we used in our prediction model both the level of cognitive functioning in the prior HRS wave and the change in cognitive scores between the prior two waves, i.e., the prior wave and the one before it. We also used the change in measures of ADL and IADL limitations between the prior two waves.

Since, as mentioned above, the cognitive assessments differ for proxy and nonproxy respondents, we estimated separate models for ADAMS subjects based on proxy status in the prior HRS wave. For nonproxy respondents, the model is

$$Dementia_i = \beta_1 TICS_i + \beta_2 \Delta TICS_i + X_i' \beta_3 + \varepsilon_i \quad (1)$$

where $Dementia_i$ is a categorical variable taking on three values (normal, CIND, demented) based on the ADAMS assessment; $TICS_i$ is a vector of cognitive test items from the TICS assessment conducted in the HRS wave prior to the ADAMS assessment; $\Delta TICS_i$ is a vector containing the changes in the scores on the TICS items between the prior two HRS waves; and X_i is a vector of characteristics such as age (five-year bands), education, gender, and summary measures of ADL and IADL limitations and their changes between the prior two HRS waves.

For proxy respondents the model is

$$Dementia_i = \gamma_1 IQCODE_i + \gamma_2 \Delta IQCODE_i + \gamma_3 PRIORPROXY_i + \gamma_4 PRIORTICS_i + X_i' \gamma_5 + u_i \quad (2)$$

where $IQCODE_i$ is the score on the Jorm IQCODE in the prior HRS wave, $\Delta IQCODE_i$ is the change in the Jorm IQCODE, $PRIORPROXY_i$ is an indicator for whether the respondent was a respondent by proxy two waves prior to the ADAMS assessment, $PRIORTICS_i$ is a vector of cognitive variables two waves prior to the ADAMS assessment for respondents who were not proxy then, and X_i is defined as above. The cognitive-score vector and the ADL and IADL limitations in Equations (1) and (2) both include a set of indicators for missing values. We estimated Equations (1) and (2) via ordered probit regression. The results are shown in Tables 1 and 2.

For both groups of respondents, those in age bands of 80 or above showed a statistically significantly greater likelihood (relative to those 71–75) of being “lower” on the normal-to-CIND-to-dementia “scale.” Furthermore, that association between age and dementia was more pronounced for those 90 or above than for those 80 to 84.

For self-respondents, most of the associations between TICS item scores at the preceding HRS wave and dementia status are statistically significant. Moreover, all of these significant relationships are in the expected direction: A higher cognition item score is associated with a greater probability of being normal and a lower probability of being demented. Five of the eight TICS item scores also show statistically significant relationships with the ordered dementia variable. There are a few other statistically significant associations in the two groups, but these are scattered and show no patterns.

Based on these models for the probability of dementia, we predicted dementia status to the full HRS over age 70, which increased the sample size available for analysis to about 6,000. Then in the augmented HRS data we estimated models to isolate costs due to dementia rather than simply the costs of those with dementia. We used HRS data from 2000 through 2008 (Hurd et al., 2013). The HRS asks respondents if they utilized a particular type of

health care, whether all of the cost of this care was covered by insurance, and if not how much they spent out-of-pocket (OOP) for this care. The 2002–2008 HRS waves asked questions about spending on the following services: nursing home stays, hospital stays, doctor visits, dental visits, outpatient surgery, home health care, other “special” services, prescription drugs, and dental services.

The measurement of nursing home spending warrants explanation. It uses self-reports of nights spent in a nursing home and information on average nursing home daily rates, and makes an adjustment for food and lodging provided by nursing homes that individuals would have to purchase in the community. For individuals covered by the Medicaid program, we used 2010 Medicaid nursing home rates and for other respondents we used 2010 average private-pay nightly rates charged by nursing homes. The latter were obtained from the 2010 MetLife Market Survey of Long-Term Care Costs. Medicaid and private pay rates are based on respondent state of residence.

HRS respondents were linked to their Medicare data. Spending by Medicare was then extracted from administrative records. Permission was required for this linkage; it was obtained from about 90% of respondents.

The analysis required the attribution of costs for informal care--unpaid care typically provided by a spouse, child or other relative. Two measures were employed to derive estimates of the costs of informal care. For the first, we identified the earnings of people similar to the caregiver in the Current Population Survey (CPS). For example, an 80-year-old wife would be imputed to have very small costs: her forgone wages would be small because of the small likelihood she would be working even if not providing care. For the second, we used the market wage of formal caregivers. This likely overstates the cost of informal care, because the family has chosen not to employ formal caregivers, implying that it values formal caregiving at less than the market cost.

To estimate the out-of-pocket spending attributable to dementia, we controlled for observable characteristics available in the HRS dataset by estimating models of the form:

$$Y_i = \alpha_1 \hat{P}(\text{Dementia}_i) + X_i' \alpha_2 + v_i \quad (3)$$

where Y_i is a measure of out-of-pocket spending, $\hat{P}(\text{Dementia}_i)$ is the respondent's estimated probability of dementia, X_i is a vector of controls for comorbidities and other confounders that could be correlated with dementia and also out-of-pocket spending, and v_i is a random disturbance term.

We estimated two different specifications of Equation (3). The first includes no other covariates aside from dementia status, and delivers the unadjusted correlation between dementia status and OOP spending. The second adjusts for demographic characteristics, economic factors, and comorbidities. Specifically, the models control for household income, age, race (indicators for white, Hispanic, and, as the reference group, any other), education (less than high school, high school, and, as the reference group, more than high school), marital status, number of living children (1 or none, 2, and, as the reference group, 3 or more), and indicator variables for ever reporting having the following comorbid conditions:

stroke, diabetes, heart disease, hypertension, lung disease, cancer, any psychological condition, and arthritis).¹

All the regressions are weighted. The HRS allocates a weight of zero to respondents in nursing homes. To account for this population in our analysis, we use the individual HRS weight for respondents who are not in a nursing home, and the most recent non-zero HRS weight for respondents who are (this procedure is suggested in the HRS documentation). All our estimations present bootstrapped standard errors to account for the fact that the probability of dementia is a predicted variable.²

Table 3 has two examples of the regressions, in this case for out-of-pocket spending on nursing homes and for total out-of-pocket spending. With respect to the latter, if the probability of dementia is changed from 0.0 to 1.0, total out-of-pocket spending is expected to increase by \$6838 (no adjustment for covariates). Because the coefficient on the probability of dementia for out-of-pocket nursing home spending is \$6498, the estimates imply that almost all the increase in out-of-pocket spending is for nursing homes. Adjustment for covariates reduces both coefficients by about nine percent.

Turning to the covariates, greater nursing-home and total out-of-pocket spending is associated with variation in several factors: greater household income, greater age, race/ethnicity (being white), and having a psychological condition. Associated with lower nursing-home and total out-of-pocket spending: being married and having less than a high school education (as opposed to more than high school). Several other factors are associated with higher or lower spending but only on either nursing-home or total OOP but not both (e.g., high school education only and having had a stroke, both with more total spending; see the table).

Total attributable costs per case were found by summing attributable costs from 12 such regressions, making adjustments for double counting in some cases. For total population costs in the population 71 and over, we first obtained estimates of the number of individuals with dementia by multiplying ADAMS age-specific prevalence rates (for age bands 71–75, 76–79, 80–84, 85–89, 90 and older) by projected population counts in these age bands (obtained from the Census population projections³). Summing across age bands gave the total number of expected cases of dementia among those age 71 and older. Multiplying this figure by estimates of per-individual costs generated an estimate of the total costs of dementia in the population. This was the approach by which we derived population costs for 2010. In addition to those, we also estimated likely costs in 2020, 2030, and 2040. To do this, we used population forecasts for 2020, 2030, and 2040 to get the expected number of

¹Observations with missing data on comorbidities are coded as zeros; the models also include indicators for missing comorbidities.

²The standard errors were calculated as the standard deviation of the estimates of α_1 from 150 bootstrap iterations. Each iteration used different estimates of $P(\text{Dementia}_i)$ as the regressor to reflect the fact that the estimated probability of dementia is a predicted regressor. Specifically, we used a parametric bootstrap (Efron and Tibshirani, 1993) to generate separate new estimates of $P(\text{Dementia}_i)$ for each of the 150 bootstrap iterations. The parametric bootstrap involved using simulated values for dementia status as the outcome in a new ordered probit prediction model. The parameters from this new model were then used to generate new estimates of $P(\text{Dementia}_i)$ among ADAMS respondents. The simulated values of dementia were generated by drawing residuals from a standard normal distribution and using the estimated parameters obtained from the prediction model using the actual ADAMS data, combined with the assumption that the data generating process was ordered probit.

³<http://www.census.gov/population/www/projections/downloadablefiles.html>

individuals of a specified age in the future, the age-specific dementia prevalence rates in ADAMS, and the estimated per-person costs.

Predicted future costs under modified trends in prevalence

Our forecast costs are based on the dementia prevalence rates from ADAMS (Hurd et al. 2013). This effectively assumes that the prevalence will remain at the levels seen in the early 2000's, when ADAMS was conducted. However, as discussed above, recent research (e.g., Matthews et al., 2013) suggests dementia prevalence rates might be declining. Meanwhile, conditions such as obesity, hypertension, and diabetes, all of which are suspected to contribute to higher risks of dementia, have been increasing. The future of dementia's prevalence and costs is thus unclear. In the present analysis, we attempt some clarification by redoing our calculations of total cost to see how they change under different assumptions about trends in dementia prevalence.

Specifically, we use two scenarios. The first uses the declining age-specific prevalence rates reported in Matthews et al. (2013) to adjust the expected future prevalence of dementia. The second adjusts the expected dementia prevalence rate based on information about the changing prevalence of three key comorbidities—hypertension, diabetes, and—obesity and information about how each of these conditions influences the risk of having dementia.

Scenario 1

We begin by recomputing the changes in the age-specific prevalence rates between 1991 and 2011 that were reported in Matthews et al. (2014). There are two reasons for this. First, Matthews et al. report results using 5-year age bands of 70–74, 75–79, etc. We have been using age bands of 71–75, 76–80, etc. Rather than attempt to correct for this discrepancy, we just apply the information reported by Matthews et al. for the 70–74 age band to the 71–75 age band, the 75–79 to the 76–80, etc. The discrepancy in age bands is only one year, and therefore unlikely to have much influence on the results.

Second, Matthews et al. report prevalence separately for men and women, while we have not been making any distinction between genders, largely because our samples broken down by age band and gender are too small. Instead, we combine the male and female prevalence rates in Matthews et al. by taking a weighted average of the two using the sample sizes they report.

From the 1991 and 2011 prevalence rates by age band, we compute the implied annual rate of change, a , for each age band according to this formula:

$$p_{1991}a^{(2011-1991)}=p_{2011}$$

The next step is to calculate the expected age-specific dementia prevalence rate in 2020, 2030, and 2040 assuming that the prevalence rate would begin at the level observed in ADAMS in 2002 and change annually by the amount calculated in the previous step. Specifically, the formula that was used is

$$p_{ADAMS} a^{(t-2002)} = p_t$$

where p_{ADAMS} is the prevalence observed in ADAMS, t is the year (2020, 2030, or 2040), and p_t is the prevalence forecast for year t . Again these calculations are done separately by age band.

Table 4 shows the prevalence rates by age-band in ADAMS and the forecast prevalence rates using the procedure described above. The ADAMS-derived dementia prevalence of 4.3% of the U.S. population aged 71 to 75 is slightly lower than the forecast prevalences, assuming the annual rate of change reported in Matthews et al. persists. However, for all higher age bands, the ADAMS-derived prevalences are lower than those based on Matthews et al. —sometimes much lower. For the median 80–84 age band, for example, the ADAMS prevalence is 18.2%, whereas from Matthews et al. it is 13.1% in 2020, falling to 9.1% in 2040.

Table 5 shows the estimated total costs based on the three different ways of calculating total costs: costs for care purchased in the market, total costs valuing informal care using forgone wage cost, and total costs valuing informal care using replacement costs. In each pair of columns the first column uses ADAMS prevalence rates and the second uses the declining prevalence rates from Table 4. Those rates are displayed in the last two columns, the “overall dementia prevalence” columns. They are the weighted average of the age-specific prevalence rates, where the weights have been generated from population forecasts of the number of individuals in a given age band. The prevalence in Hurd et al. (2013) is projected to be 13% in 2020, rising to 16% in 2040, while the prevalence assuming declines in age-specific prevalence rates is 11% in 2020, falling to 9% by 2030. That last figure is about 69% of the constant-prevalence figure of 13% in 2030 and just 56% in 2040.

The total annual monetary costs of dementia are dramatically lower with declining prevalence assumed, though the decrement varies greatly depending on the method used to value informal care. In 2040, for example, the estimates based on ADAMS prevalence rates vary from \$379 billion to \$511 billion. The corresponding costs assuming declining prevalences vary from \$226 billion to \$306 billion. The reductions in cost are \$153 billion to \$205 billion.

Scenario 2

To estimate the effects of changes in risk factors we use estimates from Barnes et al (2011), which estimates the number of cases of dementia that can be attributed to a given comorbidity (i.e., risk factor). They calculate the “population attributable risk” (PAR), or the proportion of total cases of dementia that can be attributed to a given disease. They use the following formula to calculate PAR for a given comorbidity (such as diabetes):

$$PAR = \frac{P \times (RR - 1)}{1 + P \times (RR - 1)}$$

where P is the prevalence of the comorbidity and RR is the relative risk (the ratio of the probability of having dementia conditional on having the comorbidity to the probability of having dementia conditional on not having the comorbidity). The total number of attributable cases is $PAR \times \text{Cases}$ (where “Cases” is the number of cases of dementia in the population).

They also go through the exercise of seeing how many cases of dementia could be prevented if the prevalence of a given comorbidity fell. To do this, they calculate the PAR assuming that the comorbidity prevalence is some value P' that is lower than the current prevalence:

$$PAR' = \frac{P' \times (RR - 1)}{1 + P' \times (RR - 1)}$$

They then multiply PAR' by the number of cases of dementia currently in the population, i.e., $PAR' \times \text{Cases}$. The number of cases that could be prevented by reducing the prevalence is then the number of attributable cases using the actual PAR minus the number that would arise with the lower prevalence: $PAR \times \text{Cases} - PAR' \times \text{Cases}$

In Table 6, we follow this basic logic to see what would happen if the prevalence of diabetes, hypertension, and obesity continued to increase at the same rate that they have in the last 10–20 years. CDC has data on the prevalence of these conditions, although a breakdown to individuals age 65–74 is the closest they have to individuals just entering age-eligibility for ADAMS.

A forecast of the prevalence rate for each comorbidity in 2020, 2030, and 2040 is obtained using the same approach as in scenario 1 to get the predicted dementia prevalence rate using the trends in Matthews et al. We calculate the percentage change in the prevalence rate for the comorbidity between the forecast value and the actual prevalence rate in 2002 (which is the year of ADAMS approximately). That percentage change is multiplied by the value from Barnes to adjust the population prevalence for each comorbidity that they report. We recompute the PARs reported in Barnes using the new prevalence rates, and compute the difference between the PAR in Barnes and the new PAR based on the adjusted comorbidity prevalence. We then obtained new dementia prevalence rates for our cost calculations by multiplying the age-specific dementia prevalence rate in ADAMS by $(1 + \text{the change in PAR})$. The total cost calculations then are done as they were in Hurd et al. (2013).

As shown in Table 6, when the costs of dementia are adjusted to account for the influence of changes in comorbidity prevalence, the results do not vary much from those obtained by Hurd et al. (2013). The adjustment for trends in hypertension does not raise any of the cost estimates by even 10%. The adjustments for diabetes are all within about 5%, and those for obesity, around 1% or less.

Discussion

Population aging has serious implications for health care spending and the ability of governments to support entitlement programs such as Medicare and Medicaid. Dementia is

one chronic condition that is especially pertinent when considering the implications of population aging because of its strong association with old age and because care for dementia is labor intensive and expensive. In Hurd et al we showed that if current dementia prevalence rates persist population aging will generate very large increases in health care spending for dementia. These increases may be exacerbated by reduced family sizes: there will be fewer family caregivers in the next 40 years putting increased pressure on the formal, more expensive sector. Given these findings, it is vitally important to understand whether dementia prevalence is indeed changing, and if so, to better understand the causes of this development

In this study we considered two alternative assumptions or scenarios about prevalence. One adjusts the prevalence projections using research that suggests dementia prevalence may be declining. The second uses comorbidity growth and the relationship between dementia and these conditions to adjust prevalence rates

In the first scenario we addressed declining prevalence without any specific cause. If the declines in dementia prevalence seen in studies like Matthews persist, we could see dramatic reductions in costs associated with dementia. While the reasons for the declines seen in Matthews et al. are not fully understood, a possible cause in the context of the U.S. is increases in education. For example, in the birth cohorts 1919–1938, who were 75–94 in 2013, 25% of the cohort had at least some college. In the Baby-boom cohorts (birth cohorts 1946–1965) who will be 75–94 in 2040, 56% had at least some college. Some authors have attributed a causal, protective effect of education on the risk of dementia (Langa *et al*, 2008; Stern, 2012). If that is the case, trends in education would suggest future declines.

In Scenario 2, predicted changes in comorbidity prevalence do not make a substantial difference in total costs. This suggests that increases in comorbidities are unlikely to be major contributors to growing dementia costs, although they may be serious problems in their own right. This is because the combination of the comorbidity prevalence, relative risks, and expected growth implies modest changes in prevalence. For example, there have been significant declines in the major cardiovascular complications (e.g., heart attack, stroke, amputations) of diabetes over the last 25 years, suggesting that treatment improvements are decreasing the negative effects of diabetes on body, and by extension, the brain. If treatment improvements continue, the impact of diabetes and obesity on dementia risk may be even less than we estimate here. Nonetheless, a better understanding of competing risks for mortality among those with CIND or dementia is important for good predictions of future dementia prevalence and societal burden. Will rising rates of diabetes and obesity decrease life expectancy so that those with those conditions will be less likely to live to ages where dementia risk increases?

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Table 1

Probit estimation of predictors of Dementia Status for Self-Respondents Using an Ordered Probit Model
(dementia=1, CIND=2, normal=3)

	Coef.	Std. Err.
Age less than 75	(ref)	
75–79	–0.031	0.160
80–84	–0.634 *	0.154
85–89	–0.545 *	0.176
90+	–0.903 *	0.197
Less than HS	(ref)	
HS graduate	–0.452 *	0.145
More than HS	–0.221	0.151
Female	–0.075	0.116
ADL limitations	0.020	0.069
IADL limitations	–0.206 *	0.079
Change in ADL limitations	–0.063	0.068
Changes in IADL limitations	0.099	0.077
<i>TICS items scores at previous HRS wave</i>		
Dates	0.367 *	0.089
Backward counting 20	–0.337	0.197
Serial 7	0.119 *	0.045
Scissor	–0.740	0.448
Cactus	0.035	0.159
President	0.329 *	0.164
Immediate recall	0.235 *	0.063
Delayed recall	0.222 *	0.051
<i>Change in TICS items scores between 2 previous HRS waves</i>		
Dates	–0.100	0.083
Backward counting 20	0.530 *	0.202
serial 7	0.021	0.042
Scissor	0.415	0.417
Cactus	0.310	0.174
President	0.239 *	0.105
Immediate recall	–0.098 *	0.048
Delayed recall	–0.057	0.038
<i>N</i>	657	

The regression includes indicators for missing cognitive scores, ADLs and IADLS (not shown)

Higher TICS item scores indicate higher cognition.

* Statistically significant at 0.05 level.

Table 2

Probit estimation of predictors of Dementia Status for Proxy Respondents Using an Ordered Probit Model
(dementia=1, CIND=2, normal=3)

	Coef.	Std. Err.
Age less than 75	(ref)	
75–79	–0.355	0.542
80–84	–1.418*	0.508
85–89	–1.092*	0.549
90+	–1.607*	0.527
Less than HS	(ref)	
HS graduate	–0.085	0.455
More than HS	–0.721	0.672
Female	–0.192	0.357
ADL limitations	–0.066	0.163
IADL limitations	–0.319	0.170
Change in ADL limitations	0.112	0.152
Changes in IADL limitations	0.166	0.161
Jorm IQCODE at previous HRS waves	–1.912*	0.489
<i>Two waves prior to ADAMS</i>		
Proxy respondents 2 waves prior	0.335	0.545
Change in Jorm IQCODE between 2 previous HRS waves	0.760	0.583
Dates 2 waves prior	0.155	0.220
Serial 7 2 waves prior	0.397*	0.182
President 2 waves prior	–0.271	0.851
Immediate recall 2 waves prior	–0.003	0.216
Delayed recall 2 waves prior	–0.027	0.238
cut1	–7.673*	1.858
cut2	–5.972*	1.788
N	169	

* Statistically significant at the 0.05 level.

Table 3

Regression Results for out-of-pocket Spending on Nursing Home Care and Total OOP Spending

	Out-of-Pocket Nursing Home Spending		Total Out-of-Pocket Spending	
Probability of Dementia	6497.99*** [658.75]	5928.71** [631.01]	6837.76*** [991.69]	6194.14*** [835.83]
Household Income		14.40* [7.16]		44.20*** [12.49]
Married (Yes=1)		-526.58** [75.91]		-562.25*** [139.68]
Age		37.34* [15.44]		46.09* [19.97]
White (Yes=1)		827.52** [147.05]		428.84*** [194.29]
Hispanic (Yes=1)		31.4 [153.14]		-38.48 [219.85]
Female (Yes=1)		143.38 [89.69]		425.59** [138.25]
Less than High School		-465.14** [126.08]		-1207.93*** [200.93]
High School Graduate		-147.45 [124.63]		-769.53*** [179.87]
1 or no Children		161.06 [128.89]		157.82 [169.39]
Two Children		-23.67 [128.45]		228.78 [156.46]
Stroke		241.57 [175.59]		1005.48*** [243.91]
Diabetes		52.72 [94.03]		522.34** [179.54]
Heart Disease		-70.52 [83.74]		527.20** [161.14]
Hypertension		-215.95* [110.13]		171.13 [141.30]
Lung Disease		-134.44 [100.72]		42.65 [200.84]
Cancer		-30 [96.47]		195.31 [156.49]
Psychological Condition		574.66** [183.31]		988.27*** [246.37]
Arthritis		-279.63** [82.73]		-73.5 [142.50]
Intercept	-2.43 [51.69]	-3015.56* [1204.21]	2115.95*** [92.39]	-3283.42* [1608.56]
Number of Observations	25596	25596	31936	31936

Note:

* means significant at 0.05 level;

** means significant at 0.01 level;

*** means significant at 0.001 level.

Table 4

Age-specific dementia prevalence rates

Age band	ADAMS	<u>Forecasted prevalence assuming annual rate of change reported in Mathews et al. persists</u>		
		2020	2030	2040
71–75	0.043	0.045	0.046	0.047
76–69	0.060	0.053	0.049	0.046
80–84	0.182	0.131	0.109	0.091
85–89	0.350	0.244	0.200	0.163
90+	0.374	0.225	0.170	0.128

Total Annual Monetary Costs of Dementia Under Different Assumptions Regarding Trends in Prevalence of Dementia

Table 5

	Billions of dollars annually						Overall dementia prevalence among individuals age 71+	
	Cost for care purchased in the market		Total cost valuing informal care using forgone wage cost		Total cost valuing informal care using replacement cost			
	Hurd et al. (2013)	Assuming declining prevalence	Hurd et al. (2013)	Assuming declining prevalence	Hurd et al. (2013)	Assuming declining prevalence		
2020	129.2	102.2	189.0	149.5	255.2	201.8	0.13	0.11
2030	182.8	126.7	267.5	185.4	361.1	250.3	0.13	0.09
2040	258.9	154.2	378.7	225.5	511.4	304.5	0.16	0.09

Table 6

Total Annual Monetary Costs of Dementia Adjusted for the Influence of Changes in Comorbidity Prevalence

	Cost for care purchased in the market	Total cost valuing informal care using forgone wage cost	Total cost valuing informal care using replacement cost	Dementia prevalence rate
Dementia prevalence adjusted for trends in hypertension				
2020	132.4	193.7	261.6	0.138
2030	191.0	279.4	377.3	0.140
2040	277.0	405.2	547.1	0.167
Dementia prevalence adjusted for trends in obesity				
2020	129.6	189.6	256.0	0.135
2030	183.8	268.9	363.0	0.135
2040	260.8	381.5	515.2	0.157
Dementia prevalence adjusted for trends in diabetes				
2020	131.1	191.8	258.9	0.136
2030	188.0	275.0	371.3	0.138
2040	270.8	396.1	534.8	0.163