



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.ajgonline.org

Regular Research Article

Incremental Health Care Expenditures of the Spouses of Older Adults With Alzheimer's Diseases and Related Dementias (ADRD)

Jun Chu, M.P.H., Ivy Benjenk, R.N., M.P.H., Jie Chen, Ph.D.

ARTICLE INFO

Article history:

Received July, 14 2020

Revised September, 24 2020

Accepted September, 26 2020

Key Words:

Alzheimer's disease and related dementias

spousal caregivers

health care expenditures

ADRD

Spousal caregivers

Health expenditures

ABSTRACT

Objective: Previous research has found that having a spouse with Alzheimer's disease and related dementias (ADRD) is associated with higher health care expenditures, however it is unclear if this difference remains after accounting for the demographics and health status of the non-ADRD spouse. This paper aims to estimate the adjusted incremental health care expenditures of having a spouse with ADRD. **Design:** Cross-sectional study of publicly available survey data (2003–2017 Medical Expenditure Panel Survey). **Setting:** Representative sample of U.S. households. **Participants:** Community-dwelling and married older adults ($n = 28,356$). **Measurement:** Two-part models and recycled prediction techniques to estimate the incremental effects of having a spouse with ADRD on annual health care expenditures, while adjusting for demographics, socioeconomic characteristics, and health conditions. **Results:** Spouses of older adults with ADRD were older, had worse perceived mental health, and had greater difficulties with activities of daily living, compared to older adults with cognitively normal spouses. Spouses of ADRD patients had significantly higher unadjusted total health care expenditures, however their adjusted incremental expenditure was not significantly greater. After controlling for demographics and health status, ADRD spouses had significantly higher home health care expenditures, but significantly lower outpatient expenditures. **Conclusion:** Results suggested that the higher health care expenditures in older adults with ADRD spouses can be attributed to the higher rate of comorbidities.

From the Department of Health Policy and Management (JC, IB, JC), School of Public Health, University of Maryland, College Park, MD. Send correspondence and reprint requests to Jun Chu, M.P.H., Department of Health Policy and Management, UMD School of Public Health, 4200 Valley Dr., Room 3310, College Park, MD 20742. e-mail: jchu16@umd.edu

Previous presentation: This paper was presented as podium presentation at The American Society of Health Economists (ASHEcon) 2020 Annual Meeting virtually on June 9th, 2020.

© 2020 American Association for Geriatric Psychiatry. Published by Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.jagp.2020.09.020>

Incremental Health Care Expenditures of the Spouses of Older Adults

rate of functional limitations, and mean age in this group. The increased use of home health and decreased use of outpatient in this population suggests the importance of tailoring preventative health care and social services to meet the needs of this group. (Am J Geriatr Psychiatry 2020; ■■:■■–■■)

INTRODUCTION

Alzheimer's disease and related dementias (ADRD) affect over 5 million adults in the United States.¹ The majority of individuals with ADRD live at home with spouses and their spouses often live in a state of chronic stress.² Spouses of community-dwelling persons with ADRD often act as primary caregivers, providing a range of supports from medication administration to assisting with activities of daily living (ADL).^{1,3} They are also challenged by changes in the quality of the relationship with their partner and often changes in their own self-identity.⁴ Spouses of persons with ADRD, especially those who serve as the primary caregivers of their spouses, have been found to be at high risk for negative physical and mental health outcomes, including frailty, chronic medical illness, obesity, accelerated cognitive decline, depression, and premature mortality.^{2,3,5–10}

Older adults who have spouses with ADRD average 24% higher total annual medical expenditures than older adults with cognitively normal spouses.¹¹ This increase in medical expenditures has been found to begin three months prior to their spouse receiving a formal diagnosis of ADRD. These excess expenditures also remain after accounting for differences in health conditions captured in claims data.^{11–15} It is not yet known if there are other quantifiable factors that contribute to the excess medical expenditures in this population, or if having a spouse with ADRD can significantly increase medical expenditures even after accounting for other known predictors of medical expenditures. Understanding factors that lead to excess health care expenditures is essential to improving the design of the health care delivery model, such as caregiver services and coordination of ADRD caregiving, that can reduce high health care expenditures and increase care efficiency in this population.^{16,17}

In addition, it is important to determine the types of excess expenditures, if any, that spouses of individuals with ADRD may have encountered. Previous studies have shown tremendous uses of home health care among ADRD patients, which results in ADRD patients having higher medical expenditures than persons without ADRD.^{18,19} Spouses of individuals with ADRD may also benefit from home health services as studies have shown that nursing home placement can be prolonged for ADRD patients when their spouses receive support.^{20–22} However, it is unknown whether spouses of persons with ADRD are utilizing in-home supports. Understanding the incremental home health expenditures associated with being spouses of ADRD patients can be informative to the design of Medicare and Medicaid financing and payment models.

The objective of this study is to assess incremental health care expenditures related to being a spouse of a person with ADRD using a large-scale, nationally-representative survey. Using an innovative family and spouse linkage, this is the first study to use survey data to examine the incremental expenditures associated with being a spouse of a person with ADRD and controlling for a comprehensive list of demographics, socioeconomic status, and medical conditions.¹⁸ We hypothesize that there would be significant variations of demographic and socioeconomic characteristics between spouses of ADRD and non-ADRD patients. It is an empirical question to test the "incremental" health care cost associated with being a spouse of ADRD patient. It is likely that higher health care expenditures of spouses of older adults with ADRD, compared to spouse of non-ADRD patients, could be attributed to differences in age and health conditions. In addition, we hypothesize that spouses of individuals with ADRD may have similar patterns of health care expenditures with adults of ADRD, given their caregiving experience. That is to say that spouses of individuals with ADRD would have similar acute care expenditures and greater home health and drug expenditures, compared to spouses of individuals without ADRD.

METHODS

Data

We used data from 2003 to 2017 Medical Expenditure Panel Survey (MEPS), a nationally representative survey from the Agency for Healthcare Research and Quality. The MEPS is a household-level survey that collects information on health care expenditures, utilization, health status, insurance coverage, perceived physical and mental health status, reported functional limitations, and socioeconomic characteristics for non-institutionalized civilians living in the United States. MEPS participants are recruited from participants in the previous year's National Health Interview Survey, which is conducted by the Center for Disease Control's National Center for Health Statistics. The National Health Interview Survey sampling plan is based on the census.²³ Medical condition and health care expenditure information is collected from medical records and verified by participants' medical providers. MEPS utilizes sampling weights to adjust for survey nonresponse and reflect the demographics of the U.S. Census Current Population Survey.²⁴

Study Participants

We limited our study sample to married individuals ages 65 and older who were living together in the community. We defined an individual with ADRD using the International Classification of Disease, 9th and 10th revision diagnosis code guidelines released by Centers for Medicare and Medicaid Services.²⁵ We identified spouses of persons with ADRD using the spousal identifier within MEPS. All couples where both spouses had ADRD were excluded. For the ADRD couples, the spouse of a person with ADRD was included in the analysis. For non-ADRD couples, we selected one spouse from each couple to include in our analysis using a random number generator. Our study sample has 28,356 individuals in total, including 849 spouses of a person with ADRD and 27,507 with spouses of a person without ADRD.

Variables

Our outcome variables were annual medical expenditures, which includes expenditures related to

inpatient stays, outpatient visits, emergency department (ED) visits, home health visits, prescription drugs, and annual total medical expenditures. The total medical expenditure is a combination of inpatient, outpatient, ED, dental, home health, vision, prescriptions drugs, and other medical supplies and equipment expenditures paid by third-party payers and out-of-pocket (OOP) spending paid by the spouse and/or family. All expenditures were adjusted for medical services inflation to 2019 U.S. dollars.²⁶

In order to calculate adjusted health care expenditures, we selected covariates that could potentially influence medical expenditures and categorized them into three groups based on the Andersen health care utilization model: predisposing, enabling and need.²⁷ Predisposing factors included sex, age, race/ethnicity and U.S. Census region. Enabling factors included types of health insurance, educational attainment, and family income. Need factors included self-reported physical and mental health status, self-reported impairment in one or more ADL, hypertension, diabetes, heart diseases, and smoking status. We also controlled for survey year to adjust for changes in linear trends.

Analysis

We first compared the bivariate characteristics of the two groups with χ^2 test and sample weights. Next, we then compared unadjusted likelihood of having nonzero expenditures and average expenditure amounts between spouses of persons with ADRD and spouses of persons without ADRD using Student's Independent t test. To estimate effects of having spouses with ADRD on health care expenditures, we used the two-part models, which was commonly used in health economics research when large portions of the population have no expenditures.^{28,29} Probit regression was applied as the first-part of the model to estimate the likelihood of having non-zero expenditures. With the likelihood estimated, we then applied generalized linear model (GLM) with gamma distribution with natural log link as the second part to estimate the associations of having spouses with ADRD and expenditure amount. Lastly, we used the recycled prediction method to estimate the incremental expenditure of having a spouse with ADRD.^{18,30} For this technique, we coded each individual as if

Incremental Health Care Expenditures of the Spouses of Older Adults

his/her spouse had ADRD and calculated the predicted expenditures from the GLM results. Then, we coded each individual as if his/her spouse did not have group and calculated the predicted expenditure from the GLM results. The excess medical expenditure due to being the spouse of a person with ADRD was then calculated based on the difference between the ADRD spouse group and the non-ADRD group. We constructed two models: Model 1 includes status of being a spouse of a person with ADRD, Census regions and survey year. Full model includes status of being a spouse of a person with ADRD, Census region and survey, plus predisposing, enabling and need factors aforementioned.

Stata 15 MP was used to conduct the analysis. We took into account the complex survey design by using sampling weight, sampling strata and primary sampling unit when correcting standard errors. The study involved only secondary analysis of data; therefore, it was deemed exempt from further consideration by our Institutional Review Board.

RESULTS

Table 1 shows the comparison of baseline statistics between individuals with and without ADRD spouses. Around 3% of non-institutionalized married individuals were spouses of persons with ADRD. Over 69.50% of spouse of a person with ADRD were 75 years and older as compared to 34.50% of spouse of a person without ADRD. Compared to spouses of persons without ADRD, spouses of persons with ADRDs were more likely to report difficulties with ADLs (7.8% versus 2.8%). Results also showed that spouses of a person with ADRD had significantly lower family income, and more likely to live in the South, and more likely to only have Medicare coverage.

Table 2 compares the likelihood of having health care expenditures and amounts of expenditures, if any, between the two groups. Overall, spouses of persons with ADRD were more likely to have any medical expenditures, and expenditures of hospital stay, prescription drugs, and home health services compared to ones without ADRD spouses. The likelihoods of encountering any ED expenditure, outpatient expenditures, and OOP were not significant.

In concordance with our hypothesis, **Table 2** also shows that spouses of persons with ADRD had significantly higher total health care expenditures (\$13,234.83 versus \$10,533.89), prescription drug (\$2,864.3 versus \$2,637.14), home health (\$9,811.99 versus 7,142.95), and OOP (\$1,857.73 versus \$1,410.47), compared to spouses of persons without ADRD. On the other hand, ADRD spouses had significantly lower expenditures of outpatient visits (\$2,084.21 versus \$2,534.46). Expenditures of ED and hospital stays were not significant.

Table 3 displays estimates of total medical expenditures using adjusted and unadjusted two-part models. Model 1 shows that being the spouse of a person with ADRD was significantly associated with likelihood of having any health care expenditures (part 1) and positively associated with the amount of health care expenditures if any (part 2). Model 2 controlled for predisposing, enabling, and need factors in addition to census region and survey year. Results showed that being a spouse with ADRD was positively associated with the likelihood of having any health care expenditures (part 1), but there was no significant association with the amount of total health care expenditures for those who had any expenditures (part 2). We also found that racial and ethnic minorities had lower total health care expenditures when comparing to the non-Hispanic whites, which is similar to our hypothesis. Black and Hispanic individuals had lower prescription drug cost and OOP expenditures than non-Hispanic whites (Results not shown). Lastly, we found individuals with Medicare and private insurance coverage had significantly higher likelihood of having any total expenditure than individuals who are covered by both Medicare and Medicaid, and also had higher likelihood than individuals with only Medicare coverage, which is also similar to our hypothesis. Specifically, individuals with Medicare and private insurance had higher outpatient expenditures, prescription drug expenditures and OOP expenditures (results not shown).

Table 4 shows the adjusted incremental average per-person per year health expenditures of different types of health care services using recycled prediction techniques. The adjusted annual per-person average total health care expenditure for was \$11,716.19 (SE = \$732.31) for spouses of persons with ADRD and \$10,713.41 (SE = \$165.27) for spouses of persons

TABLE 1. Descriptive Characteristics of Spouses of ADRD Patients, 2003–2017

	Individuals w/o ADRD Spouse (n = 27,507)		Individuals w/ ADRD Spouse (n = 849)		χ^2 value	Df	p Value
	Mean	SE	Mean	SE			
Age in years					104.71	596	<0.001
65–74	65.55%	0.70%	30.50%	0.24%			
75+	34.50%	0.70%	69.50%	0.24%			
Sex					27.51	596	<0.001
Male	57.17%	0.30%	42.10%	0.27%			
Female	42.83%	0.30%	57.90%	0.27%			
Race/Ethnicity					3.26	594	
NH white	39.60%	0.80%	42.20%	0.28%			
NH black	4.60%	0.30%	3.30%	0.30%			
Hispanic	6.30%	0.40%	6.90%	0.40%			
Other races	49.50%	0.70%	47.50%	0.70%			
Person's income					51.22	593	<0.001
<10K	6.20%	0.20%	11.10%	1.80%			
10K–20K	3.60%	0.20%	5.20%	0.90%			
20K–30K	13.90%	0.40%	23.20%	0.21%			
30K–50K	28.70%	0.60%	30.00%	0.22%			
>50k	47.60%	0.70%	30.40%	0.25%			
Education					3.48	596	0.12
Less than 4-year college degree	29.63%	0.30%	30.48%	0.70%			
4-year college or more	70.37%	0.30%	69.52%	0.70%			
Health insurance					3.9	595	0.14
Medicare	34.90%	0.70%	35.60%	2.60%			
Medicare & medicaid (dual eligibility)	3.60%	0.30%	6.80%	0.30%			
Medicare & private insurance	61.50%	0.70%	57.70%	2.90%			
Self-reported health status					6.16	596	<0.001
Very good/good	49.80%	0.50%	43.10%	2.70%			
Fair/poor	50.20%	0.50%	56.90%	2.70%			
Self-reported mental health status					11.66	596	<0.001
Very good/good	62.90%	0.50%	54.00%	2.60%			
Fair/poor	37.10%	0.50%	46.00%	2.60%			
Comorbidity						596	
Difficulties in any ADL	4.43%	0.20%	38.31%	1.70%	8.94		<0.001
Hypertension	22.99%	0.50%	29.37%	2.70%	1.77		0.028
Obese	25.67%	0.50%	16.67%	2.20%	6.06		<0.001
Diabetes	22.99%	0.40%	29.37%	1.90%	35.18		<0.001
Heart disease	4.33%	0.10%	5.47%	0.10%	0.49		0.48
Smoking	8.02%	0.20%	7.56%	1.00%	60.06		0.674
Census region					173.65	596	0.001
Northeast	15.48%	0.20%	14.29%	0.80%			
Midwest	21.76%	0.20%	17.42%	0.80%			
South	38.04%	0.20%	46.24%	0.80%			
West	24.73%	0.30%	22.06%	0.90%			

Note: Analyses of Medicare Expenditure Panel Survey 2003–2017. Estimates are nationally representative and are calculated adjusting for person weights, stratum and primary sampling unit. Our sample represents 617,801.36 individuals with ADRD spouses and 20,983,645 individuals without ADRD spouses that is community-dwelling elderly individuals aged 65 years and older. P-values are results from χ^2 test comparison of between individuals with ADRD spouses and individuals without ADRD spouses. Complex survey weights were applied. ADRD: Alzheimer's disease and related dementias; Df: degrees of freedom; ED: emergency department; NH: non-Hispanic; SE: standard errors.

without ADRD, although the difference was not significant (incremental difference = \$1,002.78, SE = \$738.15). Being a spouse of a person with ADRD continued to have significantly higher adjusted annual home health care expenditures (\$555.53, SE = \$162.40). In contrary to our original hypothesis,

we found lower office-based outpatient expenditures (–\$419.22, SE = \$133.24) among spouses of ADRD patients. There were no statistically significant differences between the two groups in total health care, inpatient, ED, or prescription expenditures. These were within our hypothesis.

*Incremental Health Care Expenditures of the Spouses of Older Adults***TABLE 2. Unadjusted Average Per Person Annual Health Care Expenditure Among Older Adults (≥65 years), 2003–2017**

	Percentage of Individuals That Had Nonzero Expenditures						χ^2 Value	Df	p Value
	Spouse Not Have ADRD		Spouse Had ADRD						
	N	Percentage	N	Percentage					
Total medical expenditure	27,507	96.79%	849	98.37%	113.26	596	0.03		
Total ED expenditure	27,507	12.95%	849	17.76%	283.61	596	0.01		
Total outpatient expenditure	27,507	91.84%	849	93.62%	59.86	596	0.24		
Total hospital stay expenditure	27,507	14.45%	849	18.51	184.82	596	0.01		
Total RX expenditure	27,507	91.05%	849	94.06%	156.50	596	0.04		
Total homehealth expenditure	27,507	6.18%	849	18.46%	3,445.03	596	<0.001		
Total out-of-pocket expenditure	27,507	94.46%	849	96.07%	70.28	596	0.11		

	Among Individuals With Nonzero Expenditures								
	Spouse Not Have ADRD			Spouse Had ADRD			t Test Value	Df	p Value
	N	Mean(\$)	SE	N	Mean(\$)	SE			
Total medical expenditure if any	26,332	10,553.89	120.75	829	13,234.83	633.6			
Total ED expenditure if any	3,365	318.54	9.83	142	304.45	39.48	0.29	3,505	0.77
Total outpatient expenditure if any	24,774	2,534.46	35.93	785	2,084.21	97.93	2.22	25,557	0.03
Total hospital stay expenditure if any	3,783	2,587.18	59.3	156	3,028.42	546.82	-1.41	3,937	0.16
Total RX expenditure if any	24,664	2,637.14	32.21	792	2,864.3	177.13	-2.48	25,454	0.01
Total homehealth expenditure if any	1,757	7,142.95	259.95	192	9,811.99	848.38	-3.2	1,947	0.001
Total out-of-pocket expenditure if any	25,561	1,410.47	14.67	807	1,857.73	192.27	-5.01	2,6366	0.001

Notes: Analyses of Medicare Expenditure Panel Survey 2003–2017. Estimates are nationally representative and are calculated adjusting for person weights, stratum and primary sampling unit. Our sample represents 617,801.36 individuals with ADRD spouses and 20,983,645 individuals without ADRD spouses that is community-dwelling elderly individuals aged 65 years and older. P-values are results from t test comparison of between individuals with ADRD spouses and individuals without ADRD spouses. ADRD: Alzheimer's disease and related dementias; Df: degrees of freedom; ED: emergency department; SE: standard errors.

DISCUSSION

Our study examined differences of health care expenditures among spouses of person with and without ADRD. Similar to previous research, our results showed that spouses of ADRD patients had significantly higher total health care expenditures compared to spouses of a person without ADRD.^{11,12,14} Unlike previous studies, our study controlled for demographic and socioeconomic characteristics and health status. Our study found the differences in total health care expenditures were no longer significant after controlling for predisposing, enabling, and need characteristics of the spouse of ADRD patient. This finding was within the expectation of our proposed hypothesis. This suggests that certain demographic characteristics played mediation effects between expenditures and having spouses with ADRD. Spouses of ADRD patients were more likely to be women and older when compared to ones without ADRD spouses, which was also found in previous studies.^{11,12} We found these factors to both be

positively associated with the total medical expenditures amounts.

Additionally, our study found both being racial/ethnic minorities and lacking private insurance coverage in addition to Medicare coverage were negatively associated with total medical expenditure amounts, which was also within the scope of our hypothesis. Previous studies have found that racial/ethnic minorities were less likely to utilize health care services including outpatient services, mental health services, prescription drugs and statin application, hence incurring less total health care expenditures.^{31–34} Elderly individuals who can afford to purchase private insurance may have higher income, hence they are more likely to use additional health care services and incur higher expenditures.³⁵ Additional research is needed to determine which categories of spending are contributing to these differences.

We also found significant variations in different types of health care expenditures. In particular, we found that being a spouse of a person with ADRD was associated with increased home health care

TABLE 3. Results of Two-Part Models of Total Medical Expenditures From Two Models

Variables	Model 1 ^a					
	First Part: Probit Regression			Second Part: Generalized Linear Model With Gamma Distribution		
	Dependent Variable: Binary Variable = 1 If Total Expenditure > 0			Dependent Variable: Natural Logarithm of Total Health Care Expenditure		
	Coef (Probit)	SE	t (p value)	Coef (Probit)	SE	t (p value)
Spouse and ADRD condition						
Spouse without ADRD		REF			REF	
Spouse w ADRD	0.29	0.13	2.23 (0.03)	0.16	0.07	2.20 (0.03)
Variables	Model 2 ^b					
	First part: Probit Regression			Second part: Generalized Linear model with Gamma distribution		
	Dependent variable: binary variable=1 if total expenditure>0			Dependent variable: natural logarithm of total health care expenditure		
	Coef (Probit)	SE	t (p value)	Coef (Probit)	SE	t (p value)
Spouse and ADRD condition						
Spouse without ADRD		REF			REF	
Spouse w ADRD	0.28	0.13	2.13 (0.03)	0.08	0.06	1.25 (0.21)
High blood pressure						
No		REF			REF	
YES	0.74	0.05	15.86 (<0.001)	0.10	0.03	3.74 (<0.001)
BMI>30						
No		REF			REF	
Yes	0.04	0.06	0.70 (0.48)	0.03	0.03	0.87 (0.38)
Diabetes						
No		REF			REF	
Yes	0.60	0.07	8.01 (<0.001)	0.29	0.03	8.86 (<0.001)
Ever smoked						
No		REF			REF	
Yes	-0.24	0.06	-3.81 (<0.001)	-0.04	0.06	-0.73 (0.47)
Difficulties in any ADL						
No		REF			REF	
Yes	0.16	0.20	0.78 (0.44)	0.94	0.05	17.39 (<0.001)
Age in years						
65-74		REF			REF	
75+	0.17	0.05	3.15 (0.01)	0.15	0.03	5.72 (<0.001)
Sex						
Male		REF			REF	
Female	0.24	0.04	5.95 (<0.001)	-0.10	0.03	-3.63 (<0.001)
Race/Ethnicity						
NH White		REF			REF	
NH Black	-0.41	0.08	-4.82 (<0.001)	-0.28	0.08	-3.30 (<0.001)
Hispanic	-0.40	0.06	-6.00 (<0.001)	-0.34	0.05	-6.40 (<0.001)
Other races	-0.08	0.09	-0.89 (0.37)	-0.04	0.05	-0.75 (0.45)
Education attainment						
Less than 4-year college		REF			REF	
4-year college or more	0.22	0.09	2.35 (0.02)	0.07	0.05	1.31 (0.19)
Health insurance coverage						
Medicare & Private insurance		REF			REF	
Medicare & medicaid (dual eligibility)	-0.31	0.05	-6.71 (<0.001)	-0.16	0.03	-5.67 (<0.001)
Medicare	-1.37	0.16	-8.71 (<0.001)	-0.55	0.50	-1.08(0.28)
Person's income						
<10K		REF			REF	
10K-20K	0.12	0.09	1.34 (0.18)	0.13	0.09	1.54(0.12)
20K-30K	0.14	0.07	2.07 (0.04)	0.07	0.05	1.39(0.16)
30K-50K	0.25	0.07	3.74 (<0.001)	0.02	0.05	0.40(0.69)
>50k	0.50	0.07	7.01 (<0.001)	0.08	0.05	1.69(0.09)

(continued)

Incremental Health Care Expenditures of the Spouses of Older Adults

TABLE 3. (continued)

Variables	Model 2 ^b					
	First part: Probit Regression			Second part: Generalized Linear model with Gamma distribution		
	Dependent variable: binary variable=1 if total expenditure>0			Dependent variable: natural logarithm of total health care expenditure		
	Coef (Probit)	SE	t (p value)	Coef (Probit)	SE	t (p value)
Self-reported physical health status						
Fair/poor		REF			REF	
Very good/good	-0.29	0.06	-5.17 (<0.001)	-0.64	0.03	-21.34 (<0.001)
Self-reported mental health status						
Fair/poor		REF			REF	
Very good/good	0.01	0.05	0.27 (0.78)	0.04	0.03	1.33 (0.18)
Census region						
Northeast		REF			REF	
Midwest	0.03	0.07	0.37 (0.71)	-0.01	0.05	-0.12 (0.91)
South	-0.03	0.07	-0.48 (0.64)	-0.06	0.04	-1.42 (0.16)
West	-0.03	0.07	-0.40 (0.69)	-0.06	0.05	-1.19 (0.23)

Note: Analyses of Medicare Expenditure Panel Survey 2003–2017. Estimates are nationally representative and are calculated adjusting for person weights, stratum and primary sampling unit. Our sample represents 617,801.36 individuals with ADRD spouses and 20,983,645 individuals without ADRD spouses that is community-dwelling elderly individuals aged 65 years and older. First part of the model is probit regression, and second part of the model is generalized linear model with gamma distribution and log link function. p values of first part model were calculated from the probit regression coefficients and standard errors, and p-values of second part were calculated from generalized linear model with gamma distribution and log link function coefficients and standard errors. All results are available upon request.

^a Model 1 controls spouses of ADRD patients, Census regions and survey year. Number of observations: 28,124. Degree of freedom: 596. F(18,579) = 1.76.

^b Model 2 controls spouses of ADRD patients, Census region and survey, plus predisposing, enabling and need factors discussed in Methods. Number of observations: 28,124. Degree of freedom: 596. F(36,560) = 22.88.

expenditures. This finding validated our hypothesis. Home health care providers, who are already coming to the home to care for the person with ADRD, may be uniquely suited to provide support and coordinate care for ADRD spouses. As seen by this study, providers who are making home care referrals for their ADRD patients may already be recognizing that the spouses of ADRD patients may also benefit from home care and are thus making referrals for the dyad. Alternatively, home care nurses or case managers who are assessing the home care needs of patients with ADRD may be identifying the home care needs of the spouse and reaching out to primary providers for referrals. Future studies are needed to determine the potential impacts of home health services for spouses of ADRD patients.

After controlling socioeconomic status and health conditions, we found spouses of persons with ADRD had significantly less outpatient care expenditures than spouses of individuals without ADRD, which is in contrary of our original hypothesis. Previous studies found ADRD patients had higher expenditure of

outpatient care.¹⁸ As persons with ADRD require extensive assistance and supervision, it can be difficult for their spouses to leave home, even to attend their own medical appointments. This lower use of outpatient care does not seem to have negative implications as we see no difference in inpatient and ED utilization, suggesting that they are receiving the essential. Additionally, this finding may suggest that home health can serve as an acceptable substitute for outpatient services.

Limitations

Several potential limitations of our study should be identified. First, when identifying patients with ADRD, we did not control for duration and severity of ADRD, as this information is unavailable in MEPS. Second, we did not control for an exhaustive list of comorbid conditions. Third, we did not know if the spouse was the primary caretaker of the person with ADRD. Fourth, with MEPS’s limited sample size and limited panel design, we will not be able to examine

TABLE 4. Adjusted Total and Incremental Average Per-person Annual Health Care Expenditures Among Individuals With and Without ADRD Spouse

	Total Expenditures of Individual w/o ADRD Spouse		Total Expenditures of Individual w/ ADRD Spouse		Incremental Expenditures of Having ADRD Spouse			
	Mean(\$)	SE	Mean(\$)	SE	Mean(\$)	SE	t Test Value	p Value
Total medical expenditure	10,713.41	165.27	11,716.19	732.31	1,002.78	738.15	1.36	0.18
Total ED expenditure	42.14	1.65	48.69	8.45	6.56	8.44	0.78	0.44
Total outpatient expenditure	2,490.23	46.92	2,071.01	131.75	-419.22	133.24	-3.15	<0.01
Total hospital stay cost	372.25	12.49	411.45	67.38	39.2	68.35	0.57	0.56
Total RX expenditure	2,421.67	49.77	2,489.24	157.14	67.56	166.45	0.41	0.69
Total homehealth expenditure	423.54	31.33	979.08	170.4	555.53	162.4	3.42	<0.001
Total out-of-pocket expenditure	1,450.12	23.25	1,729.47	156.53	279.34	152.02	1.84	0.07

Note: Analyses of Medicare Expenditure Panel Survey 2003–2017. Estimates are nationally representative and are calculated adjusting for person weights, stratum and primary sampling unit. Our sample represents 617,801.36 individuals with ADRD spouses and 20,983,645 individuals without ADRD spouses that is community-dwelling elderly individuals aged 65 years and older. Adjusted total and incremental expenditure were calculated based on two-part models and recycled predictions method after adjusting for age, sex race, education, income, insurance type, physical health status, mental health status, chronic conditions, physical activity and smoking. p values were results from t test comparison of adjusted expenditures between individuals with ADRD spouses and individuals without ADRD spouses. Degrees of freedom is 560. ADRD: Alzheimer's disease and related dementias; ED: emergency department; SE: standard errors.

the initiation of home care and its effect upon subsequent outpatient expenses. Finally, our study population only included the non-institutionalized population. Hence, our study results could not be generalized to spouse of persons with ADRD who reside at long-term care facilities.

Policy Implications During and Post the COVID-19 Era

These findings are increasingly important in light of the current COVID-19 pandemic. Many of the health and social services that persons with ADRD depend on, like day programs and food delivery programs, have been limited by stay-in-place orders.³⁶ Additionally, persons with ADRD have been found to be at high risk for developing severe COVID illness, thus spouses may feel obligated to halt any in-home supports and visits from friends and family members.³⁷ Interruption in regular routines, like walks in the park and trips to coffee shops, can increase cognitive impairment and feelings of loneliness for both the person with ADRD and their spouse.^{38,39} Without external supports, caregiver burden is likely to intensify, which may translate to an increase in negative physical and mental health effects.^{40,41} Additionally, since the COVID-19 pandemic, we have seen major declines in the use of the home health care services across the nation.⁴² Many home health care providers are in jeopardy of going

out of business. CMS has yet to approve reimbursement for home health services delivered through telehealth.⁴³ It is clear that both individuals with ADRD and their spouses are dependent upon home health services to address their health and social needs.⁴² Urgent research is needed to understand how changes in home health service utilization influence outcomes and other health services utilization for individuals with ADRD and their spouses, including skilled nursing facility placement. As the COVID-19 pandemic is expected to continue for the next few years, there is an urgent need to identify alternative supports that can be used to promote the mental and physical health of community-dwelling persons with ADRD and their spouses.^{44–52} Home health services delivered through telehealth may be able to mitigate the impact of the loss of in-person services as well as keep home health care providers in business so they can return to providing this critical service as the conclusion of the pandemic. It is possible that the use of outpatient care may actually increase for ADRD spouses during the COVID-19 pandemic as telehealth may actual increase access to outpatient professional services.

With the number of individuals with ADRD on the rise and cure for ADRD remaining to be out of sight, the physical and mental health of informal caregivers must become a crucial component of ADRD treatment. The National Institute of Health plans to spend over 60 million dollars in 2020 and 2021 on

Incremental Health Care Expenditures of the Spouses of Older Adults

researching how to better improve caregiver's health caregiver experience, along with creating better caregiving strategies.^{21,22} As the threat of COVID-19 continues to loom, finding the right balance of protecting older adults from infection, while ensuring they receive necessary care can be particularly challenging. Policymakers should consider achieving both goals while keeping the elderly ADRD households safe by mandating insurance programs to provide sufficient and affordable home health coverage for ADRD patients and their spouses who frequently act as the formal caregivers. Additionally, policymakers should consider reimbursement for home health services delivered through telehealth to promote continuity of care and minimize service gaps.⁴³

CONCLUSION

As a substantial public health burden in the United States, ADRD has a negative effect on not only the patient but also the spouse. Our analysis provides estimates of the annual direct medical expenditures associated with having ADRD spouses among the non-institutionalized population. Older adults with spouses that suffers from ADRD have significantly higher total health care expenditures, however this increase in costs is mostly attributed to the higher rate of medical conditions and age. After controlling for differences between groups, home health spending remains considerably higher among those with spouses that suffers from ADRD. Future studies should continue to analyze the economic

burden of ADRD on spouses and how care coordination programs could alleviate some of the caregiver burdens.

ACKNOWLEDGMENTS

We are grateful to Courtney Van Houtven, Edward Norton, Tamara Konetzka, participants at The American Society of Health Economics 2020 Annual Meeting for their helpful comments. We also thank the editor and the anonymous reviewers.

Dr. Jie Chen is supported by National Institute on Minority Health and Health Disparities grant (R01MD011523), National Institute on Aging Grant (R56AG062315), and National Institute on Minority Health and Health Disparities Grant (R01MD011523-03S1). For the remaining authors no conflict of interest was declared.

AUTHORS' CONTRIBUTION

All authors have participated sufficiently in the work to take public responsibility for all or part of the content, and have made substantive intellectual contributions to the submitted work in the form of: 1) conception and design, and/or acquisition of data, and/or analysis of data; and 2) drafting the article, and/or revising it critically for important intellectual content. All authors approve for this version to be published.

References

1. Alzheimer's Association: 2019 Alzheimer's disease facts and figures. *Alzheimers Dement* 2019; 15:321-387
2. Dassel KB, Carr DC: Does dementia caregiving accelerate frailty? Findings from the health and retirement study. *Gerontologist* 2016; 56:444-450
3. Solway E, Clark S, Singer D, Kirch M, Malani P. Dementia caregivers - Juggling, delaying, and looking forward. University of Michigan National Poll on Healthy Aging. 2017.
4. Pozzebon M, Douglas J, Ames D: Spouses' experience of living with a partner diagnosed with a dementia: a synthesis of the qualitative research. *Int Psychogeriatr* 2016; 28:537-556
5. Prigerson HG, MaCiejewski PK: A call for sound empirical testing and evaluation of criteria for complicated grief proposed for DSM-V. *OMEGA J Death Dying* 2006; 52:9-19
6. Prigerson HG, Shear MK, Newsom JT, et al: Anxiety among widowed elders: is it distinct from depression and grief. *Anxiety* 1996; 2:1-12
7. Dassel KB, Carr DC, Vitaliano P: Does caring for a spouse with dementia accelerate cognitive decline? Findings from the health and retirement study. *Gerontologist* 2017; 57:319-328
8. Sara Sanders PhD M, PhD CHO, MS STK, et al: The experience of high levels of grief in caregivers of persons with Alzheimer's disease and related dementia. *Death Stud* 2008; 32:495-523
9. Vitaliano PP, Zhang J, Scanlan JM: Is caregiving hazardous to one's physical health? A meta-analysis. *Psychol Bull* 2003; 129:946-972
10. Schulz R, Beach SR: Caregiving as a risk factor for mortality the caregiver health effects study. *JAMA* 1999; 282:2215-2219
11. Gildea DM, Kubisiak JM, Kahle-Wroblewski K: A claims-based examination of health care costs among spouses of patients with Alzheimer's disease. *J Gerontol Ser A* 2017; 72:811-817
12. Gildea DM, Kubisiak JM, Kahle-Wroblewski K, et al: Using U.S. Medicare records to evaluate the indirect health effects on spouses: a case study in Alzheimer's disease patients. *BMC Health Serv Res* 2014; 14:291

13. Suehs BT, Shah SN, Davis CD, et al: Household members of persons with Alzheimer's disease: health conditions, healthcare resource use, and healthcare costs. *J Am Geriatr Soc* 2014; 62:435-441
14. Kolanowski AM, Fick D, Waller JL, et al: Spouses of persons with dementia: their healthcare problems, utilization, and costs. *Res Nurs Health* 2004; 27:296-306
15. Szabo S, Lakzadeh P, Cline S, et al. The clinical and economic burden among caregivers of patients with Alzheimer's disease in Canada. *Int J Geriatr Psychiatry*. 0.
16. Parker D, Mills S, Abbey J: Effectiveness of interventions that assist caregivers to support people with dementia living in the community: a systematic review. *Int J Evid Based Healthc* 2008; 6:137-172
17. Barman MS, Paulson D: Piloting a dementia caregiver intervention in a primary care setting. *Clin Gerontol* 2020; 0:1-12
18. Deb A, Sambamoorthi U, Thornton JD, et al: Direct medical expenditures associated with Alzheimer's and related dementias (ARD) in a nationally representative sample of older adults – an excess cost approach. *Aging Ment Health* 2018; 22:619-624
19. Schaller S, Mauskopf J, Kriza C, et al: The main cost drivers in dementia: a systematic review. *Int J Geriatr Psychiatry* 2015; 30:111-129
20. Buhr GT, Kuchibhatla M, Clipp EC: Caregivers' reasons for nursing home placement: clues for improving discussions with families prior to the transition. *The Gerontologist* 2006; 46:52-61
21. Mittelman MS, Haley WE, Clay OJ, et al: Improving caregiver well-being delays nursing home placement of patients with Alzheimer disease. *Neurology* 2006; 67:1592-1599
22. Eters L, Goodall D, Harrison BE: Caregiver burden among dementia patient caregivers: a review of the literature. *J Am Acad Nurse Pract* 2008; 20:423-428
23. Medical Expenditure Panel Survey (MEPS). Content last reviewed August 2018. Agency for Healthcare Research and Quality, Rockville, MD. <https://www.ahrq.gov/data/meeps.html>. Accessed July 10, 2020
24. Machlin S, Yu W, Zodet M. Medical Expenditure Panel Survey Computing Standard Errors for MEPS Estimates. Agency for Healthcare Research and Quality.
25. Centers for Medicare and Medicaid Services. 2018 ICD-10 CM and GEMs. Website: <https://www.cms.gov/Medicare/Coding/ICD10/2018-ICD-10-CM-and-GEMs>. Accessed July 10, 2020
26. Dunn A, Grosse SD, Zuvekas SH: Adjusting health expenditures for inflation: a review of measures for health services research in the United States. *Health Serv Res* 2018; 53:175-196
27. Andersen RM: Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav* 1995; 36:1-10
28. Deb P, Norton EC: Modeling health care expenditures and use. *Annu Rev Public Health* 2018; 39:489-505
29. Belotti F, Deb P, Manning WG, et al: Twopm: two-part models. *Stata J Promot Commun Stat Stata* 2015; 15:3-20
30. Deb P, Munkin MK, Trivedi PK: Bayesian analysis of the two-part model with endogeneity: application to health care expenditure. *J Appl Econom* 2006; 21:1081-1099
31. Chen J, Rizzo JA, Ortega AN: Racial and ethnic differences in drug expenditures and access under medicare Part D. *J Health Care Poor Underserved* 2011; 22, 1059-1059
32. Lê Cook B, McGuire TG, Zuvekas SH: Measuring trends in racial/ethnic health care disparities. *Med Care Res Rev* 2009; 66:23-48
33. Jimenez DE, Cook B, Bartels SJ, et al: Disparities in mental health service use of racial and ethnic minority elderly adults. *J Am Geriatr Soc* 2013; 61:18-25
34. Salami JA, Warraich H, Valero-Elizondo J, et al: National trends in statin use and expenditures in the US adult population from 2002 to 2013: insights from the medical expenditure panel survey. *JAMA Cardiol* 2017; 2:56-65
35. Hatfield LA, Favreault MM, McGuire TG, et al: Modeling health care spending growth of older adults. *Health Serv Res* 2018; 53:138-155
36. Cornwell P. Thousands of Washingtonians care for loved ones with dementia. During the coronavirus pandemic, some have never felt more alone. *The Seattle Times*. June, 11 2020
37. Kuo C-L, Pilling LC, Atkins JL, et al. APOE e4 genotype predicts severe COVID-19 in the UK biobank community cohort. *J Gerontol Ser A*.
38. Ames D, O'Brien JT, Burns A: *Dementia*. CRC Press, 2017
39. Vaitheswaran S, Lakshminarayanan MM, Ramanujam V, et al. Experiences and needs of caregivers of persons with dementia in India during the COVID-19 pandemic – a qualitative study. *Am J Geriatr Psychiatry*. Published online July 2020: S106474812030405X.
40. Brown EE, Kumar S, Rajji TK, Pollock BG, Mulsant BH: Anticipating and mitigating the impact of the COVID-19 pandemic on Alzheimer's disease and related dementias. *Am J Geriatr Psychiatry* 2020; 28:712-721
41. Vahia IV, Blazer DG, Smith GS, et al: COVID-19, Mental health and aging: a need for new knowledge to bridge science and service. *Am J Geriatr Psychiatry* 2020; 28:695-697
42. Holly R. HHCN survey: 92% of home health agencies have lost revenue due to coronavirus. *Home Health Care News*. June, 1 2020.
43. Wicklund E. CMS Moves to Make COVID-19 Home Health Telehealth Expansion Permanent. *mHealthIntelligence*.
44. Goodman-Casanova JM, Dura-Perez E, Guzman-Parra J, et al: Telehealth home support during COVID-19 confinement for community-dwelling older adults with mild cognitive impairment or mild dementia: survey study. *J Med Internet Res* 2020; 22:e19434
45. Padala SP, Jendro AM, Orr LC: Facetime to reduce behavioral problems in a nursing home resident with Alzheimer's dementia during COVID-19. *Psychiatry Res* 2020; 288:113028
46. Lepkowsky CM: Telehealth reimbursement allows access to mental health care during COVID-19. *Am J Geriatr Psychiatry* 2020; 28:898-899
47. Armitage R, Nellums LB: COVID-19 and the consequences of isolating the elderly. *Lancet Public Health* 2020; 5:e256
48. Patel SS, Clark-Ginsberg A. Incorporating issues of elderly loneliness into the coronavirus Ddisease—2019 public health response. *Disaster Medicine and Public Health Preparedness*. 2020:1-2. <https://doi.org/10.1017/dmp.2020.145>
49. Nicol GE, Piccirillo JF, Mulsant BH, et al: Action at a distance: geriatric research during a pandemic. *J Am Geriatr Soc* 2020; 68:922-925
50. Banskota S, Healy M, Goldberg EM: 15 Smartphone apps for older adults to use while in isolation during the COVID-19 pandemic. *West J Emerg Med* 2020; 21:514-525
51. Zubatsky M, Berg-Weger M, Morley J: Using telehealth groups to combat loneliness in older adults through COVID-19. *J Am Geriatr Soc* 2020; 68:1678-1679
52. Middleton A, Simpson KN, Bettger JP, Bowden MG: COVID-19 pandemic and beyond: considerations and costs of telehealth exercise programs for older adults with functional impairments living at home—lessons learned from a pilot case study. *Phys Ther* 2020; 100:1278-1288