Insight on the Issues

Medicare Spends More on Socially Isolated Older Adults

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Socially isolated older adults are at greater risk for poor health and death than their well-connected counterparts. However, information is lacking on whether social isolation among older adults affects health care spending. This study is the first to examine whether social isolation also affects health care spending among older adults. By examining Medicare spending data, this study found that a lack of social contacts among older adults is associated with an estimated $6.7 billion in additional federal spending annually.

INTRODUCTION

Social isolation—defined as a lack of meaningful contacts with others—is a significant risk factor for poor health status and increased mortality.[1] Older adults may be especially at risk for social isolation because they are more likely to have experiences—like the loss of friends and loved ones, or the onset of health problems—that increase their need for a strong foundation of robust social relationships.[2] Although it seems logical that older adults who lack meaningful relationships would have higher health care spending, no studies have examined this issue. Therefore, the AARP Public Policy Institute partnered with Stanford University's Center on the Demography and Economics of Health and Aging to investigate the link between social isolation and Medicare spending.[3]

Medicare is a federal insurance program that covered over 46 million people ages 65 and older in 2015. Medicare helps pay for vital health services including inpatient hospital care, preventive care, physician visits, prescription drugs, and other services.[4] This study focused on the relationship between social isolation and Medicare spending because Medicare is the primary payer for health care services for virtually all Americans ages 65 and older.

This study is the first to explore the relationship between social isolation and Medicare spending. We found that a lack of social contacts among older adults is associated with an estimated $6.7 billion in additional Medicare spending annually.

BACKGROUND

Social Isolation as a Social Determinant of Health

Social determinants of health (social determinants) are the conditions under which people are born, live, learn, work, and age that affect health, functioning, health and social risks, and overall quality-of-life.[5] The Healthy People Initiative (Healthy People)—is

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a set of national health goals and objectives with 10-year targets established by the U.S. Department of Health and Human Services in collaboration with multiple stakeholders. Healthy People tracks and measures progress towards specific health goals that have the potential to improve the health of all Americans —including measures that help track progress towards addressing social determinants of health.[6] However, the determinants of health measures do not include the quantity or quality of an individual's social contacts.[7] In short, Healthy People does not capture data on social isolation.

Addressing social determinants of health is a primary approach to achieving health equity between and within social groups.[8] Health equity is achieved when social position and other socially determined circumstances are no longer a barrier to reaching one's full potential, including optimal well-being.[9] Because social isolation is a clear risk factor for illness and death, drawing attention to it as a social determinant should create incentive for policy makers and public health officials to place more emphasis on population-based surveillance and the development of evidence-based interventions. These activities could prolong life and reduce the burden of illness and health spending.

Social Isolation among Older Adults

A focus on older adults and social isolation is appropriate because people may become more isolated as they age.[10] Loss of social contacts due to retirement, loss of loved ones and friends, and declining health may account for the effects of aging on diminished social connectedness.[11] Increased frailty[12] and disability[13] may also play a role in age-related social isolation. Poor health may lead to older adults' isolation, or they may be isolated first, which contributes to their poor health outcomes. Both causal pathways may be present. From policy and public health perspectives, however, this distinction may not matter because interventions would be similar in either case. This paper does not attempt to demonstrate causation, although it identifies potential pathways for further investigation.

Social relationships—both quantity and quality—affect mental health, health behavior, physical health, and mortality risk. Sociologists have played a central role in establishing the link between social relationships and health outcomes, identifying explanations for this link, and discovering social variation (e.g., by gender and race) at the population level. Studies show that social relationships have short- and long-term effects on health, for better and for worse, and that these effects emerge in childhood and cascade throughout life to foster cumulative advantage or disadvantage in health. This article describes key research themes in the study of social relationships and health, and it highlights policy implications suggested by this research.

METHODOLOGY

For this study, we pooled three years of data (2006,[14] 2008, and 2010) on social isolation from the Health and Retirement Study (HRS)—a biennial nationally representative longitudinal survey of Americans ages 50 and older.[15] We linked data from each HRS year to beneficiary summary claims files containing Medicare spending for health care services that respondents received after their interview and up to December 31, 2012. The study sample included adults ages 65 and older who lived in the community at the time of the HRS survey,[16] were continuously enrolled in fee-for-service Medicare Parts A or B during the study period, and survived at least one year after their initial interview. We included Medicare beneficiaries regardless of whether they also had secondary health insurance (e.g., Medicaid, Medigap, employer-sponsored insurance). The final sample consisted of 5,270 individuals, for whom we had at least one year and a maximum of seven years of Medicare spending data. We estimated a generalized linear regression model to determine whether socially isolated fee-for-service Medicare beneficiaries generate more Medicare spending under Parts A and B combined than those with more typical levels of social contact. Medicare spending for drugs under Part D was not available. Our model controlled for many variables known to influence Medicare spending and that could also be associated with social isolation, including the enrollees' health and functional status, region of residence, socioeconomic status, demographic characteristics, Medicaid coverage status, and living arrangement—all measured at

the time of the respondents' HRS interview (for a detailed methodology, see appendix A).[17]

HOW WE MEASURED SOCIAL ISOLATION

Using a methodology adapted from Cornwell and Waite (2009),[18] we created a composite score of objective isolation (see distribution in appendix A) by standardizing[19] and totaling individuals' answers to HRS questions about the following:

- Total number of children, other family members, and friends with whom they have a close relationship
- Number of friends (exclusive of other types of relationships) with whom they have a close relationship
- Whether they have different types of relationships or whether their relationships are all of a single type (e.g., relationship only with children or with children and friends)
- How often they have *any form of contact* (broadly defined as meet, talk, or write) with their children, other family members, and friends
- How often they have *in-person meetings* with their children, *or* family members, *or* friends

The composite score measures objective isolation on a continuum, with socially isolated individuals having lower scores and people with robust social contacts having higher scores. For our analysis, we converted the composite score into a discrete variable with three categories:

- Isolated
- Connected
- Well connected

We defined the socially isolated group as those individuals with a composite score of less than one standard deviation below the mean. Connected individuals had scores within one standard deviation of the mean. Well-connected individuals had composite scores of more than one standard deviation above the mean (for details on the social isolation measure, see appendix A).

To estimate the cost of social isolation to Parts A and B of the fee-for-service Medicare program, we determined the additional Medicare spending per isolated beneficiary compared with those who were in the "connected" category.

STUDY LIMITATIONS

Our results do not apply to the entire Medicare population because our sample does not include Medicare beneficiaries under age 65, individuals enrolled in Medicare Advantage, and those who were living in institutions at the time of the initial HRS survey. In addition, we were not able to examine whether Medicare spends more on drugs for socially isolated enrollees under Part D than for those with robust social connections.

SAMPLE DESCRIPTION

Based on our social connectedness variable, an estimated 14 percent of study participants were socially isolated,[20] 70 percent were connected, and 16 percent were well connected (table 1). Medicare beneficiaries in our sample were 74 years old on average and over half the respondents (57 percent) were women. Compared with those who are connected, socially isolated respondents were more likely to be male, to be white, to live in an urban area, and to have lower household income and wealth. The socially isolated were more likely to have depression, to have difficulty performing one or more activities of daily living (ADLs), and to have five or more chronic illnesses.

Notably, in this sample of older adults, being married does not necessarily mean being socially connected. We found similar proportions of socially isolated, connected, and well-connected people were married (62–63 percent for each group). Our measure of social isolation accounts for contacts with friends, children, and other family members; a person without meaningful contact aside from his or her spouse could be deemed isolated.[21] In addition, men—who are more at risk for social isolation—are also more likely to be married (and less likely to be widowed) than women. Although it would not be correct to say that marital status has no effect on social isolation, our analysis finds that marital status and objective social network and activity are not strongly correlated,[22] and that even married older people are at risk of social isolation.

TABLE 1

Some Sample Characteristics, by Social Isolation Status (Health and Retirement Study, 2006 to 2010)[a]

Characteristics			Overall		Isolated		Connected		Well Connected	
			Percentage or Mean	SD	Percentage or Mean	SD	Percentage or Mean	SD	Percentage or Mean	SD
Social isolation	Isolated		13.7%		100%		-		-	
	Connected		70.0%		-		100%		-	
	Well connected		16.3%		-		-		100%	
Medicare spending (monthly)			$1,024	$1,489	$1,215***	$1,751	$995	$1,457	$986	$1,369
Demographics	Age		74.5	7.1	74.8	7.5	74.3	7.0	74.9*	7.0
	Male		42.8%		56.1%***		41.1%		38.7%	
	Marital status	Married	62.1%		63.1%		62.0%		61.7%	
		Never married/ divorced/ separated	11.3%		15.1%**		11.1%		8.9%	
		Widowed	26.6%		21.8%**		26.9%		29.4%	
	Race	White	88.8%		91.3%*		88.4%		88.7%	
		Black	9.9%		7.6%*		10.2%		10.4%	
		Other	1.3%		1.1%		1.4%		0.9%	
Living alone			26.9%		24.4%		27.3%		27.5%	
Covered by Medicaid (Dual)			7.4%		9.8%**		7.0%		7.0%	
Number of chronic illnesses[b]	0		7.7%		8.6%		7.3%		8.6%	
	1–2		51.2%		47.5%		51.9%		51.6%	
	3–4		35.7%		36.0%		35.8%		34.8%	
	5+		5.4%		7.9%***		5.1%		5.1%	
Depression score (CES-D, range 0–8)[c]			1.27	1.8	1.71***	2.1	1.24	1.8	1.05**	1.6
Difficulty performing at least one ADL[d]			16.1%		21.7%***		15.6%		13.6%	
Employed			15.5%		14.6%		16.0%		14.3%	
Household wealth			$595,795	$1,078,990	$502,952*	$919,386	$597,752	$1,077,132	$665,178	$1,199,512
Household income			$58,198	$140,426	$52,596	$60,345	$57,858	$132,174	$64,332	$206,727
Number of respondents			5,270		724		3,681		865	

Source: *Authors' analysis of Health and Retirement Study data linked with Medicare Claims, 2006–12.*

Note: *The table shows unweighted percentages (%) or means. SD= standard deviation. Significance tests evaluate differences compared to the connected group; p-values: * p < 0.05, ** p < 0.01, *** p < 0.001.*

[a] *Isolated = composite score of objective isolation one standard deviation below the mean; Connected = those within one standard deviation above and below the mean; Well connected = scores one standard deviation above the mean.*

[b] *Chronic illnesses refer to high blood pressure, diabetes, lung disease, heart attack/heart disease, cancer, stroke, and arthritis.*

[c] *CES-D = Center for Epidemiologic Studies Depression Scale; higher scores reflect greater levels of depression.*

[d] *ADL = activity of daily living.*

PRINCIPAL FINDINGS

After controlling for a large number of baseline variables known to influence Medicare costs, we found that the program spent an estimated $134 more monthly ($1,608 annually) for each socially isolated older adult than it did for those in the connected category who had more typical levels of social contacts. This additional spending is comparable to what Medicare pays for certain chronic conditions, such as high blood pressure and arthritis (figure 1; see full results in appendix B).

To put this increased spending in perspective, about 30 million people ages 65 and older were enrolled in fee-for-service Medicare in 2012.[23] Generalizing from the study sample to the overall fee-for-service population, approximately 4 million of those enrollees were socially isolated, with total additional expenditures of $6.7 billion annually.

The increased spending for socially isolated Medicare beneficiaries consists partly of additional skilled nursing facility (SNF) spending (see table 2). Relative to those who were connected, socially isolated individuals were 29 percent more likely to use SNF care and their monthly SNF costs were $75 higher on average.

In contrast, people who were socially isolated were not significantly more likely to use inpatient care than those who were not. But when a socially isolated person was admitted to the hospital, Medicare paid more than it would have if the person were connected, by an average of $81 per beneficiary per month.

This increase in inpatient spending without a similar increase in use suggests that socially isolated individuals may be sicker when hospitalized, or may lack the support necessary to transition out of the hospital as quickly as connected individuals. In addition, when leaving the hospital, a lack of community support may be driving the higher use of SNF care for rehabilitation. In this study, we found no difference in outpatient use or spending for socially isolated Medicare beneficiaries.

FIGURE 1

Additional Monthly Cost to Medicare for a Socially Isolated Enrollee and for an Enrollee with Selected Chronic Conditions

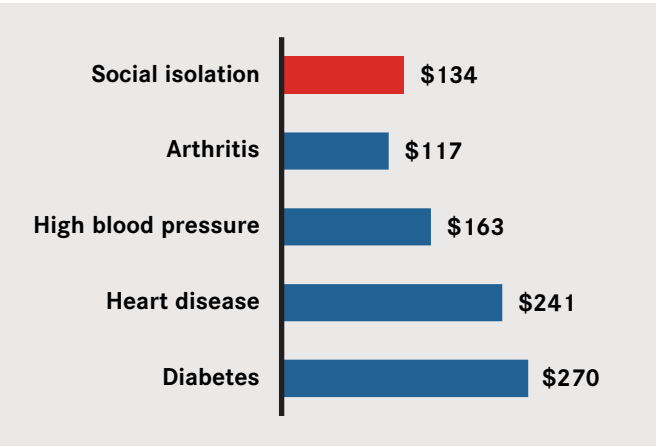


TABLE 2

Effects of Social Isolation on Monthly Medicare Spending and Likelihood of Service Use, by Type of Service *(Health and Retirement Study, 2006 to 2010)*

Type of Service	Marginal Spending per Month	Service Use[a]
Total	+ $134.0**	-
Inpatient	+ $81.0**	1.02
Outpatient	- $5.8	0.92
Skilled Nursing Facility	+ $74.5**	1.29*

Source: *Authors' analysis of Health and Retirement Study data linked with Medicare Claims, 2006–12.*

Note: *Effect is for individuals who are socially isolated compared with a reference group of people who are connected. All models include full adjustment for health and functional status, region of residence, socioeconomic status, demographic characteristics, whether the respondent is covered by Medicaid, and living arrangement. Significance tests evaluate differences with the not-isolated group; p-values: * p < 0.05, ** p < 0.01.*

[a] *Adjusted incidence rate ratio for inpatient and outpatient spending, adjusted odds ratio for skilled nursing facility.*

In addition to differences in the cost and use of health care services, we also found that subsequent risk of death is about 50 percent higher for those who are socially isolated at baseline (see table 3). This increased mortality is consistent with prior research.[24]

TABLE 3
Socially Isolated Older Medicare Beneficiaries Have Higher Death Rates Three and Six Years after Baseline Interview

Time after Baseline Interview	Group	Percentage Dying	Compared with Connected Group
Three Years	Well connected	8.9%	0.83
	Connected	10.6%	1.00
	Isolated	16.3%	1.53
Six Years	Well connected	22.3%	0.93
	Connected	24.0%	1.00
	Isolated	35.3%	1.47

About 35 percent of isolated older adults died within six years of the initial interview, compared with 24 percent of those connected and 22 percent of those well connected. These figures are unadjusted percentages and do not control for baseline sociodemographic, health, and factors related to functional status in the three groups. However, even in a model controlling for all these variables, we found that socially isolated individuals had a 31 percent higher risk of death than those who were not socially isolated.[25]

The difference in death rates suggests that isolated individuals may have poorer health trajectories (i.e., their health could be declining faster than the health of people with more robust social contacts). Although this analysis controlled for health status at the time of the initial interview, we were not able to measure health status after the baseline assessment.

FUTURE RESEARCH

This study based the operational definition of isolation on a composite of several items. More research is needed to determine the relative effect of different types of social relationships on Medicare spending and to better understand the mechanisms that link social isolation to higher Medicare spending. In addition, this study can only generalize to the age 65 and older fee-for-service Medicare population. Further research is needed to determine if additional expenditures due to social isolation are present for Medicare Advantage enrollees ages 65 and older and Medicare enrollees younger than 65—a total of 20 million people fall into these two groups.[26] In addition, future research should examine the relationship between social isolation and Medicare spending on drugs. Last, it should be noted that Medicaid—a federal and state partnership that pays the cost of medical care for some people with limited income and resources—not Medicare, is the primary payer for long-term services and supports (LTSS) in both institutional and community settings. LTSS consist of a broad range of day-to-day help needed by people with long-term conditions, disabilities, or frailty, including personal care, transportation, household management, and other social services. Therefore, future research should examine the relationship between social isolation among older adults and Medicaid spending.

POLICY IMPLICATIONS

The human costs of social isolation among older adults are high: socially isolated older adults tend to have poorer health and higher mortality risks. This study—the first to look at the relationship between social isolation and Medicare spending—reveals that a lack of social contact is also associated with increased Medicare spending. This is true even after controlling for a large number of variables known to influence Medicare spending.

Of course, social isolation is not inevitable as people age: Most older adults (86 percent in this study's sample) are not isolated. But for those older adults who have poor social connections, these findings present an opportunity for state and federal policy makers, along with private-sector actors, to identify promising interventions to alleviate isolation. This could help improve Medicare beneficiaries' health and quality of life, while potentially saving the program money.

The following are some approaches that federal and state governments, in partnership with private-sector actors, should consider:

- Fund the development of a valid and reliable tool to screen beneficiaries for social isolation, keeping in mind that marital status and widowhood are not necessarily reliable markers of social isolation.
- Fund public–private partnerships to identify and test interventions—including health prevention and promotion activities—for social isolation that are culturally competent and that consider differences in socioeconomic status, marital status, mental and functional health status, and chronic illness status. Interventions should explore the desirability and feasibility of using technology to reduce isolation among older adults.
- After a valid and reliable screening tool is developed and well-tested interventions are identified, require providers to use the tool during the Welcome to Medicare and annual wellness visits.
- Elevate the discussion of social isolation in the public health community.
- Take steps to ensure that social isolation becomes a part of the lexicon of social determinants of health by, for example, including it as a social determinant in official documents published by the federal government.

APPENDIX A. METHODS

Data Sources

This study uses pooled data from three waves (2006, 2008, and 2010) of the Health and Retirement Study (HRS)—a biennial, nationally representative, longitudinal survey of Americans ages 50 and older.[1] Although the HRS started in the early 1990s, it did not begin to regularly collect data on participants' life circumstances, subjective well-being, and social relations—through its supplemental Psychological &Lifestyle Questionnaire—until 2006. We linked data from each of the HRS years (2006, 2008, 2010) to beneficiary summary claims files that contained Medicare spending data for health care services that respondents received after their interview and up to December 31, 2012.

Study Sample

For participants in more than one of the three HRS waves, we used information from only their earliest interview to create a sample of unique respondents (N = 10,772). We constructed our analytic sample by excluding Medicare enrollees under age 65 (N = 1,334) and those living in a nursing home at the time of their HRS interview (N = 26).

We further restricted our sample to beneficiaries continuously enrolled in fee-for-service Medicare Parts A or B[2] (N = 5,938). We included Medicare beneficiaries regardless of whether they also had secondary health insurance (e.g., Medicaid, Medigap, employer-sponsored insurance). We also excluded participants who died less than a year after their HRS interview (N = 171) because Medicare spending in the last year of life can differ significantly from earlier spending. Finally, we excluded foreign residents and respondents with missing data (N = 497).

Our final analytical sample consisted of 5,270 HRS respondents who had between 1 and 7 years of post-interview Medicare spending data, depending on when they were first interviewed. For respondents who died or left the study before the end of 2012, we used Medicare spending data for the health care services they received up to their death or up to when they left the survey. On average, respondents in our sample had 4.7 years of Medicare spending data.

Measure of Objective Isolation

To measure social isolation, we adapted a methodology developed by Cornwell and Waite[3] using the National Social Life, Health, and Aging Project (NSHAP). While NSHAP and the HRS generally ask similar questions about respondents' social interactions, there is some variation in question wording between the two surveys.

Following the steps outlined by Cornwell and Waite, we started by including a broad range of variables that potentially measure social connectedness in a composite score. Appendix table A1 lists the 16 variables that we initially considered. To create

APPENDIX TABLE A1

Initial Set of Variables Measuring Social Connectedness

1. Size of social network
2. Diversity in the types of relationships
3. How often has social contact
4. Count of friends in social network
5. How often meets up with children
6. How often meets up with family
7. How often meets up with friends
8. Living arrangement
9. How often participates in groups or clubs
10. How often volunteers
11. How often attends religious services
12. Has living children
13. Has other immediate family (e.g., brothers, sisters)
14. Has friends living close by
15. Has a child living within 10 miles
16. Has a child living within 2 blocks

1 For more information on the Health and Retirement Study, visit http://hrsonline.isr.umich.edu/.

2 Medicare spending data were not available for those receiving benefits through Medicare Advantage.

3 Erin York Cornwell and Linda J. Waite, "Measuring Social Isolation among Older Adults Using Multiple Indicators from the NSHAP Study," *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 64B, suppl. 1(2009, November): i38–46.

an internally consistent composite measure of social isolation, we sequentially eliminated nine indicators (items 8 through 16 in appendix table A1) with low item-rest correlation (correlation < 0.3)—an indication that the variable was not highly *correlated* with the overall social isolation scale. In particular, we excluded the measure of respondents' living arrangements, which has been used to capture people's social contacts. We tested a binary indicator of whether the respondent lived alone as well as a continuous measure for the total number of household residents. In both cases, the item-rest correlation did not reach the 0.3 threshold such that including these variables reduced the shared variance among scale items. Others have reported a similar finding that living arrangement is not necessarily a good indicator of social isolation.[4]

To create our final composite score of objective isolation, we standardized[5] and summed coded responses to seven HRS questions about the following characteristics:

- Size of social network measured as the total number of children, other family members, and friends with whom respondents have a close relationship
- The number of friends (exclusive of other types of relationships) with whom respondents have a close relationship
- Whether respondents have different types of relationships or whether their relationships are all of a single type
- How often respondents are in contact (broadly defined as meet, talk, or write) with their children, other family members, and friends
- How often respondents meet up with their children
- How often respondents meet up with other family members
- How often respondents meet up with friends

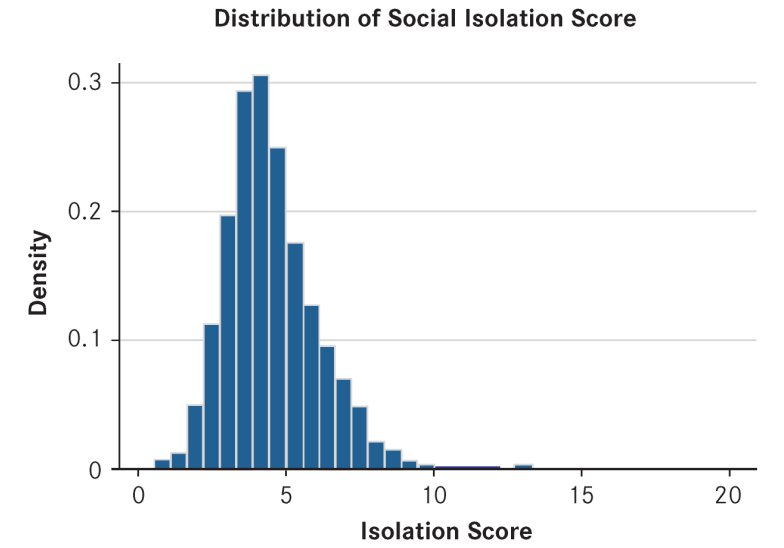
Socially isolated respondents had lower scores than those who were socially connected.

Using factor analysis, we verified that all seven items in our scale measured a single concept. Our composite scale had good internal consistency, with a Cronbach alpha coefficient of 0.72.[6]

Appendix figure A1 shows the distribution of the composite score of social isolation. Appendix table A2 shows the percentiles for this variable.

APPENDIX FIGURE A1

Distribution of the Composite Score of Objective Isolation



Source: *Authors' analysis of Health and Retirement Study data linked with Medicare Claims, 2006–12.*

Note: *Socially isolated respondents have lower scores than those who were socially connected.*

4 Ibid.; Linda J. Waite and Mary Elizabeth Hughes, "At Risk on the Cusp of Old Age: Living Arrangements and Functional Status among Black, White, and Hispanic Adults," *Journal of Gerontology* 54B (1999): S136–44.

5 Standardized variables are rescaled to have a mean of zero and a standard deviation of one. Such variables contribute evenly when they are summed into a composite score.

6 Cronbach's alpha coefficient measures a scale's internal consistency—or how closely related a set of items in a scale are. As a rule of thumb, a coefficient of 0.70 or higher indicates that the scale has good internal consistency.

The goal of this study was to understand the implications of social isolation as a social status. Our focus was not to examine differences associated with a person's *degree* of social isolation. Consequently, for the analytical models, we converted the composite score into an ordinal categorical variable[7] with three categories:

- **Isolated:** Composite scores below one standard deviation from the mean
- **Connected:** Composite scores within one standard deviation above and below the mean
- **Well Connected:** Composite scores above one standard deviation from the mean

Measure of Medicare Spending

Using the information in the beneficiary summary claims files, we calculated average monthly Medicare spending under Parts A and B for each person in the analytical sample. We did not have data on Medicare spending for drugs under Part D. For all respondents, we calculated the total amount of Medicare spending between their interview and their last available claim date (December 31, 2012, or earlier if they died or left the study prematurely). We then divided total spending by the number of months in each respondent's follow-up period. We inflated all spending amounts to 2012 dollars using the Consumer Price Index.[8]

Other Variables

In addition to our key measure of objective isolation, our analytical models controlled for several variables known to influence Medicare spending. We measured all control variables at the time of the respondent's HRS interview. These variables were the following:

- Demographic characteristics—that is, age, sex, race, education, marital status
- Socioeconomic status—that is, income, wealth, employment status

APPENDIX TABLE A2

Percentiles for the Composite Score of Objective Isolation

Variables	
1%	1.619
5%	2.333
10%	2.762
25%	3.476
50%	4.306
75%	5.381
90%	6.663
95%	7.444
99%	9.603

Source: *Authors' analysis of Health and Retirement Study data linked with Medicare Claims, 2006–12.*

- Geographic region—that is, region where respondents live[9] and whether respondents live in an urban area
- Health and functional status—that is, chronic conditions (high blood pressure, diabetes, lung disease, heart disease, cancer, stroke, arthritis), difficulty performing activities of daily living, depression, history of smoking, current alcohol use, and body mass index
- Whether the respondent lives alone
- Whether the respondent is covered by Medicaid (dual)

Finally, the models included the year of respondents' initial interview.

Statistical Models

We estimated a multivariate regression using a generalized linear model to determine whether socially isolated respondents generate more spending by Medicare than those who are in the "connected" category and have more typical levels

7 An ordinal categorical variable has two or more categories with an intrinsic order (e.g., low, medium, and high).

8 We used the Consumer Price Index for all urban consumers (CPI-U), computed by the Bureau of Labor Statistics.

9 The HRS classified each respondent as living in one of the nine following geographic regions: (a) Northeast Region: New England, (b) Northeast Region: Mid-Atlantic, (c) Midwest Region: East North Central, (d) Midwest Region: West North Central, (e) South Region: South Atlantic, (f) South Region: East South Central, (g) South Region: West South Central, (h) West Region: Mountain, and (i) West Region: Pacific.

of social contacts. The model assumed a Gamma-distributed error term with a log-link function; this is a standard approach for health care expenditures that have a skewed distribution. To ensure that our estimates are nationally representative, we used the HRS population weights and took into account the study's complex sampling design by adjusting for clustering of respondents within regions.

APPENDIX B: DETAILED RESULTS

APPENDIX TABLE B1

Generalized Linear Model Predicting Monthly Medicare Spending for Each Beneficiary *(2012 USD)*

Variables		
Social Isolation[a]	**Isolated**	**134.0*****
	Connected	Reference
	Well connected	−22.35
Age Category	65–69	Reference
	70–74	267.6***
	75–79	326.7***
	80–84	554.4***
	85+	591.9***
Male		86.22**
Married		−25.75
Race	White	Reference
	Black	152.7**
	Other	−336.5***
Living Alone		−28.73
Covered by Medicaid (dual)		237.4***
Education	< 12 years	−58.12
	12–15 years	33.77
	16+ years	Reference
Body Mass Index	< 20	135.1
	20–24	Reference
	25–29	−22.29
	30–34	24.67
	35+	99.44
Household Wealth	< $0	207.6
	$0–$50,000	110.9**
	$50,000–$150,000	15.83
	$150,000–$250,000	107.1
	$250,000–$350,000	117.5*
	> $350,000	Reference
Currently Employed		−225.1***
Household Income	$0–$30,000	46.91
	$30,000–$50,000	22.94
	$50,000–$70,000	47.92
	$70,000–$90,000	86.20
	$90,000+	Reference
Urban Resident		152.3***

Variables		
Geographic Region	Northeast Region: New England Division	Reference
	Northeast Region: Mid-Atlantic Division	177.8***
	Midwest Region: East North Central Division	-22.99
	Midwest Region: West North Central Division	-1.580
	South Region: South Atlantic Division	110.1***
	South Region: East South Central Division	-103.6***
	South Region: West South Central Division	200.6***
	West Region: Mountain Division	-30.93
	West Region: Pacific Division	56.06**
Comorbid Conditions	High blood pressure	163.4***
	Diabetes	269.5***
	Lung disease	313.1***
	Heart attack/heart disease	241.4***
	Cancer	256.9***
	Stroke	224.8***
	Arthritis	116.9*
CES-Depression Score[b]		37.79***
Lonely		-68.34***
Number of ADL Impairments[c]		161.1***
Ever Smoker		118.5***
Current Alcohol Use		-47.74
HRS Wave Year	2006	Reference
	2008	-95.50***
	2010	-262.4***
Sample Size		5,270

Source: *Authors' analysis of Health and Retirement Study (HRS) data linked with Medicare Claims, 2006–12.*

Note: *Results are from a generalized linear model, using a Gamma-distributed error term with a log-link function. Statistical significance: * p < 0.1, ** p < 0.05, *** p < 0.01.*

[a] *Isolated = isolation score is one standard deviation below the mean; Connected = isolation score is within one standard deviation above and below the mean; Well-connected = isolation score is one standard deviation above the mean.*

[b] *CES-Depression = Center for Epidemiological Studies Depression Scale; scores range from 0 to 8, with higher scores indicating greater depression levels.*

[c] *ADL = Activity of daily living.*

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3 Jonathan G. Shaw et al., "Social Isolation and Medicare Spending: Among Older Adults, Objective Isolation Increases Expenditures while Loneliness Does Not," *Journal of Aging and Health*, Volume 29, No. 7, October 2017. For more information on Stanford University's Center on the Demography and Economics of Health and Aging, visit http://healthpolicy.fsi.stanford.edu/research/center-demography-and-economics-health-and-aging.

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14 In 2006, the Health and Retirement Study (HRS) introduced a leave-behind Psychosocial & Lifestyle Questionnaire to supplement interviews with questions on social relationships, activities, and perceptions.

15 For more information about the HRS, visit http://hrsonline.isr.umich.edu/.

16 Individuals who were subsequently institutionalized remained in the study sample.

17 The year of a respondent's first interview determined the number of years for which Medicare spending data were available. Respondents who died or left the study before the end of 2012 had Medicare spending data for services received after their interview and up to their death or survey exit date. On average, respondents in the sample had 4.7 years of Medicare spending data.

18 Cornwell and Waite (2009) developed their social isolation scale using the National Social Life, Health, and Aging Project (NSHAP) survey. Although NSHAP and the HRS generally ask similar questions about respondents' social interactions, some variation occurred in question wording between the surveys.

19 Standardized variables are rescaled to have a mean of zero and a standard deviation of one. Such variables contribute evenly when they are summed into a composite score.

20 AARP Foundation, *Framework for Isolation in Adults over 50* (Washington, DC, AARP Foundation, 2012), http://www.aarp.org/content/dam/aarp/aarp_foundation/2012_PDFs/AARP-Foundation-Isolation-Framework-Report.pdf.

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22 Cornwell and Waite (2009) considered marital status (and number of children and grandchildren) for their social isolation scale but dropped these due to low item-total correlation. It is not surprising that this study's scale, based on Cornwell and Waite (2009), also finds that marital status and social isolation are not strongly linked.

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25 For a complete analysis, see Shaw et al., "Social Isolation and Medicare Spending."

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