

EXAMINING THE ROLE OF SOCIAL ISOLATION ON HOSPITALIZATIONS,
NURSING HOME ENTRY, AND MORTALITY AMONG OLDER ADULTS

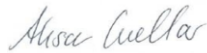
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DEDICATION

This dissertation is dedicated to my grandparents, whose devotion and investments in my education, happiness, and wellbeing equipped me with a love for older adults and a passion for pursuing work that improves outcomes and quality of life for aging populations. This includes Julia Mills Jacobsen, who firmly believed that education was the best investment a person could make; Lawrence “Jake” Jacobsen, the smartest and kindest of all the Jacobsens; Mary Lou Scott Gallucci, whose tenacity still inspires me to press forward; and Salvatore Gallucci, my close childhood confidant whose story-telling enriched my life and will forever delight all who knew him.

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LIST OF ABBREVIATIONS

Activities of daily living ADLs
Alzheimer's disease or related dementiasADRD
English Longitudinal Study of Ageing ELSA
Health and Retirement Study HRS
Home and community-based servicesHCBS
Independent activities of daily living IADLs

ABSTRACT

EXAMINING THE ROLE OF SOCIAL ISOLATION ON HOSPITALIZATIONS, NURSING HOME ENTRY, AND MORTALITY AMONG OLDER ADULTS

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Dissertation Director: Dr. Gilbert Gimm

Social isolation affects a quarter of older adults in the United States, complicating efforts for Americans who wish to age at home or in the community. Social isolation is a key risk factor for adverse health outcomes and high health care costs, and is expected to have increased during COVID-19 due to social distancing efforts. However, little research has examined the impact of social isolation on health care utilization. Literature in this area tends to be conducted internationally, uses short follow-up times, measures social isolation through single-item variables, and usually does not control for both social isolation and loneliness in the same sample. No prior studies have examined the association between social isolation and nursing home entry in a United States-based sample. This dissertation includes three studies that expand knowledge on the associations between social isolation and hospitalization, nursing home entry, and mortality in a nationally-representative sample of community-dwelling Americans ages 65 and older. Data from the Health and Retirement Study were used to construct a multi-domain measure of social isolation while controlling for loneliness. The first study uses a panel data analysis to examine whether social isolation was associated with overnight

hospital stays, nursing home entry, and mortality among older adults tracked between 2006 and 2018. The second study uses a time-to-event analysis to examine whether social isolation is associated with earlier time to long-term nursing home placement (residency of 100+ days) and mortality over ten years. The third study provides an exploratory, cross-sectional analysis to examine whether use of senior services moderates the association between social isolation and nursing home entry among respondents interviewed between 2010 and 2012. Results demonstrate that social isolation is significantly associated with increased nursing home entry and early mortality. Research examining the association between social isolation and health care utilization has important implications for the expansion of home and community-based services under Medicaid and billing codes to cover screening, referral, and treatment under Medicare. Future research should evaluate whether initiatives that enhance social connections in home or community-based settings are effective in offsetting nursing home entry, reducing premature mortality, and curbing health care costs for patients and payers.

I. INTRODUCTION

Purpose

With the aging of the United States population, a growing number of older adults prefer to “age in place” at home or in community-based settings as opposed to in nursing homes.^{1,2} Nursing home entry is costly for older adults and for payers such as Medicaid.³ However, social isolation limits the ability to age in place for more than a quarter of community-dwelling older adults,^{4,5} even as the prevalence of social isolation greatly increased during the COVID-19 pandemic due to social distancing efforts.⁶

Social isolation is an important risk factor for adverse health outcomes in older adults (i.e., age 65 years or more).^{7,8} It is associated with fatigue, obesity, falls, cardiovascular disease, poor mental health, cognitive impairment, and a 30% increase in mortality risk.^{4,9} Social isolation is also associated with higher health care costs. Older adults who are socially isolated incur more than \$6.7 billion in additional Medicare spending per year on hospitalizations, emergency room visits, and short-term rehabilitation stays.^{10,11}

However, most studies in the literature examine subjective or perceived social isolation, also known as loneliness. Other studies use single-item proxy measures of actual social isolation, such as living alone or number of social contacts, that do not fully capture the multidimensional nature of social isolation.¹¹⁻¹⁶ Very few studies control for

both loneliness and social isolation in their analyses.^{4,5,17-19} Although the two concepts of loneliness and social isolation appear to be similar at first glance, they are distinct measures that independently predict poor health.⁴

Moreover, prior research that examines the role of social isolation on health care utilization is limited with mixed findings. While some research suggests that social isolation is associated with increased health care utilization, these earlier studies used rudimentary measures of social isolation, often conflating social isolation with loneliness. Additionally, the handful of studies on this topic focus on acute care services instead of long-term care, and measure outcomes with binary indicators (e.g., yes/no). Consequently, it remains unclear whether objective social isolation is a contributing factor that leads to 1) hospitalizations, 2) nursing home entry, and 3) early mortality while controlling for loneliness. Additional research is needed to address this gap.

Social support is integral to an effective recovery at home after a hospitalization. If hospital staff identify that social support at home is limited or unavailable, they may arrange for the patient to recover in a post-acute care facility. Furthermore, a lack of any social support can make it more difficult for an older adult to manage activities of daily living (ADLs; e.g., bathing, dressing, etc.) and independent activities of daily living (IADLs; e.g., managing medications, paying bills, etc.) that are needed to live safely and independently in the community. To obtain assistance with multiple IADL or ADL needs, older adults who are socially isolated may be forced to transition to nursing homes due to a lack of adequate support. Nursing home entry can lead to greater detachment from the

community²⁰ and in turn, a greater risk of poor mental health and mortality for socially isolated older adults.

Findings from this dissertation have policy implications for Medicare spending and Medicaid home and community-based services (HCBS). Unlike loneliness, social isolation is an objective condition (e.g., frequency of social contacts) that can be addressed more directly by policy interventions. If social isolation does lead to greater use of hospitals and nursing homes, then policies to embed more frequent points of contact for socially isolated older adults may delay nursing home entry or reduce avoidable hospitalizations. For example, Medicaid could expand the availability of HCBS for older adults at greater risk of social isolation, thereby increasing contact and support.

Specific Aims

To assess whether social isolation puts older adults at risk for increased hospital stays, nursing home entry, and early mortality over time, this dissertation used nationally-representative, longitudinal panel data (2006-2018) from the Health and Retirement Study (HRS) to address the following aims.

Aim 1. Examine the risk of hospitalization for socially isolated older adults compared to older adults who are not socially isolated, while controlling for loneliness.

Aim 2. Determine whether socially isolated older adults are more likely to enter a nursing home, and whether there are longitudinal differences in the time to nursing home entry for older adults who are socially isolated as opposed to those who are not isolated.

Aim 3. Assess whether socially isolated older adults are at greater risk for early mortality compared to older adults who are not socially isolated.

Aim 4. Test whether the relationship between social isolation and nursing home entry is moderated by the receipt of senior services.

Structure

This dissertation includes three studies that examine the role of social isolation on hospitalizations, nursing home entry, and mortality using different analytical approaches to address the specific aims. The three studies are based on the same literature and conceptual framework, which are presented as background information in Chapter II. Each study uses HRS data and similarly constructed variables. The methods common to all three studies are discussed in Chapter III. However, the distinct analytical approach unique to each study, as well as each study's results and interpretation of findings, are discussed in Chapters IV, V, and VI.

The first study, described in Chapter IV, examines whether socially isolated adults ages 65 or older who were followed between 2006-2018 were more likely to 1) be hospitalized, 2) enter a nursing home, or 3) experience mortality compared to older adults who were not socially isolated. To conduct the analyses, six waves of HRS data were combined to examine whether social isolation and covariates in a given year were associated with each outcome before a biennial follow-up interview two years later. The study uses a composite social isolation score that includes marital status, living arrangement, social contacts with children, friends, and family, and participation in groups, clubs, organizations, or religious services. My findings suggest that social isolation may be associated with increased rates of nursing home entry and mortality, but not hospitalizations.

The second study examines whether social isolation is associated with earlier time to 1) long-term nursing home placement and 2) mortality over the course of ten years among a sample of community-dwelling older adults. Parametric, case II interval-censored, proportional hazards regression models were fit to the event-time data to estimate the relationships between social isolation and each outcome over time. Social isolation was defined as having a total score greater than or equal to 3 among participants. Results from this dissertation show a significant relationship between social isolation and earlier time to long-term nursing home placement and death.

Finally, the third study provides an exploratory analysis of whether senior service use may moderate the effects of social isolation on subsequent nursing home entry among a cross-section of older adults followed between 2010-2012. Survey sampling weights were applied to adjust for the complex survey design of HRS and produce nationally representative estimates. The senior services are derived from a list of services that may represent HCBS according to prior research using HRS data.²¹ After adjusting for senior service use, my findings suggest that social isolation is associated with lower odds of nursing home entry; however, when social isolation is combined with senior service use, the odds of nursing home entry increased. Though senior service use and Medicaid status were only weakly to moderately correlated, the degree to which senior services represent HCBS that proxy for Medicaid, reflecting older adults with low enough incomes to have long-term nursing home care covered, is unclear. Nevertheless, the exploratory analysis has implications for the use of Medicaid-covered HCBS by socially isolated older adults.

II. BACKGROUND

Significance

People are highly social beings who need interpersonal interactions to maintain health and well-being. Social connections affect health by influencing lifestyle, mental health, and medical compliance,²² as well as direct biological pathways.²³ A lack of social connection is of particular concern for older adults, who are more likely to experience health problems that necessitate social support to age successfully in place.²⁴

Social isolation is associated with adverse health outcomes, including fatigue,²⁵ sleep impairments,^{12,25,26} functional limitations,^{12,27} falls,^{13,28} diabetes,²⁹ cardiovascular disease,^{22,29-31} poor mental health,^{17,25,29,32-34} cognitive impairment,^{29,35-39} and a 30% increase in mortality risk.^{4,7,7-9,18,40} The relationship between social isolation and health outcomes is so strong that it is thought to rival the effects of well-established risk factors such as cigarette smoking, physical inactivity, and obesity.^{4,41,42} Despite the risk of several adverse health outcomes, about 25% of adults ages 65 or older are socially isolated.^{4,5}

Defining Social Isolation and Loneliness

The harmful effects of social isolation, as well as loneliness, on the health of older adults garnered increased attention due to social distancing efforts under COVID-19. However, these two concepts are distinct measures. Social isolation is the objective lack of social contact with others,^{4,43} whereas loneliness refers to the subjective state of feeling alone or perceived isolation.^{4,22,24,43-46} Actual social isolation can thus be a predisposing

factor for loneliness,⁴⁷ but the two conditions of loneliness and social isolation do not always co-occur. For example, a socially isolated older adult may not feel lonely (e.g., an introvert living happily and independently with a beloved pet), while a lonely individual may not be socially isolated (e.g., a person in an unhappy marriage).²⁴ Though often conflated, the two concepts of loneliness and social isolation are not highly correlated^{33,48} as they independently predict poor health.⁴

Implications for Policy

While loneliness has received the bulk of attention in the past literature, the objective concept of social isolation is important for policymakers to understand because of its cost and impact on public health. Social isolation is associated with an estimated \$6.7 billion in additional Medicare spending each year.^{10,33} In turn, programs and policies that bolster social connections may lead to reduced spending. Yet the mechanisms by which social isolation affects health care utilization are not well understood. By understanding how social isolation impacts health and spending among older adults, policymakers and payers can improve the allocation of resources needed to promote preventive services while curtailing costly or avoidable care. In assessing the relationship between social isolation and health care utilization, this dissertation seeks to inform policy and reduce the medical, economic, and personal impacts that social isolation has on older adults who strive to age in their communities as opposed to institutional settings.

Review of Past Literature

An influential 2020 report by the National Academies of Science, Engineering, and Medicine synthesized the state of the literature on social isolation and loneliness.⁴

The report solidifies the evidence for social isolation as a strong predictor of poor health outcomes. However, it also highlights the need for additional research on how social isolation affects health care utilization. The report concludes that literature on social connection and health care utilization focuses more on the role of loneliness than social isolation and that research examining social isolation yields mixed findings.^{4(chap7-6)} In addition to the work synthesized by this report, several research studies have explored the relationships between social isolation, hospitalizations, nursing home entry, and mortality.

Social Isolation and Hospitalizations

The limited number of research studies examining the relationship between social isolation and hospitalization have yielded mixed results, with some evidence suggesting a positive association. The first wide-ranging study to examine the effect of social isolation on Medicare spending was published in 2017 and used three waves of HRS data.^{10,33} The study measured the association of the two concepts of loneliness and social isolation with mean monthly spending per beneficiary, annual spending per beneficiary, Medicare reimbursement by type of care (i.e., inpatient, outpatient, and skilled nursing facility care), and likelihood of death. To conduct the study, the authors linked participant responses to Medicare beneficiary summary files for about five thousand traditional Medicare beneficiaries (i.e., continuously enrolled in Parts A or B). A scaled measure of objective social isolation was constructed from responses to HRS social connectedness questions about 1) social network size, 2) network range, 3) number of close friends, 4)

how often respondents were in contact with children, family, or friends, and, 5) how often respondents met in person with children, 6) family, and 7) friends.^{10,33}

Overall, social isolation was present in about 14% of the sample and associated with approximately \$6.7 billion in additional federal Medicare spending annually.¹⁰ Objective social isolation was predictive of higher costs, in part, due to more concentrated spending on hospitalizations; isolated beneficiaries spent about \$85 more per month on inpatient care than those who were not isolated. In contrast, loneliness was present in about 55% of the sample and was associated with reduced overall spending after controlling for socioeconomic and health-related variables – before which it was positively associated with spending. However, the study did not examine outcomes for Medicare Advantage enrollees and was limited to three waves of data. As of this writing, research using HRS datasets can allow for longitudinal analyses that span over a decade.

A study that did examine Medicare Advantage enrollees covered by a private payer in the Northwest found that beneficiaries who endorsed being socially isolated in a Medicare assessment were at higher odds for hospitalization and emergency room visits.¹¹ However, the study's focus on residents in the Northwest may inadequately represent the relationship between social isolation and hospitalization for individuals in other parts of the country. Additionally, a major drawback of this study was that the social isolation measure was limited to one question that measured subjective isolation.¹¹ While short and simple assessments are desirable, single-item assessments of social isolation are known to be insufficient and problematic.²² For example, meta-analytic data demonstrate that multivariate measures of social relationships yield data that is more

predictive of outcomes like mortality (OR=1.91) than simplistic measures (OR=1.19).¹⁸ Also, findings from this study may not be generalizable to Medicare beneficiaries in fee-for-service settings, and the sample was limited to individuals with scheduled medical wellness visits.

Social Isolation and Nursing Home Entry

Evidence on social isolation as a risk factor for nursing home entry is extremely limited. The study by Shaw et al. described above found that social isolation was predictive of higher Medicare spending due in part to higher costs associated with post-acute care in skilled nursing facilities.^{10,33} Socially isolated beneficiaries spent about \$74 more per month on skilled nursing care than those who were not isolated. In contrast, the association between loneliness and spending on skilled nursing care was not statistically significant. Similarly, research using the English Longitudinal Study of Ageing (ELSA) of older adults in the United Kingdom found that loneliness, measured by the UCLA loneliness scale, was not significantly associated with an increased risk of nursing home admission after sensitivity analyses limited the sample to older adults with data on social isolation.⁴⁹ These studies suggest that objective social isolation may be more robust than loneliness in its association with nursing home stays.

Older adults who are married tend to enter nursing homes later than their unmarried counterparts.⁵⁰ Care recipients who have a heightened sense of community are also significantly more likely to remain in the community over time.⁵¹ Similarly, living alone has been associated with greater odds of nursing home placement.⁵² A longitudinal, nationally representative cohort study using HRS data found that older adults who lived

alone and faced a health shock were more likely to experience prolonged nursing home stays (i.e., greater than 30 days) if they reported not having someone who could help them with basic personal care activities over an extended period of time. However, a lack of social support was not associated with long-term care stays in the absence of a health shock.¹⁶ Social isolation in aging populations has also been linked to a higher risk of falling,¹⁷ poor cognitive functioning,^{35,50,53} and Alzheimer's disease or related dementias (ADRD),^{4,54-56} which are predictive of earlier long-term nursing home placement in their own right.^{50,52}

In theory, individuals who lack social supports for recovery at home may be more likely to discharge to nursing homes for post-acute care following hospitalization.³³ Similarly, individuals who are more socially isolated might have fewer supports to age in place, making them more prone to transition from the community to an institutional care setting. However, no research to date has been conducted using a multidimensional measure of social isolation as a risk factor for long-term nursing home placement while accounting for loneliness at the same time.

Social Isolation and Mortality

International literature decisively shows that social isolation is associated with mortality in samples of older adults. However, most studies that have jointly examined the impacts of social isolation and loneliness on mortality using population-based samples were not conducted in the United States.⁴ An analysis using HRS data that assessed life span found that older adults who experienced persistent social isolation were at a 28% increased hazard for mortality as compared to older adults who were never

socially isolated.⁴⁰ Leading meta-analytic work by Holt-Lunstad and colleagues has found that both social isolation and loneliness are comparable to more well-established risk factors in their association with mortality.^{9,18} In contrast, the study by Shaw et al. found that social isolation, but not loneliness, was statistically significant in predicting higher mortality.³³ Longitudinal work using a British sister study of the HRS also demonstrated that after adjusting for demographic and health-related factors, social isolation, but not loneliness, was significantly associated with mortality.⁵⁷ It may be that social isolation is a robust predictor of mortality, whereas the relationship between loneliness and premature mortality is more volatile.^{4(chap2-9)} Additional work that examines the impact of social isolation and loneliness in a single longitudinal sample is needed to clarify these relationships for older adults in the United States.

Limitations of Past Research

As evidenced by the literature above, little is known about how social isolation impacts older adults' use of health services over time.⁴ This gap can be largely attributed to measurement issues, dataset limitations, and a narrow focus on acute care outcomes.

First, the conceptual ambiguity regarding social isolation and loneliness has impeded the interpretation of many findings.³³ Studies that purport to study social isolation often measure feelings that more closely align with loneliness.^{11,58-61} Instruments often mix objective and subjective characteristics under one scale, making it difficult to disentangle their effects.¹¹ Research that accurately measures social isolation tends to do so without controlling for loneliness.^{4,5,17-19} Studies also rely heavily on single-item indicators of isolation¹¹⁻¹⁶ (e.g., living alone, marital status) that do not

adequately represent the spectrum of social connection (e.g., phone calls, visits with friends, religious attendance) and are less accurate in modeling outcomes.^{17,18,24,62} Such indicators are also less applicable to older adults, resulting in inflated estimates of social isolation. For instance, older adults who have lost a spouse are disproportionately more likely to live alone. Additionally, living alone may be an indicator of better health by way of the ability to function independently.^{4(chap7-3)} Future work should use multi-component instruments to study the impact of social isolation on health, while controlling for loneliness.^{22,24,33}

Second, data limitations in past studies have precluded longitudinal, nationally representative analyses. The majority of studies examining social isolation and health care utilization use cross-sectional data.^{4,60} Prior research that is longitudinal tends to use short follow-up times.⁶³ For instance, data using the HRS usually only uses two or three rounds of data,^{10,64} whereas more rounds are available today. Furthermore, population-based studies on social isolation are rarely based in the United States.^{4,63} Those that are tend to not include a combined set of traditional Medicare and Medicare Advantage enrollees.^{11,33} Instead, many studies have relied on local or regional samples,^{11,65} focused on certain diagnoses,⁶¹ or examined subsets of older adults.^{10,11,33,65} Finally, research tends to examine the impact of social isolation on health care utilization from a systematic lens, as opposed to measuring covariates and outcomes at the individual level.^{4(chap7-6)} Longitudinal studies based in the United States that use nationally representative samples of older adults, including traditional and managed Medicare beneficiaries, are needed.

Third, research on social connection and utilization is largely limited to acute care, particularly emergency department visits and hospital stays.^{11,33,61,62,64–66} While some studies suggest narrow social networks are associated with more acute care use,^{11,33,67,68} findings are mixed.^{4,62,64,66,69} The most rigorous study to date found that concentrated spending on hospitalizations and short-term skilled nursing facility stays drove up costs among socially isolated fee-for-service Medicare beneficiaries.^{10,33} However, the study excluded Medicare Advantage enrollees and its findings regarding loneliness fluctuated when adjustments were made for sociodemographic and health-related factors.³³ Importantly, the study focused on post-acute care as opposed to long-term care in nursing facilities.

The absence of research examining the association between social isolation and long-term care is notable.⁴ Research in this area tends to come from other countries and suggests that certain components of social support (e.g., living alone, being single, caregiver use) may predispose older adults to nursing home placement.^{4,16,50,52,70–73} No study has examined the association using a multi-faceted characterization of social isolation specifically, and the degree to which international findings generalize to the United States model of health care delivery is unknown.⁴ Given that social isolation is linked to other predictors of nursing home placement, such as falls, cognitive impairment, and functional decline,^{28,38,50,52–54,56} it is surprising that research has not yet examined social isolation as a risk factor for the use of long-term care facilities.

Finally, studies that have focused on social isolation and use of senior services or HCBS are scant.⁶² This gap is important given that older adults are increasingly cared for

through HCBS in an effort to deter growing nursing home expenditures. Some have posited that the mixed findings regarding the effectiveness of HCBS in meeting this goal may be attributed to the consumption of HCBS by individuals who are not at high risk for long-term care.⁷⁰ Consequently, HCBS use may not be associated with reduced long-term care utilization because consumers of HCBS are not as likely to need long-term care to begin with. If social isolation is a risk factor for long-term care placement in nursing homes, then socially isolated individuals might comprise the very population who would benefit from HCBS the most and could be better targeted for delivery of these services.

Alternatively, HCBS may serve as a proxy for low income, which would dilute the ability to observe any protective effects HCBS may have as a mechanism to delay nursing home entry. Since HCBS is covered under Medicaid, including a measure of HCBS in models that estimate long-term care placement may be estimating the effect of poverty (low income) as opposed to the impact of HCBS per se. Additional research that controls for Medicaid status can elucidate the specific role of HCBS on the timing of nursing home entry.

While some researchers caution against the idea that HCBS may be effective in reducing costs associated with long-term care placement,⁷⁴ additional research is needed to understand whether socially isolated older adults are more or less likely to receive HCBS and whether receiving HCBS could moderate nursing home placement. A better understanding of these relationships can address whether HCBS are a cost-effective mechanism to combat social isolation, promote aging in place, and curb rising costs attributed to institutionalization among older adults.

Research Contributions

Empirical Evidence that Addresses Knowledge Gaps

The studies described in this dissertation will provide new empirical evidence to expand knowledge on the relationships between social isolation, health care utilization, spending, and aging in place, which have not been examined in a comprehensive manner.

This study's examination of social isolation as a risk factor for nursing home entry is novel. In theory, individuals who are more socially isolated might have fewer supports at home, making them more likely to enter nursing homes for their long-term care needs. However, rigorous research has not yet been conducted on the association between social isolation and long-term care placement or time to such placement. Evidence from the studies presented in Chapters VI and V provide further impetus to shift resources toward a community-based setting to delay nursing home entry.

Additionally, insights regarding the relationship between social isolation and premature mortality are presented in Chapters IV and V. Each of these studies addresses this issue from a longitudinal lens and takes the important step of adjusting for both loneliness and depression in a population-based sample based in the United States.

Empirical evidence on social isolation and hospitalization is presented in Chapter IV. Although these findings remain mixed, this study contributes new information based on a model that controls for both social isolation and loneliness, provides results over an extensive follow-up period, and includes Medicare Advantage enrollees as well as traditional Medicare fee-for-service beneficiaries.

This dissertation also contributes exploratory information about the potential moderating effects of senior services on the relationship between social isolation and nursing home entry. It is unknown whether senior services provide the additional contact and support needed by isolated individuals to improve health. If so, senior service use might affect the pathways between social isolation and utilization. From an interventional standpoint, social isolation is “low-hanging fruit” if delivery of senior services can address the condition by simply providing more points of contact. By examining this relationship, the exploratory study presented in Chapter VI sets the stage for future research that informs policies and practices that bolster the social contacts needed to curb cost of care and promote aging in place.⁷⁵

Methods that Advance Knowledge

The methods and instruments used throughout this dissertation’s three studies are also important in overcoming barriers that have held social isolation research back. The dataset identified for this study, the HRS, allows for robust longitudinal analyses. While most research in this area uses cross-sectional studies, the first two analyses presented in Chapters IV and V examined the same individuals over the course of ten years, painting a clearer picture of the impact of social isolation on health care utilization over time while controlling for loneliness. Furthermore, in Chapter VI, the HRS dataset is extrapolated to a nationally representative subsample of Medicare beneficiaries.

The instrument used in this dissertation to measure social isolation overcomes a methodological limitation in the existing literature. Because there is no gold standard by which to measure social isolation, myriad constructs and measures complicate the ability

to examine social isolation across surveys or samples.⁶³ Researchers should develop an emerging consensus on standardized measures of social isolation that can be replicated, in a similar way to how loneliness is measured using the UCLA score. After an exhaustive review of various metrics, the studies described in this dissertation make use of a reliable social isolation measure that has been used previously in HRS data analyses and can be reconstructed in international datasets similar to the HRS, which will better enable researchers to draw conclusions about the impact of social isolation on health-related outcomes across different samples of older adults in multiple countries.

Conceptual Framework

Social isolation in older adults tends to be associated with negative health behaviors and outcomes. Along this pathway, it is plausible that social isolation may also lead to suboptimal health care utilization. These relationships can be bidirectional as well as direct or indirect in nature. However, the relationship between social integration and health outcomes is more nuanced in that the quality of social connections can improve – or harm – an individual’s health.

To better understand the mechanistic pathways by which social connectivity (or a lack thereof) affects health and subsequent health care utilization, the studies included in this dissertation adapted a conceptual framework first developed in 2016 by Holt-Lunstad and Smith (Figure 1).²² These authors originally used this framework to explain the pathways between social connection, cardiovascular disease, and mortality.²² However, these mechanisms can also be applied to health care utilization as an outcome resulting from social isolation itself or by the morbidity it causes. Under the adapted framework,

mediating pathways are grouped into lifestyle/behavioral factors, psychological factors, and morbidity – all of which can lead to health care utilization and mortality directly as well as indirectly through incidence and progression of illness.

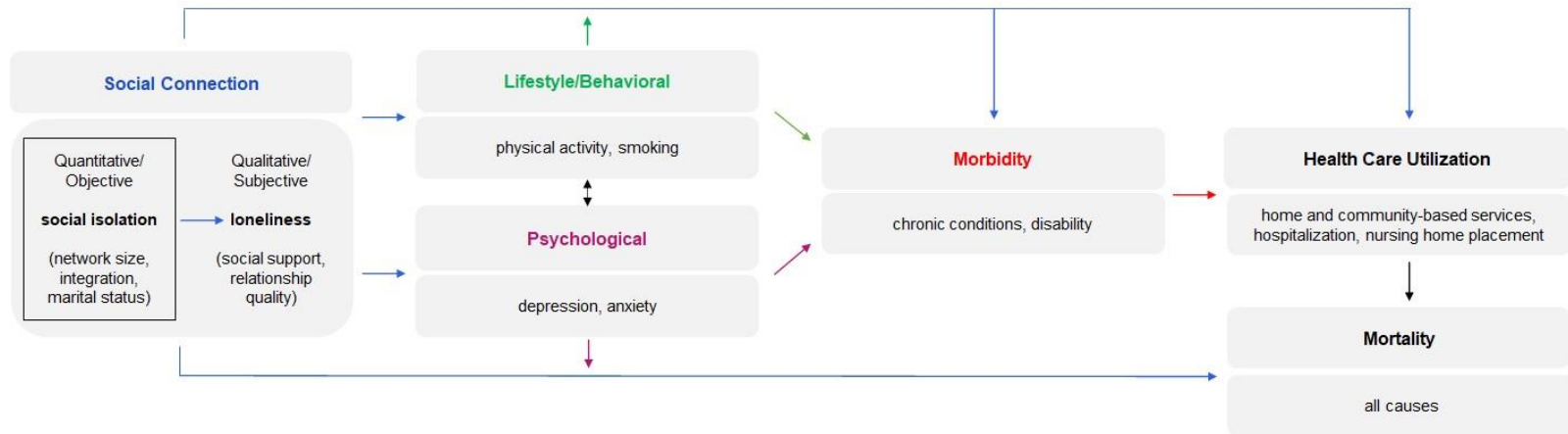


Figure 1. Conceptual framework modeling indirect and direct pathways between social isolation, health care utilization, and mortality

Social isolation is generally thought to impact health care utilization and mortality through increased morbidity. The effects of social isolation on morbidity can be indirect, occurring through lifestyle/behavioral and psychological pathways, or social isolation and result in morbidity directly, through its impact on neurobiological functioning. The indirect and direct explanatory pathways are further described below. However, it should be noted that social isolation can bypass pathways to morbidity altogether by resulting in health care utilization or mortality directly, such as in the case of accidents (e.g., choking).

Lifestyle/Behavioral Pathways

Social isolation may lead to lifestyle factors that make disease, health care utilization, and mortality more likely. Examples of observable pathways that were measured in this study were physical activity and smoking. For instance, a socially isolated individual may be more sedentary in the absence of social interactions that would otherwise engage her or him in activities outside of the home. Similarly, socially isolated older adults may lack the instrumental support needed to access goods or services (e.g., a car ride from an adult child to physical therapy or a friend dropping off a healthy meal). A lack of instrumental support may result in “forced lifestyle choices” (e.g., lack of exercise, poor nutrition) that contribute to disability or chronic disease (e.g., impaired physical function, heart disease), which in turn, lead to increased health care utilization.

Alternatively, the lack of social influence may result in “voluntary lifestyle choices” that contribute to negative outcomes.⁷⁶ For instance, in the absence of a companion who might encourage exercise or smoking cessation, a socially isolated older

adult may lack the accountability and emotional support needed to encourage daily walks or quitting nicotine. An isolated older adult may even pick up smoking as a way to interact with others. In contrast, individuals with more social connections may be better able to take on positive values and norms shared by members of their network.^{33,76} For instance, an individual who surrounds himself with peers who have adopted positive lifestyles that include exercise, not smoking, and healthy eating may join their peers in health-promoting behaviors.³² Such healthy behaviors may prevent diabetes, coronary heart disease, or stroke, helping to ward off hospitalizations. Similarly, such shared norms may help an older adult to preserve physical function, avoid frailty, and prevent falls, enabling them to maintain independence and deter nursing home placement.

On the other hand, social integration does not always lead to shared lifestyle values that are healthy. It is possible that a socially connected older adult may surround themselves with peers who model negative health behaviors like smoking or risk-taking behaviors. It is easy to see how adopting these lifestyle choices could lead to negative health and hospitalization. Whichever the scenario, social connections (or the lack thereof) can lead to consequential lifestyle choices that may positively or negatively affect the use of hospitals or nursing homes.

Psychological Pathways

Social isolation or integration has important implications for mental and psychological health, which in turn, are predictive of health care utilization. Examples of observable pathways that were measured in this study were loneliness and depression. A theoretical perspective by Berkman (2007) describes psychosocial mechanisms that

mediate the relationship between social isolation and negative health outcomes.⁷⁶

According to Berkman, socially integrated individuals are more likely to get together with friends, attend social functions, participate in occupational or social roles, join in group recreation, or attend church; these forms of engagement reinforce meaningful social roles, provide a sense of value, belonging, and attachment, and improve mental health.⁷⁶

Additionally, socially integrated individuals who have access to a range of social connections may find that different connections address different psychological needs. For example, a spouse may provide someone with emotional support through love, care, sympathy, or understanding, all of which may lead to better self-esteem, a sense of purpose, and emotional wellbeing.⁷⁶ Similarly, a close friend may provide appraisal support, such as encouragement or reminders of all the ways in which an individual is equipped to excel during a difficult time. These psychological factors can boost morale, circumventing negative behaviors or outcomes (e.g., substance abuse, depression) that could otherwise escalate into hospitalizations (e.g., overdose) or even mortality (e.g., suicide).⁴³ In contrast, an informal caregiver may be better able to provide instrumental support by providing assistance with tangible needs or access to material resources or goods (e.g., getting groceries, cooking, transportation to appointments, making phone calls, managing household tasks, paying bills).⁷⁶ From a psychological standpoint, access to adequate instrumental support may relieve stress and improve one's sense of security among older adults who require assistance with daily tasks. This ability to live at home

with peace of mind that one's needs are being met can minimize the need or desire for nursing home placement.

As with lifestyle/behavioral factors, not all social ties are supportive of psychological health.⁷⁶ Some social connections may deteriorate psychological wellbeing, as in the case of contacts who neglect or abuse an older adult. Adverse mental health stemming from unhealthy relationships may lead to negative health behaviors or health conditions that place older adults at risk for hospitalization or nursing home entry. For example, intimate partner violence may lead to post-traumatic stress disorder, which in turn is associated with impaired cognition (e.g., slower processing speed, dissociative symptoms, poor reasoning skills). Individuals living with cognitive impairment are more at risk for developing dementia, which increases the odds of nursing home placement. Consequently, social connections do not necessarily equate to positive mental health.

Individuals who are socially isolated, on the other hand, may experience depression or anxiety due to loneliness, a missing sense of connection or purpose, or a lack of emotional or instrumental support. These psychological factors may increase stress, thereby elevating cortisol production and blood pressure that lead to cardiovascular disease, a top risk factor for hospitalization.³³ In contrast, the mere presence of another individual can alleviate stress.²⁴ Depression is a well-known and particularly robust pathway between social isolation and adverse health outcomes.⁴

Morbidity Pathways

Under the Holt-Lunstad conceptual framework,²² social isolation or connection can also affect morbidity directly, resulting in hospitalizations, nursing home entry, or

mortality. One direct causal pathway between social isolation and morbidity is infectious disease. In this case, social connection, as opposed to isolation, results in illness through the transmission of disease (e.g., seasonal influenza, COVID-19). Infection may lead to hospitalization or skilled nursing care following a hospital discharge. The example of infectious disease is unique in demonstrating social isolation as a protective factor against morbidity and subsequent health care utilization.

Social isolation can also directly impact morbidity through impaired neurobiological functioning. Such pathways are presented in a paper focusing on loneliness and cognition by Cacioppo and Hawley.⁷⁷ From an evolutionary psychology perspective, an individual who is keenly aware of their social isolation may become hypervigilant for social threats, producing attentional, confirmatory, and memorial biases.⁷⁷ Accordingly, isolated individuals may implicitly construe their social world as threatening, hold pessimistic or defeatist attitudes or expectations, and dwell on negative social events that discourage them from social participation, further alienating themselves.^{43,77,78} This cycle of isolation can lead biological dysregulation, particularly with regard to issues in the endocrine system. This includes an overactive hypothalamic pituitary adrenal axis that diminishes sleep quality and an increased allostatic load that increases inflammatory responses in the brain, impairing cognitive function.^{43,77,78}

In summary, the effects of social isolation on health care utilization and mortality can transpire through lifestyle/behavioral factors that impact morbidity, psychological conditions that impact morbidity, or through the direct effects of isolation on morbidity, which in turn, may increase hospitalization, nursing home entry, and premature mortality.

Social isolation may affect utilization indirectly through health behaviors and lifestyle choices or through mental, emotional, physical, and social health that shape health care use and longevity. Additionally, isolation has direct implications for negative neurobiological functioning associated with some morbidities. Finally, social isolation may bypass lifestyle/behavioral, psychological, or morbidity pathways altogether if it results in accidents or unintentional injuries that directly cause hospitalization, nursing home entry, or mortality. Whereas social connections can lead to factors that may positively or negatively mediate health care utilization, social isolation tends to pose detrimental outcomes for health care utilization and mortality.

III. METHODS

The three studies reported in this dissertation shared many of the same methods, which are described here in Chapter III. These overarching methods largely comprised the data sources from which study participants and variables were derived, the construction of key explanatory variables (e.g., social isolation, loneliness, and depression scores), and the covariates specified in the analytic models. Additional methods specific to each study are described under the “Approach” in Chapters IV-VI.

In all analyses, a p-value of less than 0.05 was chosen to denote statistical significance. Analyses were performed using the Stata statistical software program (Version 16, StataCorp, College Station, Texas). The George Mason University institutional review board determined this research study (protocol #1915572-1) to fall under Exemption #4, as detailed at 45 CFR Part 46 Subpart A Section 46.101,⁷⁹ as it did not meet the definition of human subject research according to federal regulations.

Data Sources

This dissertation used data from seven waves of the HRS.⁸⁰ Publicly accessible files for years 2006, 2008, 2010, 2012, 2014, 2016, and 2018 of the HRS core dataset, the RAND longitudinal file, and the Psychosocial & Lifestyle Questionnaire were merged to create a single analytic file for use in the three empirical studies.

Core HRS Dataset

The HRS is a nationally-representative survey administered biennially to 20,000 adults ages 50 and older since 1992.⁸⁰ A new birth cohort is added to the study every six

years. As of 2006, half of HRS respondents are randomly assigned to receive the survey by telephone, and the other half is randomly assigned to face-to-face interviews complemented by a self-administered, mail-back psychosocial and lifestyle questionnaire. All participating respondents must be community-dwelling at the time of their first survey, but respondents are surveyed if they transition into nursing homes. Response rates to core HRS questions from the 2006 wave onward generally surpass 87%.⁸¹ Variables derived from this file included key tracking information as well as respondents' monthly religious attendance, which was used in constructing the social isolation scores.

RAND Longitudinal File

The RAND Corporation provides a clean, longitudinal version of the HRS data file which uses consistent variable names and appends repeated measures for core HRS participants after each wave (i.e., every two years). The RAND HRS longitudinal file includes many variables used in this study.⁸² For example, key outcome variables (hospitalizations, nursing home entry, and mortality) were obtained from the RAND HRS file. The living arrangement and marital status variables used in constructing the social isolation scores were also derived from this file, as were key demographic variables (e.g., age, race/ethnicity), lifestyle/behavioral variables, disability and chronic condition variables, and variables used to construct the depression scores.

Psychosocial & Lifestyle Questionnaire

Beginning in 2006, the HRS introduced a supplementary Psychosocial & Lifestyle Self-Administered Questionnaire with questions on social relationships.⁸³ Each wave, the questionnaire is administered to an alternating 50% sample of the larger HRS

cohort, resulting in repeated measures for each half of the sample every other wave (i.e., every four years). This study calculated an individual’s social isolation score during three time points: years 2006, 2010, and 2014 for “Sample A,” and years 2008, 2012, and 2016 for “Sample B” (Table 1). Response rates for the questionnaire range from 73% to 88% of the core HRS questionnaire.⁸³ Variables pulled from this file included monthly contact with children/family/friends and monthly participation in groups/clubs/organizations, which were used in constructing respondents’ social isolation scores, as well as variables used to construct the loneliness scores.

Table 1. Psychosocial Self-Administered Questionnaire administration, by year

Year					
2006	2008	2010	2012	2014	2016
Sample A Time 1	Sample B Time 1	Sample A Time 2	Sample B Time 2	Sample A Time 3	Sample B Time 3

Measures

The measures selected for inclusion in this dissertation’s analytic models were informed by the adapted Holt-Lunstad and Smith conceptual framework (Chapter II),²² and included key explanatory variables; sociodemographics; lifestyle/behavioral, psychological, and morbidity-related covariates; and key outcome variables. The main explanatory variables were consistent across all three studies. Covariates were selected a priori and were largely consistent across the three studies with the exception of the third study, which included an additional indicator for senior service use (Chapter VI). The

outcome variables differed slightly across the three studies, but always captured facets of overnight hospitalization, nursing home entry, and/or mortality.

Explanatory Variables

This study examined social isolation as the key explanatory variable of interest. Loneliness and depression were secondarily examined as explanatory psychosocial factors. Though related, each of these three conditions independently predicts poor health in other studies.⁴ In the current sample, Pearson's correlations indicate that social isolation was weakly correlated with loneliness ($r=0.25, p<0.001$) and depression ($r=0.19, p<0.001$), whereas loneliness and depression were moderately correlated ($r=0.41, p<0.001$). This finding is consistent with prior studies that provide evidence that social isolation and loneliness are weakly to moderately correlated among older adults.⁸⁴ Correspondingly, separate variables were constructed to measure the impact of each condition on health care utilization and mortality.

Social isolation. Social isolation was the key explanatory variable of interest. A 6-item measure for social isolation was constructed based on the methodology first published for use in HRS by Crowe et al.⁴⁰ and originally adapted to HRS by Coyle⁸⁵ (Table 2). The Coyle-Crowe measure is derived from a validated metric used in ELSA,^{32,57} a sister study of the HRS that shares the same language for many of the underlying questions asked of HRS respondents.

Currently, no gold standard or uniform approach for measuring social isolation exists in the literature. A 2020 report issued by the National Academies of Sciences, Engineering, and Medicine concluded that a key limitation of social connection research

is the myriad constructs and metrics used to measure social isolation, which “complicates the ability to draw conclusions between social isolation and health outcomes.”^{24(chap9-7)} Therefore, it is important that researchers establish consistency with regard to an accurate measurement of social isolation, at the very least, when using the same dataset. The measure used in HRS by Coyle⁸⁵ and Crowe⁴⁰ is appealing in that it differs very little from the validated measure used in ELSA (with the exception that the ELSA measure combines marital status and living arrangement under one dimension, resulting in a final scale of 0-5, whereas the HRS measure distinguishes between the two characteristics, resulting in a final scale of 0-6). A similar metric was developed for HRS by Kotwal et al.,⁸⁶ however, it focuses on social isolation at the end-of-life, adds an additional dimension for the proximity of children, and equates lower scores to higher social isolation. Other measures adapted from the National Social Life, Health, and Aging Project²⁴ and from the National Health and Aging Trends Study⁵ have also been applied to HRS,^{8(Supplement),14} though there are greater inconsistencies in the underlying questions used to construct the metrics across studies.

The Coyle-Crowe measure of social isolation includes six components for 1) marital status, 2) living arrangement, 3) frequency of contact with children, 4) frequency of contact with family, 5) frequency of contact with friends, and 6) social participation in groups, clubs, social organizations, and religious services. Marital status was coded as 0 = married for respondents who were married or partnered and as 1 = not married for respondents who were separated, divorced, widowed, or never married. Living arrangement was dichotomized into 0 = more than 1 person in the household versus 1 =

lives alone. Additionally, nine questions asked, on average, how often respondents meet up with, speak on the phone with, or write to children, family, or friends who do not live with them. Responses to each of these questions included: three or more times a week; once or twice a week; once or twice a month; every few months; once or twice a year; or, less than once a year/never. The three forms of contact (meet, speak, write) were collapsed into one variable each for children, family, and friends. The resulting three variables capturing social contact with children, family, and friends were coded as 0 = once a month or more versus 1 = less than monthly. Finally, variables denoting participation in groups, clubs, organizations, or religious services were combined to create a single indicator (Figure A-1), where participation in these activities was denoted as 0 = once a month or more and 1 = less than monthly (Table 2).

Table 2. Six-item measure of social isolation

Construct	Metric	Points
Marital status	Not married	1
Living arrangement	Lives alone	1
Social contact	Less than monthly contact with children	1
	Less than monthly contact with other family	1
	Less than monthly contact with friends	1
Social participation	Less than monthly participation in any groups, clubs, organizations, or religious services	1

Following established methodology, scores were pro-rated for respondents who provided data for at least three of the six items (Figure A-1).^{40,57} Items were then summed

to create a continuous score that could range from 0 to 6 where a higher score indicates greater isolation. In the first study, social isolation was treated as a continuous variable. In the second and third analyses, social isolation is treated dichotomously, wherein participants were classified as socially isolated if their scores fell into the top quintile, which translated to a score of ≥ 3 .^{40,57} However, it should be noted that this cut-off is relatively arbitrary in that it is not grounded in clinically meaningful outcomes.

Loneliness. Loneliness was included as a potential mediator and additional explanatory variable of interest. Loneliness was measured using the 3-item UCLA loneliness scale, which is an established standard in the literature. The full version of this widely used instrument consists of a 20-item scale with good internal consistency and test-retest correlation that measures various subjective psychological experiences and perceptions related to loneliness.^{87,88} A shortened 3-item version of the scale is commonly used, available for all HRS waves included in this study (2006 forward), corresponds well with the larger scale, and has good concurrent and discriminant validity.⁸⁹

The 3-item UCLA scale includes questions that measure the frequency with which respondents feel that they are 1) lacking companionship; 2) left out; and 3) isolated from others. Scores for respondents who did not answer more than one of three components were counted as missing, whereas scores for respondents who answered at least two of three components were pro-rated. Item responses were reverse-coded so that higher scores correspond to more severe loneliness, with final scores ranging from 3-9. A continuous measure was used in analyses, however, past research using the HRS dataset

has categorized older adults with scores between 3-5 as “not lonely” and scores between 6-9 as “lonely.”⁵⁷

Depression. This study used the revised 8-item Center for Epidemiological Studies-Depression Scale (CES-D) to examine depression. The revised scale has good internal consistency, a factor structure comparable to that of prior versions of the CES-D, and yields results that are closely associated with self-report of physician diagnosis and psychiatric treatment.^{90,91} The composite measure sums six "negative" sentiments and two reverse-coded "positive" sentiments, including whether respondents felt the following all or most of the time during the past week: 1) depressed; 2) that everything is an effort; 3) that their sleep is restless; 4) alone; 5) sad; 6) that they could not get going; 7) happy; and 8) that they enjoyed life. The HRS calculates scores for respondents who answer at least three of the eight question components. Final scores for all respondents range from 0-8, where higher scores correspond to worse depressive symptoms. A continuous measure was used in analyses, however, scores greater or equal to 4 are generally considered to be indicative of clinically-relevant depressive symptomology.^{90,92-94}

Outcome Variables

Three primary outcome variables were drawn from the core HRS: overnight hospitalizations, overnight nursing home stays, and mortality.

Hospitalizations. At each wave, participants reported whether or not they had experienced an overnight hospital stay within the two years that had passed since the previous interview. Hospitalizations were binarized into a variable that defined

individuals as having been hospitalized or not in response to the question, “[Since date of last interview / In the last two years], have you been a patient in a hospital overnight?”

Nursing home entry. At each wave, respondents self-reported whether or not they had experienced an overnight stay at a nursing home during the two years since the previous interview. Nursing home stays were binarized into a variable that defined individuals as having had an overnight nursing home stay or not in response to the question, “[Since date of last interview / In the last two years], have you been a patient overnight in a nursing home, or other long-term health care facility?” Individuals with nursing home stays 100 days or longer were classified as long-term care residents in this dissertation’s second study, described in Chapter V.

Mortality. At each wave, a binary indicator variable derived from the tracker file flagged whether or not a respondent died during the two years since the previous interview.

Sociodemographics

Informed by studies examining predictors of health care utilization in the general population, sociodemographics included age, gender, race, ethnicity, and Medicaid enrollment.⁵⁰ Age was measured in 10-year brackets of 65-74, 75-84, 85-94, and 95+. Race was categorized into three mutually exclusive categories including White, Black, and Other. A separate variable indicated whether respondents identified as Hispanic or Latino. Lastly, an indicator variable flagged respondents who endorsed being currently covered by Medicaid under a government health insurance program.

Additional Covariates

Based on the conceptual framework (Figure 1),²² additional covariates were included given their potential to act as explanatory pathways between social isolation and hospitalizations, nursing home stays, and mortality. These covariates were grouped into lifestyle/behavioral mediators, mental health mediators, and physical health/morbidity mediators.

Lifestyle/behavioral mediators. Dichotomous variables for smoking cigarettes and engagement in physical activity were included as lifestyle/behavioral mediators. Current smoking status was determined by asking respondents who reported ever having smoked, “Do you smoke cigarettes now?” Those who reported “yes” were categorized as currently smoking. Physical activity was defined as engaging in moderate and/or vigorous physical activity at least twice a week in response to the questions “How often do you take part in sports or activities that are vigorous, such as running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel?”; and “How often do you take part in sports or activities that are moderately energetic, such as gardening, cleaning the car, walking at a moderate pace, dancing, floor or stretching exercises?” For each question, respondents could answer “more than once a week,” “once a week,” “one to three times a month,” or “hardly ever or never.” Respondents who endorsed engaging in either moderate or vigorous activity at least twice a week were categorized as physically active.

Mental health mediators. Loneliness and depression, secondary explanatory variables of interest, were also considered to be important mental health mediators along

the causal pathway between social isolation and health care utilization/mortality. These conditions were measured through the 3-item UCLA loneliness scale and 8-item CES-D, as described in detail previously.

Physical health mediators. Indicators of morbidity included a count of chronic conditions and a separate indicator that flagged individuals living with Alzheimer's disease or related dementias. For each condition, respondents were asked in their initial interview if they had been told by a doctor that they had the condition. To assess whether the condition remained current in follow-up interviews, respondents were asked, "Since we last talked to you on [date of previous interview], has a doctor told you that you have...". The count of chronic conditions was based on a list of seven including: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism. An indicator for Alzheimer's disease or related dementias was considered separately, given its strong association with nursing home placement.

Finally, functional limitations were approximated through two variables measuring whether or not respondents experience difficulty with activities of daily living (ADLs) and independent activities of daily living (IADLs). For each task, respondents were asked how difficult it is for them to perform the activity, and could answer "not at all difficult," "a little difficult," "somewhat difficult," or "can't do at all." Respondents who answered "somewhat difficult" or "can't do at all" were then categorized as having

limitations performing that task. A well-established 3-item ADL variable scored respondents on whether they reported difficulty with 1) bathing; 2) eating; and 3) dressing,⁹⁵ and a widely-used IADL variable scored respondents on whether they reported difficulty with 1) using a telephone; 2) taking medication; and 3) handling money. Both variables could range from 0 to 3 where higher scores indicated greater functional limitations.

More details on the analytic approach specific to each study appear in Chapters IV, V, and VI under the “Approach” sections.

IV. STUDY ONE: THE IMPACT OF SOCIAL ISOLATION ON HOSPITALIZATION, NURSING HOME ENTRY, AND MORTALITY AMONG COMMUNITY-DWELLING OLDER ADULTS OVER TIME

The first study performed a panel data analysis of older adults followed between 2006-2018 to examine whether social isolation was associated with three outcomes: (1) overnight hospital stays, (2) nursing home entry, and (3) mortality. To address whether socially isolated older adults are more likely to be hospitalized, enter a nursing home, or experience mortality compared to older adults who are not socially isolated, cross-sectional time-series analyses with random effects were conducted over six waves of stacked data to examine whether social isolation and covariates in a given year were associated with each outcome in the subsequent two years. The following research questions were the focus of the study.

Research Questions

- 1) Are socially isolated older adults more likely to experience an overnight hospital stay over a two-year period, compared to older adults who are not socially isolated?

Hypothesis: Socially isolated older adults will experience more frequent hospitalizations due to a higher burden of illness, forgone preventive care, a higher reliance on inpatient stays as opposed to outpatient care, and a higher likelihood of rehospitalization than older adults who are not socially isolated.

- 2) Are socially isolated older adults more likely to have an overnight nursing home stay over a two-year period, compared to older adults who are not socially isolated?

Hypothesis: Socially isolated older adults are more likely to enter a nursing home than older adults who are not socially isolated due to inadequate social support needed to function safely and successfully at home.

- 3) Are socially isolated older adults at greater odds of mortality over a two-year period than older adults who are not socially isolated?

Hypothesis: Socially isolated older adults will have higher odds of mortality within a two-year period than older adults who are not socially isolated due to the negative impacts of social isolation on lifestyle/behavioral and psychological factors that directly or indirectly lead to mortality.

Social support is integral to maintaining health, independence at home, and for recovery after injury. It was hypothesized that socially isolated older adults would face higher odds of hospitalization due to a lack of support in maintaining health, a lower likelihood of seeking preventive care, and less engagement in daily activities needed to deter illness or injury and age safely in a community setting. This view also reflects research that suggests older adults with smaller or weaker social networks are more likely to be rehospitalized and rely more on inpatient care as opposed to outpatient services.^{4(chap7-6),62} Lower use of outpatient or preventive care by those who are socially isolated may signal difficulties in accessing such care due to poor instrumental support.

Faced with inadequate support, socially isolated older adults were also hypothesized to be more likely to resort to nursing homes for their care needs. This risk was believed to hold true for older adults living in the community who could no longer care for themselves without professional support. However, it was also believed that

hospitalized socially isolated older adults would be more likely to discharge to a nursing home for their recovery.

Finally, it was hypothesized that socially isolated older adults would experience higher odds of two-year mortality compared to older adults who were not socially isolated. This is due both to the direct effects of isolation on mortality and the indirect risks that increased illness and health care utilization associated with isolation pose for mortality.

In addition to the study-specific analytical approach described below, overarching methods applicable to all three studies are described in Chapter III.

Approach

The purpose of this study was to examine whether social isolation was associated with 1) overnight hospital stays, 2) overnight nursing home stays, and 3) mortality among community-dwelling older adults across twelve years. Three multivariate logistic regression models with random effects were performed to examine these relationships among a panel dataset of older adults interviewed between 2006-2018.

Equation 1 Logistic regression with random effects using panel data

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 \text{Isolated}_{ij} + \hat{\beta}_2 \text{Lonely}_{ij} + \hat{\beta}_3 \text{Depressed}_{ij} + \hat{\beta}_4 X_{ij} + \hat{\beta}_5 Z_{ij} + \varepsilon_i$$

In the general estimating equation presented in Equation 1, \hat{Y}_i represents the predicted odds of experiencing the outcome (i.e., hospitalization, nursing home entry, or death) for a given individual i at round j . The key explanatory variable of interest is Isolated_{ij} , a continuous variable that includes the social isolation score for a given individual i during the previous round j . Secondary explanatory variables of interest include Lonely_{ij} and Depressed_{ij} , continuous variables that comprise the loneliness and

depression scores for an individual i during the previous round j . Next, X_{ij} represents a vector of individual sociodemographic covariates including gender, race, ethnicity, age, and Medicaid status, while Z_{ij} represents a vector of health-related covariates including physical activity, smoking, number of chronic conditions, functional status, and ADRD. Lastly, ε represents the error term. Drawing from the conceptual framework (Figure 1), the estimated coefficients approximate how respondents with different demographic, psychosocial, lifestyle, and morbidity attributes experience different probabilities of the three primary outcomes: hospitalization, nursing home entry, and mortality.

Data Structure

Most covariates were drawn from the core HRS dataset and are available for every wave of data (i.e., every two years). However, social isolation data was collected from an alternating 50% sample of the larger HRS cohort each wave, resulting in repeated measures for each half of the sample every other wave (i.e., every four years) (Table 1). As such, this study stacked data to construct three repeated measures for the same individuals spanning 2006 to 2018. Time 1 comprised Sample A respondents with explanatory data for 2006 and outcome data over the next two years (through 2008), stacked on Sample B respondents with explanatory data for 2008 and outcome data over the next two years (through 2010). Time 2 included explanatory data for 2010 and 2012 and outcome data for 2012 and 2014 for Samples A and B, respectively. Finally, Time 3 included explanatory data for 2014 and 2016 and outcome data for 2016 and 2018 for Samples A and B, respectively. The stacked data structure used in the analyses is depicted in Figure 2.

Social Isolation Time 1		Social Isolation Time 2		Social Isolation Time 3	
2006	2008	2010	2012	2014	2016
Sample A	Sample B	Sample A	Sample B	Sample A	Sample B

Outcome Time 1		Outcome Time 2		Outcome Time 3	
2006-2008	2008-2010	2010-2012	2012-2014	2014-2016	2016-2018
Sample A	Sample B	Sample A	Sample B	Sample A	Sample B

Figure 2. Stacked dataset structure for panel data analyses with three time points spanning 2006-2018
Notes: This approach examines how social isolation in an index year (Sample A: 2006, 2010, 2014; Sample B: 2008, 2012, 2016) impacts outcomes (hospitalization, nursing home entry, and death) over the next two years: (Sample A: 2006-2008, 2010-2012, 2014-2016; Sample B: 2008-2010, 2012-2014, 2016-2018).

Participants

The unit of analysis in this study was a given respondent in a given wave. Therefore, unique individuals could be represented in the analytic sample more than once over time if they remained eligible and provided repeated measures across waves. To be eligible for inclusion, respondents had to be community-dwelling and at least 65 years of age at the time of their index Psychosocial & Lifestyle Questionnaire containing social isolation data. However, respondents could transition to an institutional setting in later waves (e.g., Time 2 or Time 3) and still be included in longitudinal analyses so long as they were community-dwelling at the time of their index interview. Respondents missing more than three of the six components required to calculate a social isolation score for a

given wave, or that were missing outcome data for a given wave, were excluded from that time point in analyses.

Results

This study included 24,231 observations in person-years across 12,811 unique individuals. There were 12,723 (52.62%) observations from Sample A and 11,457 (47.38%) from Sample B. A majority of respondents were female, identified as White and non-Hispanic/Latino, and were between the ages of 65-74. About 15% of participants were socially isolated, 24% were lonely, and 12% were classified as having depressive symptomology during any given wave. These findings reflect those from previous studies that used the same dataset and similar measures of social isolation, loneliness, and depression.^{33,40,57,86,94} About 31% of observations experienced overnight hospital stays, 6% had an overnight nursing home stay, and 7% died. Additional descriptive characteristics can be found in Table 3.

Table 3. Study one: Descriptive characteristics of community-dwelling older adults

Measure	Number (%) or Mean Score (SD)
Explanatory variables, mean (SD)	
Social isolation score ^a	1.28 (1.16)
Loneliness score ^b	4.35 (1.56)
Depression score ^c	1.30 (1.83)
Outcome variables	
Hospitalized	6,715 (31.31)
Nursing home entry	1,256 (5.85)
Deceased	1,670 (6.91)
Time point	

Time 1 (2008-2010)	8,848 (36.59)
Time 2 (2012-2014)	7,995 (33.06)
Time 3 (2016-2018)	7,337 (30.34)
Female	14,142 (58.49)
Age in years	
65 to 74	12,628 (52.22)
75 to 84	8,833 (36.53)
85 to 94	2,582 (10.68)
95 or older	137 (0.57)
Race	
White	20,385 (84.31)
Black	2,954 (12.22)
Other	841 (3.48)
Hispanic	1,776 (7.34)
Medicaid	1,790 (7.40)
Smokes	2,074 (8.58)
Not physically active	11,508 (47.59)
ADL score, ^d mean (SD)	0.19 (0.54)
IADL score, ^e mean (SD)	0.11 (0.42)
Number of chronic illnesses, ^f mean (SD)	2.38 (1.30)
ADRD	677 (2.80)

Notes. Sample size: N = 24,180 person-years across 12,811 unique individuals; Numbers represent n (%) unless otherwise indicated; Missing observations include n = 2,730 for hospital stays and n = 2,701 for overnight nursing home stays.

Abbreviations. ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias.

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and higher scores indicate more severe social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

Hospitalization

Individuals who were socially isolated tended to have lower odds of hospitalization than those who were not socially isolated, however this finding was not significant (OR: 0.97; CI: 0.94–1.00). Higher depression scores (OR: 1.08; CI: 1.06–1.10), but not loneliness scores (OR: 1.02; CI: 0.99–1.04) were associated with significantly higher odds of hospitalization. Individuals who were older, enrolled in Medicaid (OR: 1.16; CI: 1.01–1.33), smoked (OR: 1.17; 1.03–1.33), were not physically active (OR: 1.18; CI: 1.10–1.26), and who had more ADL limitations (OR: 1.25; CI: 1.17–1.35), chronic illnesses (OR: 1.35; CI: 1.32–1.39) or a diagnosis of ADRD (OR: 1.51; CI: 1.22–1.87) were all at significantly greater odds of being hospitalized. Women (OR: 0.92; CI: 0.85–0.98) and respondents who identified as Black (OR: 0.85; CI: 0.76–0.94) or Hispanic/Latino (OR: 0.65; CI: 0.56–0.75) experienced lower odds of having an overnight hospitalization (Table 4).

Table 4. Overnight hospital stays among community-dwelling older adults

Characteristic	Odds Ratio	95% Confidence Interval	P-Value
Social isolation score ^a	0.97	0.94 – 1.00	0.078
Loneliness score ^b	1.02	0.99 – 1.04	0.170
Depression score ^{c***}	1.08	1.06 – 1.10	<0.001
Time point			
Time 1 (2008-2010)	<i>Ref.</i>		
Time 2 (2012-2014) ***	0.84	0.78 – 0.91	<0.001
Time 3 (2016-2018) ***	0.78	0.72 – 0.85	<0.001

Female [*]	0.92	0.85 – 0.98	0.018
Age, years			
65 to 74	<i>Ref.</i>		
75 to 84 ^{***}	1.34	1.25 – 1.44	<0.001
85 to 94 ^{***}	1.66	1.47 – 1.87	<0.001
95 or older ^{***}	3.11	1.83 – 5.30	<0.001
Race			
White	<i>Ref.</i>		
Black ^{**}	0.85	0.76 – 0.94	0.003
Other	1.00	0.81 – 1.22	0.975
Hispanic ^{***}	0.65	0.56 – 0.75	<0.001
Medicaid [*]	1.16	1.01 – 1.33	0.037
Smokes [*]	1.17	1.03 – 1.33	0.013
Not physically active ^{***}	1.18	1.10 – 1.26	<0.001
ADL score ^{d***}	1.25	1.17 – 1.35	<0.001
IADL score ^e	1.08	0.98 – 1.18	0.115
Number of chronic illnesses ^{f***}	1.35	1.32 – 1.39	<0.001
ADRD ^{***}	1.51	1.22 – 1.87	<0.001

Notes. Sample size: N = 11,572 unique individuals; 21,450 person-years; Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and higher scores indicate more severe social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

^{*}Significant at $p < 0.05$.

^{**}Significant at $p < 0.01$.

^{***}Significant at $p \leq 0.001$.

Nursing Home Entry

Socially isolated older adults were at 1.21 (CI: 1.14–1.29) greater odds of nursing home entry compared to older adults who were not socially isolated. Additionally, both loneliness (OR: 1.06; CI: 1.02–1.11) and depression (OR: 1.06; CI: 1.02–1.10) were associated with greater odds of nursing home entry. Women (OR: 1.29; CI: 1.11–1.49) and older adults who were not physically active (OR: 1.64; CI: 1.42–1.89), had more difficulties with ADLs (OR: 1.59; CI: 1.43–1.77), IADLs (OR: 1.17; CI: 1.02–1.34), more chronic illnesses (OR: 1.25; CI: 1.32), or ADRD (OR: 2.90; CI: 2.14–3.93) were all at greater odds of entering a nursing home. In contrast, respondents who identified as Black (OR: 0.61; CI: 0.48–0.77), Hispanic or Latino (OR: 0.36; CI: 0.25–0.52), or who smoked (OR: 0.73; CI: 0.55–0.98) had lower odds of nursing home entry (Table 5). A sensitivity analysis that excluded individuals living with ADRD yielded similar results, suggesting that social isolation influences nursing home entry even for older adults who do not experience long-term cognitive impairment.

Table 5. Overnight nursing home stays among community-dwelling older adults

Characteristic	Odds Ratio	95% Confidence Interval	P-Value
Social isolation score ^{a***}	1.21	1.14 – 1.29	<0.001
Loneliness score ^{b**}	1.06	1.02 – 1.11	0.008
Depression score ^{c**}	1.06	1.02 – 1.10	0.006
Time point			
Time 1 (2008-2010)	<i>Ref.</i>		
Time 2 (2012-2014)	1.02	0.87 – 1.19	0.797
Time 3 (2016-2018)	1.01	0.85 – 1.19	0.930
Female ^{***}	1.29	1.11 – 1.49	0.001

Age, years				
65 to 74	<i>Ref.</i>			
75 to 84 ^{***}	2.40	2.04 – 2.82		<0.001
85 to 94 ^{***}	6.67	5.41 – 8.21		<0.001
95 or older ^{***}	10.68	5.50 – 20.74		<0.001
Race				
White	<i>Ref.</i>			
Black ^{***}	0.61	0.48 – 0.77		<0.001
Other	0.81	0.51 – 1.29		0.376
Hispanic ^{***}	0.36	0.25 – 0.52		<0.001
Medicaid	1.15	0.89 – 1.48		0.289
Smokes [*]	0.73	0.55 – 0.98		0.035
Not physically active ^{***}	1.64	1.42 – 1.89		<0.001
ADL score ^{d***}	1.59	1.43 – 1.77		<0.001
IADL score ^{e*}	1.17	1.02 – 1.34		0.029
Number of chronic illnesses ^{f***}	1.25	1.18 – 1.32		<0.001
ADRD ^{***}	2.90	2.14 – 3.93		<0.001

Notes. Sample size: N = 11,583 unique individuals; 21,479 person-years; Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and higher scores indicate more severe social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

^{*}Significant at $p < 0.05$.

^{**}Significant at $p < 0.01$.

^{***}Significant at $p \leq 0.001$.

Mortality

Social isolation was significantly associated with greater odds of mortality (OR: 1.13; CI: 1.08–1.19). Depression (OR: 1.02; CI:1.08), but not loneliness (OR: 1.00; 0.96–1.03), was significantly associated with mortality as well. Older adults who smoked (OR: 1.92; CI: 1.62–2.27), did not exercise (OR: 1.97; CI: 1.75–2.22), had difficulty with ADLs (OR: 1.43; CI: 1.32–1.56) or IADLs (OR: 1.24; CI: 1.12–1.36), or who had more chronic illnesses (OR: 1.27; CI: 1.21–1.32) or ADRD (OR: 1.35; CI: 1.07–1.71) were all at greater odds of mortality. However, respondents who identified as female (OR: 0.60; CI: 0.54–0.67) or Hispanic/Latino (OR: 0.64; CI: 0.49–0.81) faced lower odds of mortality (Table 6).

Table 6. Mortality among community-dwelling older adults

Characteristic	Odds Ratio	95% Confidence Interval	P-Value
Social isolation score ^{a***}	1.13	1.08 – 1.19	<0.001
Loneliness score ^b	1.00	0.96 – 1.03	0.939
Depression score ^{c***}	1.05	1.02 – 1.08	0.001
Time point			
Time 1 (2008-2010)	<i>Ref.</i>		
Time 2 (2012-2014) ^{***}	0.73	0.64 – 0.83	<0.001
Time 3 (2016-2018) [*]	0.87	0.76 – 0.99	0.037
Female ^{***}	0.60	0.54 – 0.67	<0.001
Age, years			
65 to 74	<i>Ref.</i>		
75 to 84 ^{***}	1.93	1.70 – 2.20	<0.001
85 to 94 ^{***}	4.08	3.42 – 4.86	<0.001
95 or older ^{***}	10.14	6.58 – 15.63	<0.001

Race				
White		<i>Ref.</i>		
Black	0.90	0.76 – 1.05		0.215
Other	0.88	0.64 – 1.25		0.452
Hispanic ^{***}	0.64	0.49 – 0.81		<0.001
Medicaid	1.20	1.00 – 1.44		0.055
Smokes ^{***}	1.92	1.62 – 2.27		<0.001
Not physically active ^{***}	1.97	1.75 – 2.22		<0.001
ADL score ^{d***}	1.43	1.32 – 1.56		<0.001
IADL score ^{e***}	1.24	1.12 – 1.36		<0.001
Number of chronic illnesses ^{f***}	1.27	1.21 – 1.32		<0.001
ADRD [*]	1.35	1.07 – 1.71		0.013

Notes. Sample size: N = 12,811 unique individuals; 24,180 person-years; Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer’s disease and related dementias
^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and higher scores indicate more severe social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

^{*}Significant at $p < 0.05$.

^{**}Significant at $p < 0.01$.

^{***}Significant at $p \leq 0.001$.

Discussion

This study examined the association between social isolation and the occurrence of overnight hospital stays, nursing home entry, and mortality reported during biennial follow-up interviews among a panel of community-dwelling older adults followed between 2006-2018. The empirical results show that social isolation was significantly

associated with increased odds of nursing home entry and mortality, but that social isolation did not affect the odds of a hospitalization.

This study found a strong, significant association between nursing home entry and social isolation. To the best of this author's knowledge, the study is the first to examine this relationship over time among a large cohort of community-dwelling older adults in the United States. It is hypothesized that individuals who are more socially isolated have fewer supports at home, making them more likely to enter nursing homes for their post-acute and/or long-term care needs.

This finding has important implications for Medicaid spending on HCBS and Medicare billing codes. Addressing social isolation in the community setting through additional points of contact covered under Medicaid HCBS may be a cost-effective point of intervention in the effort to prevent or delay nursing home entry. Similarly, Medicare coverage of social isolation screening and treatment may help deter costs associated with 30-day hospital readmissions or discharges to skilled nursing facilities. It is in hospitals' best interests for ICD-10 diagnostic codes to be expanded and for existing Z-codes to better utilized to bill for screening, referral, and treatment of social isolation and loneliness. For instance, z60.4 for social exclusion and rejection, z63.2 for inadequate family support, z63.3 for absence of a family member, and z65.8 for other specified problems related to psychosocial circumstances could be harnessed to address psychosocial conditions that might otherwise increase the chance of a rehospitalization.⁹⁶ Similarly, CPT or HCPCS billing codes that allow outpatient providers to bill for social

isolation screening or referrals to community supports and services may help address the problem upstream.

While loneliness or perceived isolation has received the bulk of attention in past literature, the objective measure of actual social isolation lends itself well to informing programs and policies that aim to reduce costs associated with nursing home entry. Furthermore, social isolation and loneliness may be exacerbated in institutional settings, where older adults may be confined to the premises, live farther away from friends and family, and have difficulty forming meaningful relationships with other residents or staff around them.^{4,20} The findings from this study provide further impetus to shift clinical or supportive resources to the community setting. Future research should examine the effectiveness of community-based interventions, such as provision of HCBS, that combat social isolation in the effort to delay or offset nursing home placement.

This study corroborates previous literature in its finding that increased levels of social isolation are significantly associated with mortality in older adults.^{9,57} Perhaps more importantly, it contributes to the literature on loneliness and mortality, of which there is considerably less empirical evidence than for social isolation and mortality.^{4(chap-5)} While substantial evidence suggests that loneliness is associated with increased rates of premature death, this evidence is based on research designs that do not control for social isolation. This study takes the important step of examining the effects of social isolation and loneliness on mortality in the same analytic model and sample.

In line with a prior rigorous study performed using data from ELSA in the United Kingdom,⁵⁷ findings from the present study also suggest that loneliness is not

significantly associated with mortality when controlling for social isolation, depression, and other sociodemographic and health-related factors. It may be that loneliness, often thought to be the psychological manifestation of objective social isolation, is not the primary mechanism explaining the relationship between social isolation and early mortality.^{4,57}

A significant empirical relationship between social isolation and hospitalization was not observed; if anything, the study yielded suggestive evidence that social isolation in older adults may be associated with fewer hospital stays. Research on the impact of social isolation on hospitalizations is scarce, and evidence continues to be mixed.⁴ Although one study suggests social isolation may be associated with greater inpatient spending among Medicare beneficiaries,³³ most prior studies have reported varied findings, often find no impact, tend to be internationally-based,⁶³ and fluctuate when adjustments are made for sociodemographic and health-related factors.³³ In the present study, older adults who were socially isolated were hypothesized to be at increased risk for hospitalizations due to forgone preventive care, worsened physical and mental health, or greater reliance on emergency departments for routine care. However, this hypothesis was not supported by the data.

Several factors may explain why findings from this dissertation do not show evidence of increased risk of hospitalization among socially isolated older adults. It is possible that socially isolated older adults lack the social support of caregivers who might otherwise encourage a visit to the emergency room or provide timely transportation to a hospital. Additionally, individuals who require immediate hospitalization may seek acute

care regardless of social support, which would result in a weak association between social isolation and increased risk of hospitalization. Though it is mixed, some research suggests that socially isolated older adults may forgo preventive care services.^{4(chap7)} It is plausible that they instead rely on emergency departments for routine care. If these individuals are not admitted as inpatients, then social isolation may be more closely associated with emergency department utilization as compared to overnight hospital stays.¹¹ Future research should explore the associations between social isolation and outpatient care, emergency department visits, and hospitalizations in clarifying these relationships.

Despite the null findings for hospital stays, this study contributed to the literature on social isolation and acute care by addressing the problem using a large population-based sample from the United States, a longitudinal analytical approach, a multi-domain characterization of social isolation, and by adjusting analyses to control for loneliness.^{4(chap7)} Additional work that examines the impact of social isolation on hospitalization is still needed to elucidate this relationship.

Another notable finding relates to the interplay between depression and loneliness in their associations with hospitalizations, nursing home entry, and mortality. Both conditions were significantly associated with higher rates of nursing home entry. However, only depression was significantly associated with hospitalizations and mortality. Given that depression and loneliness are moderately correlated, it is somewhat surprising that one but not the other explains these outcomes. It may be that depression, as opposed to loneliness, represents a more acute clinical syndrome that better

approximates illness severity and thus serves as a more important explanatory pathway between social isolation and hospitalizations or mortality. For instance, depression may encompass adverse symptoms with direct implications for health, such as sleep problems, appetite loss, and suicidal thoughts. Additionally, depression may take longer to manifest than loneliness and thus, at the point of diagnosis, may indicate more exacerbated health, which could explain the stronger associations with acute care use and mortality.

Finally, age, race, and ethnicity played important roles as factors that influence the association between social isolation and each outcome measure. Though the direct implications of older age for increased health care utilization and mortality may seem obvious, there may also be a component of social isolation at play. Past research has suggested that the oldest age brackets have fewer options for social connection, placing those individuals at further risk for adverse outcomes above and beyond the deterioration in health that is associated with increased age.^{4(chap7-6),97}

Interestingly, respondents who identified as Hispanic or Latino enjoyed significantly lower odds of hospitalizations, nursing home stays, and mortality in all three analyses. Additionally, Black respondents experienced lower odds of hospitalizations and nursing home stays when compared to their White counterparts. The majority of epidemiological studies do not stratify results by race or ethnicity, and it is unclear whether these findings reflect more robust social connections among minority populations in general, or whether minority persons who experience social isolation are somehow better insulated from negative health consequences. In line with the first argument, a large epidemiological study using the National Health and Aging Trends

Study found that Black and Hispanic older adults had lower odds of social isolation compared with White older adults.⁵ On the other hand, a population-based study using the National Health Interview Survey found that Hispanics with only moderate levels of social integration were just as protected against mortality as Hispanics with high levels of social integration, whereas for Whites and Blacks, only the highest levels of social integration provided a survival advantage.⁹⁸ Future research should consider the dose-response effect of social isolation on hospitalizations, nursing home entry, and mortality among members of different racial and ethnic groups, and moreover, whether any of these identities are associated with factors that may moderate the impact of social isolation on adverse forms of health care utilization.

With regard to the lower rates of hospitalizations and nursing home entry, it could also be that a cultural distrust of inpatient and long-term care settings, combined with the lack of affordability of hospitals and nursing homes, results in poorer access to needed care. Following this rationale, the lower odds of hospitalization and nursing home entry may represent a racial inequity as opposed to an advantage. For instance, members of minority populations who are low income and live in states that have not expanded Medicaid may be just above the poverty line needed to qualify them for Medicaid, which would otherwise cover long-term care for isolated individuals who lack caregiver support. Additional work is needed to understand whether the lower odds of hospitalization and nursing home entry seen among minority populations in this study represent an advantage or disadvantage to these subsets of older adults.

This study includes several limitations. First, the data were observational and mainly gathered through self-report. It is difficult to draw causal conclusions due to the observational nature of the data. Additionally, rates of social isolation, chronic illness, hospitalization, and nursing home entry, among other variables, are likely to be underreported. It is also quite likely that the population of interest, socially isolated individuals – and particularly older adults experiencing the most extreme levels of social isolation – are harder to locate and recruit and thus were less likely to participate in this study.^{4,99} However, problems related to underrepresentation and underreporting likely lead to underestimates, not overestimates, of the associations between social isolation and negative health outcomes.

Second, it is not possible to rule out issues of reverse causality; i.e., that social isolation may be more common in older adults with a higher severity of illness, and that health care utilization and mortality are higher because of the greater proportion of illness rather than because of social isolation.⁵⁷ While this possibility cannot be ruled out completely, previous work in ELSA, an HRS-sister study, has yielded similar results after trying to attenuate this concern by excluding the sickest participants.⁵⁷ Future research should consider the use of instrumental variables and other causal methods to further tease out this possibility.

Finally, the variables included in the dataset exclude measures of some factors that could influence a person's ability to access in-person care (e.g., precise geographical indicators, proximity to clinical locations, access to transportation, attitudes about health care use).⁶⁰ Future research that is able to make use of more granular geographic

identifiers and issues or attitudes related to accessing care may help elucidate the relationships between social isolation and health care utilization.

In conclusion, this study found that social isolation was significantly associated with nursing home entry and increased rates of mortality among older adults. Overall, this study extends the research literature on social isolation and health care utilization by using a strong analytical approach, longitudinal design, large sample representative of the United States population, multidimensional measure of social isolation, and by controlling for both social isolation and loneliness in the same sample. Programs and policies that aim to curtail health care spending by reducing nursing home entry, that aim to improve quality of life through enhancing social connection, and that aim to reduce early mortality rates should consider objective social isolation as an amenable point of intervention to improve health-related outcomes.

V. STUDY TWO: LONGITUDINAL EFFECTS OF SOCIAL ISOLATION ON LONG-TERM NURSING HOME PLACEMENT AND MORTALITY IN COMMUNITY-DWELLING OLDER ADULTS – A TIME-TO-EVENT ANALYSIS

Nursing homes are the primary providers of long-term care in the United States. As of 2015, there were about 1.4 million nursing home residents.³ However, the majority of older Americans would prefer to age at home or in the community as opposed to institutional care settings.^{1,2} Not only do older adults prefer to live at home to maintain their independence and personal space,¹ but the average cost of nursing home care was \$82,000 annually in 2016.³ Avoiding the high cost of care associated with nursing homes is also a priority for payers such as Medicaid, which covers the vast majority of long-term care. In 2015, the cost of nursing home care totaled over \$55 billion for Medicaid alone.³

Older adults who are more socially connected may be better equipped with the resources and instrumental support needed to delay long-term care placement. Conceivably, one's care trajectory may in part depend on the social resources, and consequently, pooled assets, available to an older adult. For instance, an older adult with more social resources may have finances saved or made available by their adult children to afford informal or formal caregiving at home. If needed, this individual may transition to an independent living facility or assisted living facility before resorting to a nursing home. When a well-connected older adult reaches the point of requiring nursing home care, it is plausible that they are older⁷³ and have exhausted more of their financial assets, thereby qualifying for Medicaid coverage of long-term care.

In contrast, a socially isolated older adult may be more likely to lack the social and financial support needed to remain at home or transition to a care setting that provides more independence than a nursing home. An isolated older adult may qualify for Medicaid coverage of long-term care sooner and, from a clinical perspective, may necessitate a higher level of care sooner given the association between social isolation and myriad chronic health conditions.⁴ In these cases, long-term care placement may be appropriate, but potentially could have been avoided with better provision of social support earlier on in the care trajectory.

Research has yet to examine whether social isolation may be a risk factor for earlier long-term care placement among older adults in the United States. Syntheses of longitudinal studies have found that living alone is associated with increased risk of institutionalization, whereas marital status, greater number of living children, and familial support are associated with a decreased risk.^{50,70} A sense of community engagement is thought to be associated with greater likelihood of remaining in the community.⁵¹ Studies based on Iowan and British populations have also found that loneliness is significantly associated with a higher likelihood of nursing home admission and shorter time to nursing home admission.^{49,100} Similarly, an American study found that a lack of perceived social support was associated with nursing home stays longer than 30 days among older adults who lived alone and had recently experienced a health shock.¹⁶ Work from Canada suggests that older adults with poorer social connections who are hospitalized or live in assisted living facilities may be at greater risk for transitioning to long-term care, though findings vary based on resident age, frailty levels, and

characteristics of the discharging facility.^{73,101} Finally, a German study that used the Lubben Social Network Scale found that social isolation was associated with double the odds of institutionalization.⁷² However, the study focused on the oldest old, used a measurement scale that combines objective and subjective aspects of social connection, and did not include distinct measures for both social isolation and loneliness.

The present study is novel in its examination of social isolation as a risk factor for earlier time to long-term care placement. By using a decade-long follow-up period, a United States-based population, a multidimensional measure of objective social isolation, and inclusion of measures for both social isolation and loneliness, this study addresses gaps previously identified by reviews of the literature.^{4(chap2),63} Policy interventions to reduce nursing home placement have focused on delivering goods and supportive services to older adults through HCBS. The delivery and enhancement of social connections and contacts through avenues such as HCBS might be a promising tactic for reducing nursing home stays if social isolation is associated with earlier time to long-term care placement.

Research Questions

- 1) Are there differences in the time to long-term nursing home placement between older adults who are socially isolated compared to not socially isolated?

Hypothesis: Socially isolated older adults will experience earlier time to long-term care placement due to a higher burden of illness, faster deterioration of health, and lack of social support at home compared to older adults who are not socially isolated.

2) Are there differences in the time to mortality between older adults who are socially isolated compared to not socially isolated?

Hypothesis: Socially isolated older adults will die earlier than older adults who are not socially isolated due to the negative impacts of social isolation on lifestyle/behavioral and psychological factors that directly or indirectly lead to mortality.

In addition to the study-specific analytical approach described below, overarching methods applicable to all three studies are described in Chapter III.

Approach

The purpose of this study was to examine whether social isolation is associated with earlier time to 1) long-term nursing home placement and 2) mortality among a sample of community-dwelling older adults who were followed for ten years, spanning 2006-2018. Social isolation was measured as a binary variable where scores greater or equal to 3 classified participants as socially isolated. Long-term care was defined as a nursing home stay lasting 100 days or more. Parametric, case II interval-censored, proportional hazards regression models were fitted to the event-time data to estimate the relationships between social isolation and each outcome over time.

Equation 2 Interval-censored proportional hazards regression

$$\log h_i(t) = \log \beta_0(t) + \beta_1 \text{Isolated}_i + \beta_2 \text{Lonely}_i + \beta_3 \text{Depressed}_i + \beta_4 X_i + \beta_5 Z_i + \varepsilon_i$$

In the general estimating equation presented in Equation 2, $\log h_i(t)$ represents the log hazard rate of experiencing the outcome (i.e., long-term nursing home placement or death) for a given individual i at time t . The baseline log hazard rate is expressed by $\log \beta_0(t)$. The key explanatory variable of interest is Isolated_i , a binary variable that

categorizes a given individual i as socially isolated or not socially isolated at the time of their index interview. Secondary explanatory variables of interest include $Lonely_i$ and $Depressed_i$, continuous variables that comprise the loneliness and depression scores for an individual i during their baseline interview. Next, X_i represents a vector of individual demographic covariates including gender, race, ethnicity, age, and Medicaid status, while Z_i represents a vector of health-related covariates including physical activity, smoking, number of chronic conditions, functional status, and ADRD. Lastly, ε_i represents the error term. Drawing from the conceptual framework (Figure 1), the estimated coefficients approximate how respondents with different demographic, psychosocial, lifestyle, and morbidity attributes experience different hazard rates of long-term nursing home placement and mortality.

Data Structure

Outcome data for the time-to-event analyses were stacked across Sample A and Sample B participants to create five time points for those who completed the baseline social isolation questionnaire during 2006 (Sample A) or 2008 (Sample B) (Figure 3). Social isolation, loneliness, depression, and the additional covariates informed by the conceptual framework (Figure 1) were measured at baseline and used to estimate the proportional hazard of experiencing a long-term nursing home stay or death across a period of ten years, as depicted in Figure 3.

Sample	Baseline	→	Time 1 (2 years)	→	Time 2 (4 years)	→	Time 3 (6 years)	→	Time 4 (8 years)	→	Time 5 (10 years)
Sample A	2006		2008		2010		2012		2014		2016
Sample B	2008		2010		2012		2014		2016		2018

Figure 3. Stacked dataset structure for interval-censored time-to-event analyses with five time points spanning 2006-2018

Notes: Time-to-event analyses used interval-censored proportional hazards models to examine the relationships between psychosocial factors (e.g., social isolation) and relevant covariates measured at baseline with time until occurrence of key outcome events (i.e., long-term nursing home placement and mortality) over ten years. Each wave, a rotating 50% subsample of the longitudinal cohort provided information on key psychosocial factors. Data was then stacked for each subsample (Sample A and Sample B) and re-assessed every two years over five time points for both groups.

Participants

The unit of analysis in this study was a unique older adult. Individuals could only be represented in the analytic sample once. Individuals were followed over the course of ten years until they died, were lost to follow-up, or the follow-up period concluded. To be eligible for inclusion, respondents had to be community-dwelling and at least 65 years of age at the time of their index Psychosocial & Lifestyle Questionnaire in 2006 (Sample A) or 2008 (Sample B). Respondents missing more than three of the six components required to calculate a baseline social isolation score were excluded from the analyses.

Censoring

Right-censoring and case II (general) interval-censoring were used in estimating the proportional hazards associated with social isolation and each outcome.

Right-censoring occurs when the true unobserved event lies to the right of the censoring time. In the present analyses, observations were right-censored if the event occurred after the ten-year study period or, in the case of the time to nursing home placement analysis, never at all. In the time to mortality analysis, participants were also right-censored if they were lost to follow-up prior to the occurrence of the outcome or the conclusion of the study period. In the time to nursing home placement analysis, individuals were right-censored if they died prior to the outcome having occurred or the conclusion of the study period. However, individuals who were lost to follow-up for reasons other than death before the end of the study were excluded from the time to nursing home placement analysis, due to concerns that their loss to follow-up could be related to the event of interest (i.e., long-term care placement).

The study also made use of case-II interval-censoring, which occurs when the outcome of interest is not exactly observed but is known to lie within an interval between two time points.¹⁰² In this instance, observations were interval-censored when nursing home placement or death was known to have occurred sometime during the 2-year interval between two interviews. By not assuming interval event times as exact times, the analysis reduces biased estimates and underestimation of the true error variance.¹⁰³

A theoretical example of the censoring structure is presented in Figure 4. In this schematic, the outcome of interest never occurred for IDs #3, 6, 7, and 9, which are right-censored. For example, for ID #3, the lower endpoint is Time 5 (10 years) and the upper endpoint is coded as missing; we do not know if the event could have occurred after the follow-up period, all that is known is that the event did not occur by the final timepoint (Time 5).

In contrast, the outcome did occur for IDs #1, 2, 4, 5, 8, and 10. The “X” designates the true time during which the event occurred; however, this event time is not known by the analyst. The analyst can say with certainty that the event occurred since the prior interview, within the 2-year interval. These observations are interval-censored.

In cases where an event occurred, the lower (left) endpoint of the interval represents the last measurement occasion before the event occurred, and the upper (right) endpoint of the interval represents the first occasion after which the event is known to have occurred. For example, for ID #1, the lower endpoint is Time 1 (2 years) and the upper endpoint is Time 2 (4 years). For ID #10, the lower endpoint is Baseline (0 years) and the upper endpoint is Time 1 (2 years). For ID #4, the lower endpoint is Time 4 (8

years) and the upper endpoint is Time 5 (10 years). When such events are known to have occurred within the 2-year interval, cases are interval-censored.

ID	Baseline			Time 1	Time 2	Time 3	Time 4	Time 5	Event ever occurred?	Censoring
	Socially isolated?	Age (years) / other covariates		Event between 0-2 years	Event between 2-4 years	Event between 4-6 years	Event between 6-8 years	Event between 8-10 years		
1	no	65-70			X				yes	interval-censored
2	yes	70-75						X	yes	interval-censored
3	no	70-75	→						no	right-censored
4	no	65-70						X	yes	interval-censored
5	yes	90+			X				yes	interval-censored
6	no	80-85	→						no	right-censored
7	no	90+							no	right-censored
8	no	70-75	→				X		yes	interval-censored
9	yes	65-70							no	right-censored
10	no	85-90		X					yes	interval-censored

Figure 4. Schematic for interval-censored time-to-event analyses

Model Selection

Several parametric survival distributions and parameterizations were fit to the event-time data in selecting the final models. Goodness-of-fit plots were examined for exponential distributions with a proportional hazards parameterization, Weibull distributions with robust standard errors and a proportional hazards parameterization, and lognormal distributions with an accelerated failure-time parameterization. Plots with the Cox–Snell residuals and the estimated cumulative hazard function corresponding to these residuals were used in the selection of the best fitting model. The plot in which the plotted estimated cumulative hazards were closest to the reference line formed by the Cox–Snell residuals determined the best fitting model.

Results

This study included 8,364 community-dwelling older adults in the United States. The overall sample included 4,166 participants (49.81%) from Sample A and 4,198 participants (50.19%) from Sample B (Figure 3). The time to nursing home placement analysis included 6,705 right-censored observations and 650 interval-censored observations for whom long-term nursing home placement occurred. The time to mortality analysis included 4,784 right-censored observations and 3,580 interval-censored observations for whom death occurred.

A majority of respondents were female and identified as White and non-Hispanic/Latino. About 15% of older adults were socially isolated, reflecting estimates from previous studies using the same dataset and similar measures of social isolation.^{33,40,57,86} The average participant was not lonely (defined as scoring lower than a

6) and had normal levels of depression (defined as scoring lower than a 4). About 9% of individuals were placed into long-term care and over two thirds died during the ten-year follow-up period. Additional descriptive characteristics can be found in Table 7.

Table 7. Study two: Descriptive characteristics of community-dwelling older adults

Measure	Number (%) or Mean Score (SD)
Explanatory variables	
Socially isolated ^a	1,240 (14.83)
Loneliness score, ^b mean (SD)	4.39 (1.58)
Depression score, ^c mean (SD)	1.37 (1.86)
Outcome variables	
Long-term nursing home placement	650 (8.84)
Deceased	3,580 (42.80)
Female	4,834 (57.80)
Age in years	
65 to 74	4,554 (54.45)
75 to 84	2,886 (34.51)
85 to 94	874 (10.45)
95 or older	50 (0.60)
Race	
White	7,135 (85.31)
Black	990 (11.84)
Other	239 (2.86)
Hispanic	554 (6.62)
Medicaid	606 (7.25)
Smokes	772 (9.23)
Not physically active	3,666 (43.83)
ADL score, ^d mean (SD)	0.19 (0.53)
IADL score, ^e mean (SD)	0.11 (0.43)
Number of chronic illnesses, ^f mean (SD)	2.30 (1.28)
ADRD	279 (3.34)

Notes. Sample size: N = 8,364 unique individuals; Numbers represent n (%) unless otherwise indicated; Missing observations include n = 1,009 for long-term nursing home placement; Long-term nursing home placement is defined as having a nursing home stay lasting 100 days or more.

Abbreviations. Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias.

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and were binarized so that a score of 3 or above indicates social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

Goodness-of-fit

Exponential distributions and Weibull distributions with proportional hazards parameterizations were compared during model selection. A lognormal distribution with an accelerated failure-time parameterization was also examined for mortality. Judging by the closeness of the plotted estimated cumulative hazards to the reference line formed by the Cox–Snell residuals, the model using an exponential distribution with proportional hazards parameterization was selected for the mortality outcome. As depicted in Figure 5, goodness-of-fit was relatively precise for this outcome.

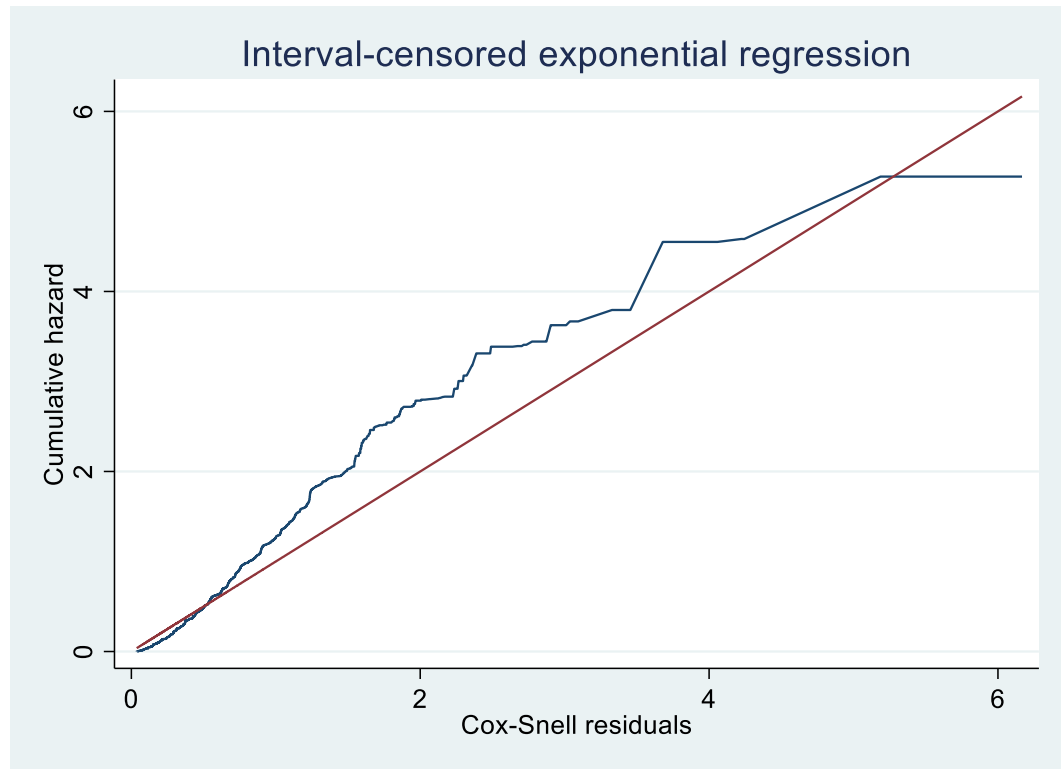


Figure 5. Goodness-of-fit for an interval-censored exponential regression model with proportional hazards in estimating mortality

Notes: Goodness of fit for the model can be determined visually by plotting the Cox–Snell residuals versus the estimated cumulative hazard function corresponding to these residuals. The model appears to fit the data well given that the plotted estimated cumulative hazards are close to the reference line that is formed by the Cox–Snell residuals.

The Weibull distribution with robust standard errors and proportional hazards parameterization was selected for the model estimating long-term nursing home placement (Figure 6). Though not as good-fitting as the model estimating mortality, the model estimating long-term nursing home placement fit moderately well.

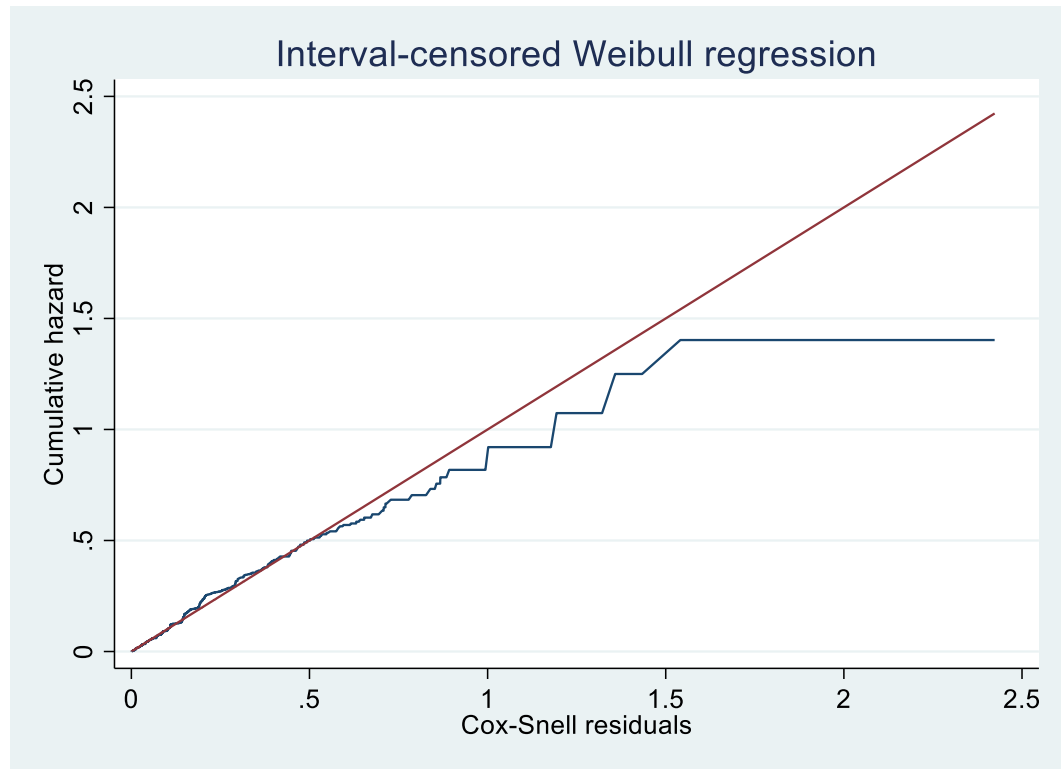


Figure 6. Goodness-of-fit for an interval-censored Weibull regression model with proportional hazards in estimating long-term nursing home placement

Notes: Goodness of fit for the model can be determined visually by plotting the Cox–Snell residuals versus the estimated cumulative hazard function corresponding to these residuals. The model appears to fit the data moderately well given that the plotted estimated cumulative hazards are close to the reference line that is formed by the Cox–Snell residuals.

Time to Long-term Nursing Home Placement

The estimated hazard ratio of time to long-term nursing home placement among 7,355 older adults tracked over ten years was approximately 1.27 times larger for socially isolated participants than for participants who were not socially isolated (CI: 1.03–1.56). Additionally, loneliness increased the hazard of earlier long-term nursing home placement by 1.08 (CI: 1.03–1.14). However, higher depression scores did not appear to have a significant effect. Women (HR: 1.32; CI: 1.11–1.57), Medicaid enrollees (HR:

1.40; CI: 1.02–1.93), physically inactive participants (HR: 1.38; CI: 1.17–1.63), older adults experiencing difficulty with IADLs (HR: 1.50; CI: 1.27–1.77), those with more chronic illnesses (HR: 1.09; CI: 1.02 – 1.16), and older adults living with ADRD (HR: 3.41; CI: 2.45–4.74) were all at higher risk for transitioning to long-term nursing home placement sooner. On the other hand, older adults who identified as Black (HR: 0.53; CI: 0.39–0.72) or Hispanic or Latino (HR: 0.33; CI: 0.20–0.54) were at lower risk of early long-term care placement. Additional findings can be seen in Table 8.

Table 8. Time to long-term nursing home placement among socially isolated older adults over ten years

Characteristic	Hazard Ratio	95% Confidence Interval	P-Value
Social isolation status ^a			
Not socially isolated	<i>Ref.</i>		
Socially isolated*	1.27	1.03 – 1.56	0.024
Loneliness score ^{b**}	1.08	1.03 – 1.14	0.002
Depression score ^c	1.02	0.98 – 1.07	0.296
Female ^{***}	1.32	1.11 – 1.57	0.002
Age, years			
65 to 74	<i>Ref.</i>		
75 to 84 ^{***}	4.05	3.33 – 4.92	<0.001
85 to 94 ^{***}	10.96	8.62 – 13.93	<0.001
95 or older ^{***}	14.86	6.13 – 36.02	<0.001
Race/ethnicity			
White	<i>Ref.</i>		
Black ^{***}	0.53	0.39 – 0.72	<0.001
Other	0.61	0.30 – 1.23	0.166
Hispanic ^{***}	0.33	0.20 – 0.54	<0.001
Medicaid*	1.40	1.02 – 1.93	0.037

Smokes	0.79	0.55 – 1.14	0.202
Not physically active ^{***}	1.38	1.17 – 1.63	<0.001
ADL score ^d	1.05	0.88 – 1.25	0.560
IADL score ^{e***}	1.50	1.27 – 1.77	<0.001
Number of chronic illnesses ^{f*}	1.09	1.02 – 1.16	0.011
ADRD ^{***}	3.41	2.45 – 4.74	<0.001

Notes. Sample size: N = 7,355 unique individuals; Long-term nursing home stays are defined as nursing home stays lasting 100 days or more.

Abbreviations. Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and were binarized so that a score of 3 or above indicates social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

*Significant at $p < 0.05$.

**Significant at $p < 0.01$.

***Significant at $p \leq 0.001$.

Figure 7 depicts the average participant's time to long-term nursing home placement curves for those who were not socially isolated versus isolated. The plot also suggests that socially isolated respondents experienced transitions to long-term care facilities earlier than older adults who were not socially isolated.

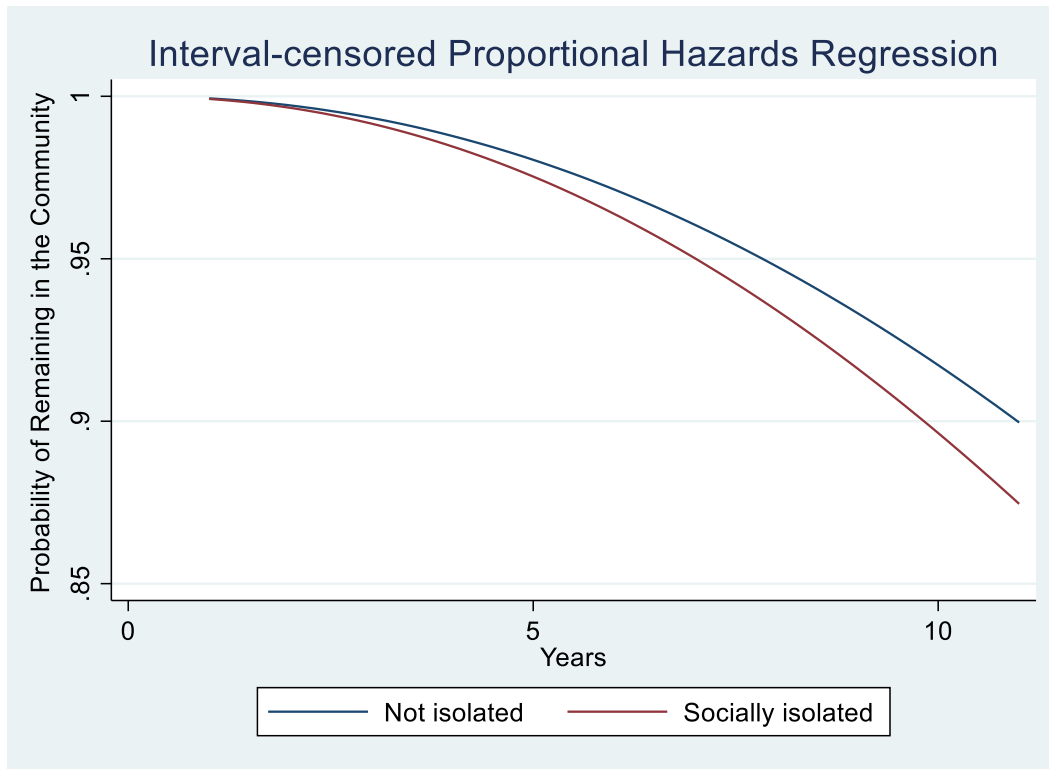


Figure 7. Survival curves for time to long-term nursing home placement among socially isolated and integrated older adults over ten years

Time to Mortality

Among a sample of 8,364 older adults followed for ten years, the estimated hazard ratio of time to mortality for those who were socially isolated was approximately 1.17 times larger than the hazard for those who were not socially isolated (CI: 1.07–1.28). Older adults with higher depression scores were at greater risk for earlier mortality as opposed to those with lower scores (HR: 1.03; CI: 1.01–1.05). Loneliness scores, however, did not appear to have a significant effect. Medicaid enrollees (HR: 1.19; CI: 1.05–1.34), older adults who smoked (HR: 1.79; CI: 1.62–1.99) physically inactive participants (HR: 1.37; CI: 1.27–1.46), older adults experiencing difficulty with ADLs

(HR: 1.16; CI: 1.10–1.23) and IADLs (HR: 1.15; CI: 1.08–1.23), those with more chronic illnesses (HR: 1.20; CI: 1.17–1.23), and older adults living with ADRD (HR: 1.32; CI: 1.13–1.53) were all at higher risk for earlier mortality. In contrast, females (HR: 0.68; CI: 0.64–0.73) and participants identifying as Hispanic or Latino (HR: 0.80; CI: 0.69–0.94) experienced a significantly reduced risk of earlier death. Additional findings can be seen in Table 9.

Table 9. Time to mortality among socially isolated older adults over ten years

Characteristic	Hazard Ratio	95% Confidence Interval	P-Value
Social isolation status ^a			
Not socially isolated	<i>Ref.</i>		
Socially isolated ^{***}	1.17	1.07 – 1.28	<0.001
Loneliness score ^b	1.02	0.99 – 1.04	0.120
Depression score ^{c**}	1.03	1.01 – 1.05	0.007
Female ^{***}	0.68	0.64 – 0.73	<0.001
Age, years			
65 to 74	<i>Ref.</i>		
75 to 84 ^{***}	2.11	1.95 – 2.28	<0.001
85 to 94 ^{***}	4.09	3.72 – 4.50	<0.001
95 or older ^{***}	7.56	5.62 – 10.15	<0.001
Race/ethnicity			
White	<i>Ref.</i>		
Black	0.92	0.83 – 1.02	0.128
Other	0.95	0.76 – 1.18	0.642
Hispanic ^{**}	0.80	0.69 – 0.94	0.005
Medicaid ^{**}	1.19	1.05 – 1.34	0.007
Smokes ^{***}	1.79	1.62 – 1.99	<0.001
Not physically active ^{***}	1.37	1.27 – 1.46	<0.001

ADL score ^{d***}	1.16	1.10 – 1.23	<0.001
IADL score ^{e***}	1.15	1.08 – 1.23	<0.001
Number of chronic illnesses ^{f***}	1.20	1.17 – 1.23	<0.001
ADRD ^{***}	1.32	1.13 – 1.53	<0.001

Notes. Sample size: N = 8,364 unique individuals.

Abbreviations. Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and were binarized so that a score of 3 or above indicates social isolation.

^bLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^cDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^dActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^eIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^fThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

*Significant at $p < 0.05$.

**Significant at $p < 0.01$.

***Significant at $p \leq 0.001$.

The survival function plot in Figure 8 depicts the survival curves for isolated and not isolated community-dwelling older adults. The risk of earlier death for an average older adult who was socially isolated was higher than that for the same older adult who was not socially isolated, again demonstrating that social isolation appears to increase the risk of earlier mortality.

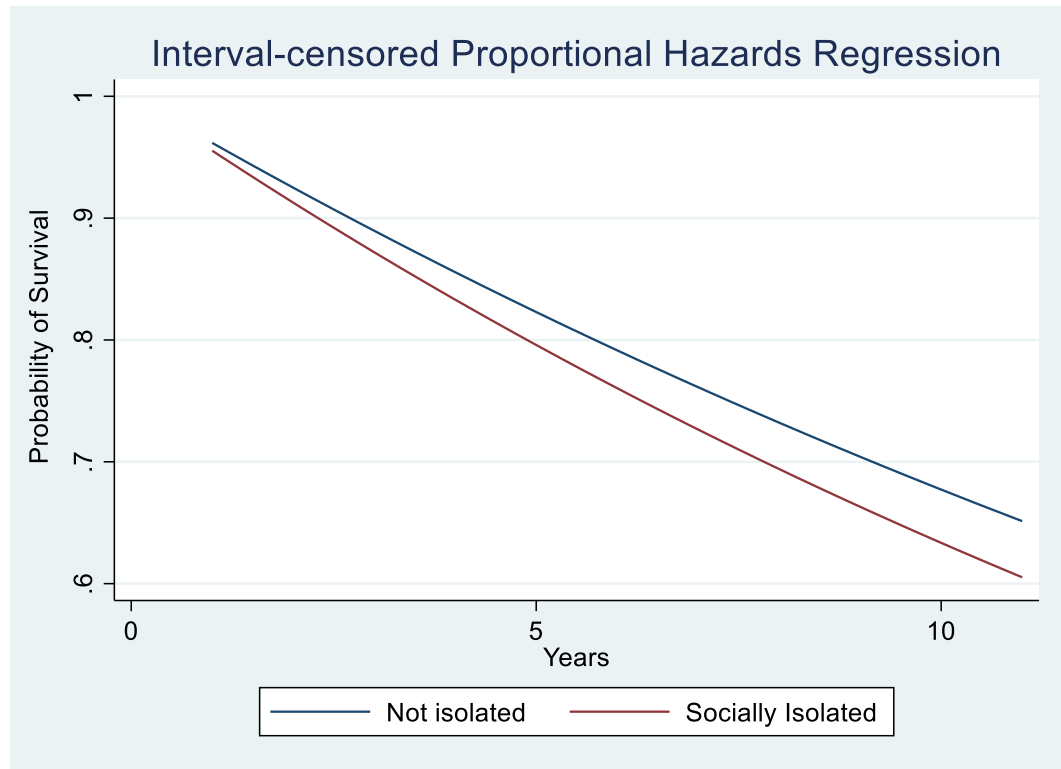


Figure 8. Survival curves for socially isolated versus integrated community-dwelling older adults over ten years

Discussion

This study found that social isolation significantly decreased the time to long-term nursing home placement and to mortality over the course of ten years among a large sample of community-dwelling older adults. Socially isolated older adults were at about 27% greater risk of earlier transitions to long-term care placement within ten years, making social isolation a larger risk factor than loneliness, smoking, difficulty with ADLs, or an individual's number of chronic conditions. Additionally, isolated older adults were at about 17% greater risk of earlier death within a ten-year period, rivaling

the effects of more well-established risk factors such as functional impairments and number of chronic illnesses.

This study builds on the existing literature on social isolation and health outcomes in several ways. The empirical finding that social isolation is associated with earlier nursing home placement is novel, as to this author's knowledge, no studies have yet examined whether socially isolated older adults are more likely to be placed into long-term care facilities over an extended period of time. In theory, socially isolated older adults who are faced with inadequate support at home may be driven to nursing home entry at earlier ages. However, it is also possible that earlier placement into nursing homes is appropriate for this population, particularly if the increased burden of illness associated with social isolation results in increased care needs that are better addressed in an institutional setting. Either way, providing senior services and social support at home may equip older adults with the care they need to either avoid nursing home placement or to deter the onset of illnesses or geriatric syndromes that might otherwise necessitate nursing home care. Additional research should explore the reasons why social isolation is associated with earlier time to nursing home placement, and whether interventions that aim to address social isolation in home or community settings have an impact on subsequent nursing home placement.

Additionally, this study builds on ongoing work that shows social isolation is a strong predictor of premature death.^{4,9,18,57} Previous work on this topic tends to be internationally-based, include short follow-up times, use unidimensional characterizations of social isolation (e.g., living alone), and often does not measure both

social isolation and loneliness in the same sample.^{4,63} As of a 2020 comprehensive review, just five studies had jointly examined the impacts of social isolation and loneliness on mortality using population-based samples, and none were conducted in the United States.⁴ This study advances the evidence base by addressing each of these limitations.

Interestingly, loneliness, but not depression, was significantly associated with shorter times to long-term care placement. However, the reverse was true for mortality; depression was associated with slightly shorter time to death whereas loneliness was not. Though loneliness and depression are closely related, it is possible that loneliness better reflects the need for instrumental support, making it a stronger predictor of long-term care placement. In contrast, depression may be indicative of the greater severity of illness associated with social isolation, making it a stronger predictor of premature death. For instance, depression may encompass adverse symptoms with direct implications for mortality, such as sleep problems, appetite loss, and suicidal thoughts. Additionally, depression may take longer to manifest than loneliness and thus, at the point of diagnosis, may indicate more exacerbated health, which could explain the stronger associations with time to mortality. Additional research is needed to more deeply explore the interplay between loneliness, depression, long-term nursing home placement, and mortality.

This study includes several notable limitations. The data are observational and mainly gathered through self-report. It is difficult to draw causal conclusions due to the observational nature of the data. Additionally, rates of social isolation, chronic illness, and nursing home stays are likely to be underreported. It is also quite likely that the

population of interest, socially isolated individuals – particularly older adults experiencing the most extreme levels of social isolation – are harder to locate and recruit and thus were less likely to participate in this study.^{4,99} Loss of follow-up due to nursing home placement is also a concern. As such, older adults who dropped out of the sample in the time to nursing home placement analysis were excluded instead of censored. Additional waves of data will help to build the sample size and should be appended as they are released to improve the power of this study. Inclusion of future HRS waves may also help to improve or better inform an appropriate distribution and parameterization of the model estimating long-term nursing home placement.

Finally, it is not possible to rule out issues of reverse causality and illness as a potential confounder; i.e., that social isolation may be more common in older adults with a higher severity of illness, and that nursing home placement and mortality are higher because of the greater proportion of illness rather than because of social isolation.⁵⁷ While this possibility cannot be ruled out completely, previous work in ELSA, an HRS-sister study, has yielded similar results after trying to attenuate this concern by excluding the sickest participants. Future research should consider the use of instrumental variables and other causal methods to further tease out this possibility.

By filling the evidence gap on the association between social isolation and long-term care placement and contributing methodological rigor to the knowledge base on mortality, this study makes advances in research on social isolation that may provide valuable information to stakeholders. Programs and policies that aim to reduce health care costs and improve quality of life by facilitating aging in place may look to social

isolation as a point of intervention. The objective nature of social isolation makes treating it relatively feasible compared to more subjective conditions such as loneliness or depression. As compared to loneliness and depression, social isolation appears to have more robust ties to multiple negative health outcomes such as nursing home entry and mortality, further elevating its appeal as a point of intervention. However, sheer increases in social contacts may not adequately address the effects of loneliness on nursing home entry or the effects of depression on mortality. Future research should evaluate whether initiatives that enhance social connectivity and support at home or in the community are able to delay nursing home stays and mortality.

VI. STUDY THREE: SENIOR SERVICES AS A MODERATOR OF THE RELATIONSHIP BETWEEN SOCIAL ISOLATION AND NURSING HOME ENTRY AMONG COMMUNITY-DWELLING OLDER ADULTS: AN EXPLORATORY STUDY

The third study performed an exploratory analysis to examine whether senior service use may moderate the effects of social isolation on subsequent nursing home entry among a cross-section of older adults followed between 2010-2012. Senior services such as Medicaid-covered HCBS are designed to meet the needs of older adults who require long-term care services and supports in their home or community. One of the policy goals behind senior services like HCBS is that, by providing these services at home, they may facilitate older adults to age in place, avoiding or delaying transitions to more costly institutional care settings.

In theory, socially isolated older adults may lack the informal caregiving support needed to carry out activities that allow them to age successfully in place. Accordingly, senior services delivered in the home or community may provide the supports needed by this at-risk group to avoid nursing home placement. However, research is mixed with regard to whether senior services are protective in preventing institutionalization versus whether they are associated with higher rates of nursing home use. For instance, service use may be an indicator of greater severity of illness or care needs, resulting in close associations with nursing home use if the impact of service use cannot be easily teased apart from the impact of illness severity. A 2020 umbrella review found inconsistent evidence for the protective benefits of HCBS in preventing or delaying long-term nursing home placement.⁷⁴

Furthermore, the extent to which senior services are delivered to socially isolated older adults who need them is unclear. On the one hand, the burden of illness and functional impairments more commonly experienced by socially isolated older adults may make them disproportionately in need of senior services.³³ But because socially isolated individuals are, by definition, isolated, they may have less contact with those who could connect them to senior services. By examining whether socially isolated older adults are more or less likely to receive senior services, this paradox can be explored.

In turn, the primary aims of this exploratory study were to determine whether certain senior services that were hypothesized to represent HCBS were used more often by older adults who were socially isolated compared to those who were not isolated, and whether the services significantly interacted with social isolation to reduce nursing home entry among older adults interviewed between 2010-2012.

Research Questions

- 1) Are socially isolated older adults more or less likely to use senior services compared to older adults who are not socially isolated?

Hypothesis: Despite their increased burden of illness, socially isolated older adults will be less likely to receive senior services due to their isolated nature, which makes it harder to identify and refer them to needed senior services.

- 2) Do senior services moderate the relationship between social isolation and nursing home entry among community-dwelling older adults?

Hypothesis: Socially isolated older adults who receive senior services will be at lower odds of entering a nursing home over a two-year time period, compared to socially isolated older adults who do not use senior services.

In addition to the study-specific analytical approach described below, overarching methods applicable to all three studies are described in Chapter III.

Approach

The purpose of this study was to examine whether receiving senior services moderated the relationship between social isolation and nursing home entry. Chi-square tests and pairwise correlation coefficients were calculated to examine the association between social isolation status and use of senior services. A multivariate logistic regression model was performed to examine whether senior service use cross-sectionally moderated the relationships between social isolation and nursing home entry.

Equation 3 Multivariate logistic regression using cross-sectional data

$$\widehat{Nursing\ Home}_i = \hat{\beta}_0 + \hat{\beta}_1 Isolated_i + \hat{\beta}_2 Serv_i + \hat{\beta}_3 X_i + \hat{\beta}_4 Z_i + \hat{\beta}_5 Isolated_i * Serv_i + \varepsilon_i$$

In the general estimating equation presented in Equation 3, $\widehat{Nursing\ Home}_i$ represents the predicted odds of experiencing an overnight nursing home stay any time over the previous two years (2010-2012) for a given individual i . The key explanatory variable of interest is $Isolated_i$, a binary variable that categorizes a given individual i as socially isolated or not socially isolated in 2010. Additionally, $Serv_i$ is a binary variable that categorizes whether a given individual i was receiving senior services hypothesized to represent HCBS between 2010-2011. Next, X_i represents a vector of individual demographic covariates including gender, race, ethnicity, age, and Medicaid status, while Z_i represents a vector of health-related covariates including loneliness, depression,

physical activity, smoking, number of chronic conditions, functional status, and ADRD in 2010. The moderating variable is represented by $Isolated_i * Serv_i$, which interacts social isolation status with senior service use for a given individual. Lastly, ε represents the error term. Drawing from the conceptual framework (Figure 1), the estimated coefficients approximate how respondents with different demographic, psychosocial, lifestyle, and morbidity attributes experience different probabilities of nursing home entry.

Health Care Mail Survey

A cross-section of participants interviewed between 2010-2012 were identified using the comprehensive analytic file that was merged from the core HRS dataset, the RAND longitudinal file, and the Psychosocial & Lifestyle Questionnaire. Additional data was then pulled from the 2011 Health Care Mail Survey, an off-year study that contains questions about senior service use. A total of 7,652 respondents completed the off-year study, with a response rate of 75%.¹⁰⁴

Data Structure

Data on senior service use is only available for 2011. Consequently, this exploratory study was limited to Sample A respondents who completed the Psychosocial & Lifestyle Questionnaire in 2010 (Table 1), completed the off-year Health Care Mail Survey on senior service use in 2011, and reported data on nursing home stays over the prior two years during the 2012 core interview. In other words, baseline social isolation status and relevant covariates from 2010 were combined with the supplemental data on

senior services collected in 2011 to estimate associations with overnight nursing home stays between 2010-2012 (Table 10).

Table 10. Study three: Measurement time points for variables of interest

Variables of Interest	Measurement Year
Social isolation	2010
Sociodemographic/health covariates	2010
Senior services	2011
Nursing home entry	2010-2012

Participants

The unit of analysis in this study was a unique respondent interviewed from 2010-2012. Individuals could only be represented in the analytic sample once. To be eligible for inclusion, the respondents had to be community-dwelling and at least 65 years of age at the time of their 2010 Psychosocial & Lifestyle Questionnaire containing social isolation data. Because the study was limited to respondents who completed the 2010 questionnaire, all participants were derived from 50% sample of the larger HRS cohort who were randomly assigned to Sample A (Table 1).

Home and Community-based Services

There is variation in which services are considered HCBS due to the state-by-state variation in Medicaid waivers that cover these services. As such, the list of senior services hypothesized to represent HCBS in the present study were modeled off of prior research performed in HRS by Sonnega et al.²¹ In line with the prior research, senior

services thought to represent HCBS included: 1) meals on wheels; 2) other food or nutrition services; 3) transportation services; 4) adult day care/respite care; 5) and chore services.²¹ Departing from their definition, 6) services for individuals with ADRD were also included, whereas supportive services for caregivers were not.

To identify older adults who received these senior services, interviewees were first prompted, “Many communities have special services available for seniors. Have you ever used any services sponsored by a senior services agency or a community organization intended to assist seniors?” Respondents who responded yes were then presented with a list of 17 senior services and asked, “Are you currently using any of these services?” Respondents who selected any of the six senior services listed above were categorized as currently using senior services thought to represent HCBS.

Results

This study included 1,689 participants, representing a weighted 15,475,582 community-dwelling older adults in the United States. A majority of respondents were female and the majority of participants identified as White and non-Hispanic/Latino. About 14% of older adults were socially isolated and just over 5% used the six senior services. These findings reflect those from previous studies that used the same dataset and similar measures of social isolation and senior service use.^{21,33,40,57,86}

Senior service use was not significantly correlated ($r = 0.02$, $p = 0.20$) or otherwise associated with social isolation status ($\chi^2(1, N = 3,203) = 1.63$, $p = 0.20$). Among older adults who used senior services, the mean number used was 1.25 (SD =

0.06). The average participant was not lonely (defined as scoring lower than a 6) and had normal levels of depression (defined as scoring lower than a 4). Just over 3% of individuals experienced an overnight stay at a nursing home. Additional descriptive characteristics can be found in Table 11.

Table 11. Descriptive characteristics of community-dwelling older adults, 2010-2012

Measure	Unweighted N (Weighted %)
Explanatory variables, mean (SD)	
Socially isolated ^a	660 (13.81)
Used senior services ^b	180 (5.40)
Loneliness score, ^c mean (SD)	4.22 (0.04)
Depression score, ^d mean (SD)	1.16 (0.06)
Nursing home entry	317 (3.33)
Female	4,931 (57.59)
Age in years, mean (SD)	74.39 (0.31)
Race	
White	5,688 (88.72)
Black	1,849 (7.69)
Other	814 (3.59)
Hispanic	1,260 (5.94)
Medicaid	852 (5.72)
Smokes	1,416 (8.82)
Not physically active	3,997 (47.98)
ADL score, ^e mean (SD)	0.19 (0.02)
IADL score, ^f mean (SD)	0.11 (0.01)
Number of chronic illnesses, ^g mean (SD)	2.28 (0.03)
ADRD	346 (1.30)

Notes. N = 1,689 raw individuals representing 15,475,582 sub-population members; Numbers represent weighted means and standard deviations where specified.

Abbreviations. HCBS: home and community-based services; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and were binarized so that a score of 3 or above indicates social isolation.

^bSenior services included: 1) meals on wheels; 2) other food or nutrition services; 3)

transportation services; 4) adult day care/respite care; 5) chore services; and 6) services for individuals with Alzheimer's disease or related dementias.

^cLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^dDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^eActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^fIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^gThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

Impact of Senior Service Use

Older adults who used any of the six senior services had 4.12 greater odds of nursing home entry in the following two years compared to those who did not use them (CI: 1.91–8.88). After adjusting for senior service use, older adults who were socially isolated were about 66% less likely to enter a nursing home than older adults who were not socially isolated (0.15–0.80). However, this relationship reversed when social isolation was interacted with senior service use. Being socially isolated in combination with using senior services was associated with 5.85 greater odds of entering a nursing home (CI: 1.11–30.94). Additionally, those of older age (OR: 1.08; CI: 1.03–1.13) and who identified as Hispanic or Latino (OR: 4.13; CI: 1.02–16.78) were at greater odds of nursing home entry. Additional results can be seen in Table 12.

Table 12. Moderating effects of senior service use on social isolation in estimating overnight nursing home stays among community-dwelling older adults, 2010-2012

Characteristic	Odds Ratio	95% Confidence Interval	P-Value
Socially isolated ^{a*}	0.34	0.15 – 0.80	0.014
Used senior services ^{b***}	4.12	1.91 – 8.88	0.001
Socially isolated × Senior services [*]	5.85	1.11 – 30.94	0.038
Loneliness score ^c	1.16	0.92 – 1.46	0.211
Depression score ^d	0.95	0.79 – 1.13	0.520
Female	0.75	0.40 – 1.43	0.379
Age, years ^{**}	1.08	1.03 – 1.13	0.002
Race			
White	<i>Ref.</i>		
Black	0.96	0.25 – 3.69	0.947
Other	0.57	0.13 – 2.52	0.456
Hispanic [*]	4.13	1.02 – 16.78	0.047
Medicaid	0.73	0.25 – 2.11	0.550
Smokes	0.58	0.14 – 2.44	0.453
Not physically active	1.61	0.82 – 3.18	0.165
ADL score ^e	1.02	0.63 – 1.66	0.921
IADL score ^f	0.94	0.48 – 1.85	0.860
Number of chronic illnesses ^g	1.18	0.93 – 1.50	0.160
ADRD	2.33	0.41 – 13.21	0.333

Notes. Sample size: N = 1,689 unique individuals representing 15,475,582 sub-population members; Ref: reference group; ADL: activities of daily living; IADL: independent activities of daily living; ADRD: Alzheimer's disease and related dementias

^aSocial isolation was measured through the 6-item Coyle-Crowe Scale. Scores range from 0-6 and higher scores indicate more severe social isolation.

^bSenior services included: 1) meals on wheels; 2) other food or nutrition services; 3) transportation services; 4) adult day care/respite care; 5) chore services; and 6) services for individuals with Alzheimer's disease or related dementias.

^cLoneliness was measured through the 3-item UCLA Loneliness Scale. Scores range from 3-9 and higher scores indicate more severe loneliness.

^dDepression was measured through the 8-item Center for Epidemiological Studies-Depression Scale. Scores range from 0-8 and higher scores indicate more severe depression.

^eActivities of daily living were measured through a 3-item scale that assessed difficulty with eating, bathing, and dressing. Scores range from 0-3 and higher scores indicate greater difficulty.

^fIndependent activities of daily living were measured through a 3-item scale that assessed difficulty with using the telephone, taking medications, and handling money. Scores range from 0-3 and higher scores indicate greater difficulty.

^gThe number of chronic illnesses ranges from 0-7 based on the presence of the following conditions: 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease, except asthma, such as chronic bronchitis or emphysema; 5) a heart attack,

coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or a transient ischemic attack; and 7) arthritis or rheumatism.

*Significant at $p < 0.05$.

**Significant at $p < 0.01$.

***Significant at $p \leq 0.001$.

Figure 9 depicts the interaction effect between senior service use and social isolation. The average predicted probability of having an overnight nursing home stay was 0.03 for older adults who were not socially isolated and did not use senior services (CI: 0.02–0.04), 0.01 for socially isolated older adults who did not use senior services (CI: 0.002–0.02), 0.10 for older adults who were not socially isolated but did use senior services (CI: 0.04–0.16), and 0.22 for socially isolated older adults who used senior services (CI: 0.17–0.42). Using senior services increased the predicted probability of nursing home entry for socially isolated older adults from about 0.01 to 0.22, whereas for older adults who were not socially isolated, using senior services increased the predicted probability of nursing home entry from about 0.03 to just 0.10. The marginal effect of using senior services on nursing home entry was 0.07 (CI: 0.01–0.13) for older adults who were not socially isolated as opposed to 0.21 (CI: 0.01–0.41) for older adults who were socially isolated.

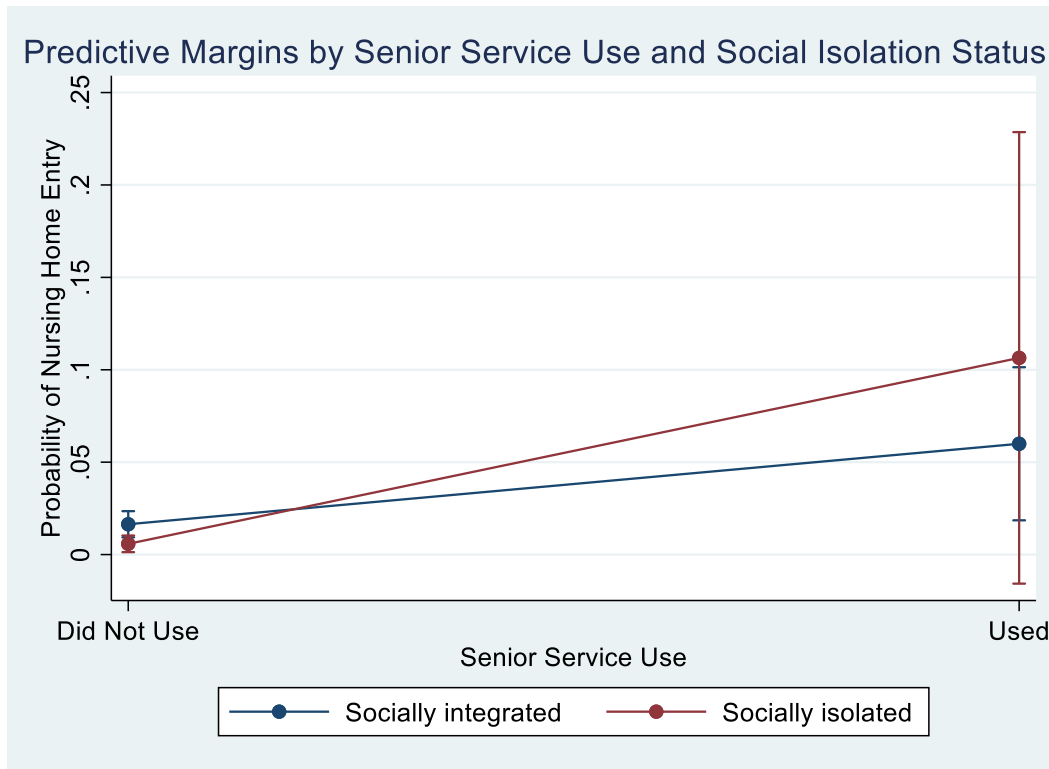


Figure 9. Predictive margins of nursing home entry by senior service use and social isolation status

Discussion

The present study examined the association between senior service use and social isolation and considered senior service use as a potential moderating covariate in estimating the relationship between social isolation and nursing home entry. Contrary to this study's first hypothesis, results demonstrated that there was no significant association between social isolation status and use of senior services. This suggests that socially isolated older adults may not be any more (or less) likely to receive needed services compared to their socially integrated counterparts.

Interestingly, social isolation was associated with lower odds of nursing home entry after adjusting for senior service use and the interaction term. Though exploratory

in nature, this finding demonstrates a reverse direction in the relationship between social isolation and nursing home entry compared to that seen in the first two studies of this dissertation.

Because HCBS are only covered for Medicaid recipients, adjusting for senior services thought to represent HCBS may approximate adjusting for low income. Long-term care in nursing homes is also covered by Medicaid. If senior services served as a proxy for low income, adjusting for them may have resulted in estimates that reflect the impact of social isolation on nursing home entry for wealthier individuals who would not be eligible for Medicaid and thus not have long-term care coverage. By effectively controlling away the impact of lower income, including senior services as a covariate in the model may have dampened the observed association that social isolation has with nursing home entry, resulting in the reversed, negative association seen in this study. However, a Pearson's correlation test suggests that senior service use was not highly correlated with Medicaid ($r=0.23$, $p<0.001$), suggesting that many services did not actually represent HCBS, clouding the viability of this interpretation.

However, needing senior services is likely to signify greater severity of illness or impairment that could lead to nursing home entry. The odds of nursing home entry were more than four times higher among older adults who used senior services compared to those who did not. Similarly, findings from a meta-analysis of longitudinal studies in the United States found that having a caregiver was associated with greater odds of nursing home entry.⁵⁰ As such, adjusting for senior service use may not only control for wealth, but for health, further muting the ability to observe the effects that social isolation has on

nursing home entry for the sickest individuals. This too might have contributed to the reverse association seen between social isolation and nursing home entry in this study.

It should be emphasized that services hypothesized to represent HCBS in the present study were surmised from a larger survey question regarding senior services in general. Certainly, some proportion of these services would have encompassed non-Medicaid covered senior services, convoluting the proxy relationships theorized above. Again, this was evidenced by the relatively weak correlation between senior service use and Medicaid status ($r=0.23$, $p<0.001$), suggesting that many of the services endorsed were covered by non-Medicaid entities. Policy stakeholders for whom this study's findings are relevant would differ depending if senior services were community-based (for instance, covered under the Older Americans Act) or represented HCBS (covered by Medicaid). Future research should control for robust indicators of health and wealth to more effectively pinpoint the role that social isolation has for nursing home entry when controlling for senior services, and should take steps to better target the roles that non-Medicaid senior services versus HCBS have on nursing home entry.

With regard to this study's second research question, findings demonstrated a strong interaction effect between social isolation and senior service use on nursing home entry. Older adults who were both socially isolated and using senior services had the highest odds of nursing home entry within a two-year follow-up window. By including an interaction term, the negative relationship between social isolation and nursing home entry was reversed so that socially isolated older adults who used senior services were at almost six times the odds of entering a nursing home. Senior services such as HCBS were

hypothesized to delay or prevent nursing home entry by delivering needed supports to individuals in their homes or communities. Instead, senior services appear to have been closely associated with entry into a nursing home, particularly for those who were isolated. It is unclear whether this reflects an actual relationship (i.e., using senior services leads to nursing home placement, perhaps through referral) or whether this reflects HCBS proxying for low income and illness severity, which are closely associated with nursing home entry in their own right. However, it is conceivable that older adults who are socially isolated but using senior services have more health issues that require nursing home care and that these issues are identified earlier than if they were not connected to senior services. Though the present study adjusted for Medicaid status, chronic illness, and difficulty with ADLs and IADLs, research that further controls for confounders related to household income and severity of illness may better be able to answer the question of whether HCBS and other senior services can fulfill their promise of offsetting nursing home visits and costs by helping older adults who lack informal supports to age in place.

Notably, the moderating effects of senior services were stronger for older adults who were socially isolated than for those who were not socially isolated. Among those who were not isolated, the average predicted probability of nursing home entry raised from 3% for those who did not use senior services to just 10% for those who did. This is in comparison to an increase of 1% to 22% for isolated older adults who used senior services. The steeper effect of senior service use for those who were isolated as opposed to those who were not isolated may reflect the greater severity of illness

associated with social isolation. Additionally, it likely reflects the higher rates of Medicaid eligibility among older adults who were socially isolated (18%) compared to those who were not (7%) ($X^2(1, N = 5,498) = 106.30, p < 0.001$). This dyad may put socially isolated older adults at much greater risk for nursing home entry compared to older adults who were not socially isolated but used senior services.

There were several limitations to this study. First, the study included a relatively small sample size (just over 1,500 in the final regression model). However, weights were applied to project the effect of social isolation and senior service use on nursing home stays to a much larger sub-population. Additionally, the data was cross-sectional and included a short follow-up duration of two years. Importantly, HCBS were deduced based on a list of senior services that participants endorsed using. However, HCBS vary from state to state based on Medicaid waivers, and the services described as HCBS in the study may have not qualified as Medicaid-covered HCBS for participants depending on where they resided. Future research would benefit from a larger sample size, lengthier follow-up period, additional waves of senior service use data, and a more accurate measurement of HCBS as opposed to other senior services. As such, this analysis was exploratory in nature and its findings should be interpreted with care.

By examining the interplay between social isolation and senior service use, this exploratory study takes an important first step in estimating the impact of delivering senior services to socially isolated older adults in the effort to offset nursing home entry. No prior studies have used a multidimensional metric of social isolation in examining whether this condition might predispose older adults to nursing home entry in the United

States, while also controlling for senior service use and loneliness. This study provides novel information for stakeholders who aim to deliver HCBS or other senior services to socially isolated older adults in an effort to reduce cost of care, improve aging in place, and enhance social support for aging populations.

VII. CONCLUSION

This dissertation contributes novel information to the research literature on social isolation and health care utilization by demonstrating that social isolation was associated with increased odds of nursing home entry and shorter time to long-term care placement among a population-based sample of community-dwelling older adults followed between 2006-2018. This research also builds on studies conducted internationally by finding that social isolation was associated with higher odds of mortality and earlier time to mortality over the course of a decade in the United States. This research did not find a significant relationship between social isolation and hospitalization, but addressed the problem using rigorous methods including a longitudinal approach and multi-component measures for social isolation and loneliness. Finally, this dissertation took initial steps in exploring the potential for senior services to attenuate the relationship between social isolation and nursing home entry, a policy goal that does not seem to be supported by the present work.

By helping to fill the evidence gap on social isolation and nursing home entry, this dissertation may provide valuable information to stakeholders who aim to reduce health care spending on post-acute and long-term care at a time when the implications for social isolation on nursing home entry have increased due to the COVID-19 pandemic. Programs and policies that aim to delay or deter nursing home entry may look to social isolation as an important contributing factor. However, there is little high-quality evidence that identifies whether interventions to address social isolation and loneliness are effective.^{4(chap9),63,99,105} Future research needs to rigorously examine whether efforts to

combat social isolation can produce meaningful reductions in the condition or subsequent health care utilization. Sheer increases in social contacts may not adequately address the effects of loneliness on nursing home entry or the effects of depression on mortality. Nevertheless, the objective nature of social isolation and its robust relationships with nursing home entry and mortality make it a tenable point of intervention compared to other psychosocial conditions. Future research should evaluate whether initiatives that enhance social connections in home or community-based settings are effective in offsetting nursing home entry, reducing premature mortality, improving quality of life and satisfaction, and curbing health care costs for patients and payers alike.

APPENDIX

1. Not married	→	Needs a response to count	→	Component One	→	Final indicator needs responses to at least 3 of 6 components to count
2. Lives alone	→	Needs a response to count	→	Component Two	→	
Social contact						
3. Children						
<input type="checkbox"/> Meet		Needs at least one response to count		Component Three		
<input type="checkbox"/> Speak	→		→			
<input type="checkbox"/> Write						
4. Family						
<input type="checkbox"/> Meet		Needs at least one response to count		Component Four		
<input type="checkbox"/> Speak	→		→			
<input type="checkbox"/> Write						
5. Friends						
<input type="checkbox"/> Meet		Needs at least one response to count		Component Five		
<input type="checkbox"/> Speak	→		→			
<input type="checkbox"/> Write						
6. Social participation						
Groups, clubs, organizations (2006)	→					
Sport/social/other clubs (2008-2018)	→					
Political/community/other groups (2008-2018)	→	Needs at least one response to count		Component Six		
Local community arts group (2014-2018)	→		→			
Religious services (2004-2018)	→					

Figure A-1. Level of missingness permitted in six-item measure of social isolation

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BIOGRAPHY

Mary Louise Pomeroy was born and raised in Washington, DC, where she graduated from the Holton-Arms School in Bethesda, Maryland in 2007. She received her Bachelor of Arts in 2011 from the University of Vermont, where she majored in psychology. She began her professional research career at Vanderbilt University Medical Center in Nashville, Tennessee, where she developed an interest in health care utilization and quality of health care for older adults. She completed her MPH at Johns Hopkins University in Baltimore, Maryland in 2016, where she concentrated in health systems and policy. From 2017-2022, she completed her PhD in health services research where she focused on health systems and policy issues for aging populations, subsidized housing residents, and individuals living with disabilities. She received the Graduate Award for Excellence in Health Systems Research in 2019, and served as the president of her University's AcademyHealth student chapter from 2019-2022. During her doctoral program, she developed a keen interest in social isolation and its implications for health care utilization among older adults. In 2022, she was awarded an NIH-funded T32 institutional research training grant that allowed her to continue her research as a post-doctoral fellow at the Johns Hopkins Roger C. Lipitz Center for Integrated Health Care. Mary Louise continues her professional development as an active member of several professional organizations including AcademyHealth and the Gerontological Society of America, where she presented results from this dissertation in 2022.