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Cognitive Impairment and the Trajectory of Loneliness in Older Adulthood: Evidence from the Health and Retirement Study

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Abstract

Objective: To examine whether the trajectory of facets of loneliness—emotional and social—varied by cognitive impairment status in older adulthood.

Methods: Data came from the Health and Retirement Study 2008–2018 waves (N = 15,352). Cognitive impairment was assessed using standard cutoffs on the modified Telephone Interview for Cognitive Status for cognitive impairment not dementia (CIND) and dementia. The 11-item UCLA Loneliness scale was used to measure emotional and social loneliness.

Results: Using multilevel modeling, we found that CIND and dementia status were associated with higher overall, emotional, and social loneliness, controlling for physical health, social contact, and depressive symptoms. The trajectory of loneliness did not vary by cognitive status. There were modest variations by sociodemographic factors.

Discussion: Persons with CIND and dementia experience heightened emotional and social loneliness, but cognitive impairment does not contribute to the worsening of loneliness. Older adults' social integration may be maintained early in cognitive impairment.

Keywords

Loneliness; Cognitive impairment; Dementia; Cognitive impairment not dementia (CIND); Longitudinal

Loneliness is the distressing feeling that arises from a mismatch between desired and perceived quality of social relationships (Hawkley & Cacioppo, 2010; Perlman & Peplau, 1982). It is distinct from social isolation, which is a lack of social connection (Coyle & Dugan, 2012). There is a growing concern regarding the loneliness of older adults. Although estimates vary across studies, a recent survey showed that one in three (34%) older Americans aged 50–80 reported feeling a lack of companionship and 27% reported feeling isolated during the past year (Solway et al., 2019). Advanced age does not cause loneliness, but older adults are more likely to experience risk factors that can contribute

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to loneliness, such as poor health conditions and changes in social relationships (Hawkley & Kocherginsky, 2018; National Academies of Sciences, Engineering, and Medicine, 2020; Pinquart & Sorensen, 2000). While recent research has established that loneliness is a strong risk factor for cognitive decline, Alzheimer's disease (AD), and dementia (Boss et al., 2015; Lara et al., 2019; Luchetti et al., 2020; Sutin et al., 2020), cognitive health may also function as a crucial factor in the trajectory of loneliness in older age.

Declines in communication and interpersonal functions are one of the recognized characteristics of neurodegenerative disorders such as Alzheimer's disease and dementia (McKhann et al., 2011). Cognitive declines are linked to changes in personality traits relevant for loneliness, like increases in neuroticism and introversion (Islam et al., 2019). Further, impaired cognition could have a negative effect on the ability to perform various tasks needed to maintain social relationships (Aartsen et al., 2004; Shouse et al., 2013). For example, those with cognitive impairment may face limitations in memory (e.g., remembering details about the other person), social perception (e.g., interpreting social cues and facial expressions), empathy, and emotional regulation that are required in social situations (Desmarais et al., 2018), resulting in social withdrawal and unmet social needs. Indeed, older adults with lower cognitive function tend to have fewer contacts with people in outer circles of their social network (Shouse et al., 2013) and are more likely to have a decrease in the proportion of friends in their social network (Aartsen et al., 2004). The severe level of dementia was linked to worsening of social network quality over 18 months (Dyer et al., 2020). These findings suggest that cognition is a prerequisite for maintaining social ties and preventing increases in loneliness. The current study examines the unique association between different cognitive functioning status (normal, CIND, and dementia) and the level of and change in loneliness among older adults.

Emotional and social loneliness

Loneliness is a multidimensional construct that includes both emotional and social dimensions (De Jong Gierveld & Van Tilburg, 2006; Weiss, 1973). Weiss (1973) noted that emotional loneliness refers to the lack of important others whom one can establish close attachment and emotional affection, whereas social loneliness refers to a perceived deficiency in social networks that provide a sense of belonging and community. Although most work is based on the unidimensional measure of loneliness, there is evidence that these two domains may have different correlates (Liu & Rook, 2013; van Baarsen et al., 2001). For example, emotional loneliness is associated with physical limitations, depression, and low income (Dahlberg & McKee, 2014; Peerenboom et al., 2015), whereas social loneliness is associated with being male, having less contact with family and friends, and low community integration (Dahlberg & McKee, 2014; Wolfers et al., 2021). Examining the role of cognitive impairment for emotional and social loneliness can be valuable in understanding the etiology of loneliness and in designing targeted interventions (Schnittger et al., 2012).

The effect of cognitive impairment on loneliness

Most research on the longitudinal association between cognition and loneliness has focused on either loneliness as a risk of cognitive impairment (Boss et al., 2015; Lara et al., 2019; Sundström et al., 2020; Sutin et al., 2020) or their bidirectional relation. Studies that modeled bidirectional associations find both one-directional (Ayalon et al., 2016; McHugh Power et al., 2019; Okely & Deary, 2019) and bidirectional (Yin et al., 2019; Zhong et al., 2017) associations. Ayalon et al. (2016), for example, found that lower levels of memory preceded higher levels of loneliness 4 years later. Similarly, when subdomains of cognitions were examined, lower levels of processing speed, visuospatial ability, and crystallized ability (Okely & Deary, 2019) and lower ability to sustain attention (McHugh Power et al., 2019) have been linked to higher loneliness longitudinally. Donovan et al. (2017) found that lower memory was associated with higher levels of loneliness, but memory did not predict change in loneliness over time. Other studies have found support for bidirectional relationships. Some studies find, for example, that lower cognitive function is associated significantly with higher loneliness at subsequent assessments and vice versa over 9 years (Zhong et al., 2017) and that memory and loneliness change reciprocally over a 10-year follow up (Yin et al., 2019).

Further, most work has focused on either loneliness and cognition as continuous variables (e.g., bidirectional relations) or cognitive status as the outcome (e.g., risk of dementia). An equally important question is whether the trajectory of loneliness varies by cognitive status. That is, do individuals report more or less loneliness if they have a significant cognitive impairment, such as CIND or dementia. Previous research showed that a person with mild cognitive impairment (MCI) may have minimal physical impairment (Petersen, 2004) but experience lower levels of social engagement (Amano et al., 2020; Kotwal et al., 2016) and greater loneliness compared to those with normative cognitive functioning (Yu et al., 2016). We extend this work to examine change in loneliness over 9 years. In addition, most previous studies used a 1-item loneliness item (Donovan et al., 2017; Okely & Deary, 2019; Zhong et al., 2017) or a 3-item version of the UCLA scale to assess loneliness (Ayalon et al., 2016; McHugh Power et al., 2019; Yin et al., 2019), leaving a gap in the literature on potentially differential associations with emotional and social loneliness (Ollanketo et al, 2019).

The current study examined whether level of and change in loneliness over 9 years varies by cognitive status (normal, CIND, and dementia) among older adults in the United States. The study addressed whether the association between cognitive impairment status and loneliness is independent of indicators for physical health, mental health, and social contact. Furthermore, we examined whether the associations differed across overall and sub-domains of loneliness (emotional and social). Lastly, we explored whether the association between cognition and loneliness differed across age, gender, race/ethnicity, and education.

Method

Sample

Data come from the Health and Retirement Study, a nationally representative panel study of Americans over the age of 50 years and their spouses regardless of age. Launched in 1992, HRS collects data on the health, family, employment, and wealth of participants every two years (Sonnega et al., 2014). In 2008, the HRS introduced an extended 11-item loneliness measure in a self-administered psychosocial questionnaire for a random 50% of eligible households. The other half of the HRS sample completed the same psychosocial questionnaire in 2010. For both samples, follow up questionnaires were administered at every other wave (i.e., four-year intervals). The 2008 and 2010 samples were combined to create a three-wave dataset that covers up to 9 years of follow-up (Wave 1: 2008/2010, Wave 2: 2012/2014, Wave 3: 2016/2018). The analytic sample was restricted to those aged 50 years and older at Wave 1 (2008/2010) and those with loneliness data available in at least one wave (N = 15,352).

Measures

Loneliness.—Overall loneliness and two facets were measured using a modified UCLA Loneliness scale (Hawkley et al., 2005; Russell, 1996). Respondents answered how often they had experienced feelings described in the items on a 3-point scale from 1 (*often*) to 3 (*hardly ever or never*). An overall loneliness score was computed as the average of the 11 items, after four negatively worded items were reverse-coded. Additionally, measures of emotional and social loneliness were scored from the subset of available items. The items were chosen from previous studies that used the UCLA scale to develop emotional and social loneliness domains that correspond to constructs from Weiss (1973; Lee & Cagle, 2017; O'Súilleabháin et al., 2019). Emotional loneliness was measured with four items that asked about lack of companionship, felt left out, isolated from others, and alone. Social loneliness was measured by the average score of four items that measured having people to talk to, turn to, feel close to, and part of a group of friends. These items were reverse-coded and averaged. For all variables, higher scores indicate higher loneliness. Cronbach alphas for overall, emotional, and social loneliness ranged from .84 to .89 at each wave.

Cognitive impairment.—Cognitive impairment was assessed with the modified Telephone Interview for Cognitive Status (TICSm; Brandt et al., 1988; Crimmins et al., 2011). The TICSm score was computed as the sum of three cognitive tasks that included immediate and delayed recall of 10 words to test memory (range 0–20 points), serial 7s subtraction to test working memory (range 0–5 points), and backward counting to test attention and processing speed (range 0–2 points). The total score ranged from 0–27 points. Participants were classified into three categories of cognitive status based on the cutoff criteria validated against a comprehensive neuropsychological assessment and clinical diagnosis of dementia (Langa et al., 2005): normal cognition (TICSm score 12–27), cognitive impairment not dementia (CIND; TICSm score 7–11), and dementia (TICSm score 0–6). HRS participants completed the cognitive assessment every two years, but because the loneliness outcome variable was assessed every four years, cognition scores from the wave concurrent with loneliness were used in the present analyses. In the analysis, cognitive

impairment status was coded as two dummy variables; (1) participants who ever scored in the CIND range at any wave were coded as “ever CIND” and; (2) persons who ever scored in the dementia range at any wave were coded as “ever dementia”. Participants who scored in the CIND range at one assessment but scored in the dementia range at a subsequent assessment were classified as “ever dementia” and were not included in the “ever CIND” category.

Sociodemographic covariates.—Self-reported sociodemographic information from Wave 1 was used as covariates. Age, gender, education years, race (White, Black or African American, other/unknown) and Latinx ethnicity were included in the statistical models.

Health and social covariates.—Physical health (Stickley & Koyanagi, 2018), depressive symptoms (Donovan et al., 2017; Peerenboom et al., 2015), and social contact (McHugh et al., 2017) from each wave were included as time-varying covariates. Physical health was defined as both functional limitations and disease burden. *Functional limitations* were assessed as whether the participant had difficulties performing instrumental activities of daily living (IADLs; sum of five items). *Disease burden* was measured as the count of ever been diagnosed with eight health conditions (high blood pressure, diabetes, cancer, lung disease, heart condition, stroke, psychiatric problems, or arthritis). *Depressive symptoms* were assessed with 7 items from Center for the Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). Participants were asked to evaluate how they felt during the past week by responding ‘yes’ or ‘no’ to the items. To avoid conceptual and measurement overlap with loneliness, one item (“felt lonely”) was excluded from the original 8 items of CES-D administered in the HRS (Sutin et al., 2020). Two positively worded items were reverse-coded, and the sum score of 7 items was used. Finally, marital status and social contact frequency were used as indicators of social isolation. *Marital status* was coded as binary (1=married, 0=Separated/Divorced, Widowed, and Never married). *Social contact frequency* was assessed across three modes of contact (meeting up, phone call, writing or email) across children, family members, and friends on a scale from 1 (*Three or more times a week*) to 6 (*Less than once a year or never*). The items were reversed scored in the direction of higher contact and averaged across modes and types of relationship.

Analytic plan

Preliminary analyses were conducted to describe the sample and examine bivariate correlations between variables at the analytic baseline wave. Multilevel modeling was used to examine the association between cognitive impairment status and change in loneliness over time using the SPSS MIXED procedure (Peugh & Enders, 2005). Multilevel modeling is suitable to accommodate repeated observations across waves (level 1) nested within respondents (level 2). The models were built sequentially to test the independent effect of cognitive impairment status on level and change in loneliness, controlling for the covariates. Model 1 included cognitive impairment status and the sociodemographic covariates. Model 2 added physical health covariates (i.e., functional limitations and disease burden). Model 3 added marital status and social contact. Model 4 added depressive symptoms. Functional limitations, disease burden, marital status, social contact frequency, and depressive symptoms were treated as time-varying covariates. The models were run

separately for overall, emotional, and social loneliness. Continuous predictor variables were grand-mean centered and categorical variables were dummy coded. Time was modeled as linear (Wave 1–3 = 0–2). An interaction term between cognitive status and time estimated the association between cognitive status and linear change in loneliness. In exploratory analyses, interaction terms were tested to examine whether the association between cognition and loneliness differed by age, gender, race/ethnicity, and education. Significant interaction effects were probed by estimating the simple slopes of loneliness outcomes for one standard deviation above and below the sample mean of the predictor variables (Aiken & West, 1991; Preacher et al., 2006). Additionally, the same analyses were performed using the cognitive impairment status at baseline as the predictor to test the robustness of the associations (Supplementary table 1). Significance was set to $p < .05$ for the main analyses and to $p < .01$ for the interactions given the large number of estimates included in the moderation models.

Results

Sample characteristics

Descriptive statistics and bivariate correlations for baseline study variables are shown in Table 1. At the first wave, 16% of the sample was categorized as CIND and 3% had dementia. The proportions of persons with CIND and dementia were higher in later waves (18% CIND and 4.5% dementia at Wave 3). The percent of participants who scored in the CIND category at any wave was 25.7%, the percent of participant who scored in the dementia category was 7.8%. Bivariate correlations at baseline indicated that the three loneliness variables had small correlations with CIND and dementia status ($r = .04$ to .11).

Loneliness Trajectories by Cognitive Impairment Status

Overall loneliness (slope b = .01, p< .001) and social loneliness increased slightly (slope b = .02, p <.001), whereas emotional loneliness did not change over the three waves (slope b = 0.001, p =.69), controlling for demographic covariates. To address the research questions, multilevel models that tested the association between cognitive status and the trajectory of the three loneliness outcomes are presented in Table 2 and Figure 1. Participants with CIND had higher overall, emotional, and social loneliness compared to participants with normal cognition. This association was independent of physical health (Model 2), marriage status and social contact (Model 3), and depressive symptoms (Model 4). Similarly, participants with dementia also had higher overall, emotional, and social loneliness compared to participants with normal cognition, independent of covariates. The interaction term between cognitive status and time indicated that both CIND and dementia were unrelated to change in loneliness over time. In other words, the slopes or rate of change in loneliness was not significantly different in people with or without cognitive impairment.

Age, gender, race/ethnicity, and education differences in the association between cognitive impairment and loneliness

We also examined whether the association between cognitive impairment and loneliness differed by age, gender, race/ethnicity, and education. Interaction terms with each of these factors were entered separately. Results are shown in Supplementary Tables 2–6. First,

there was no significant moderation effect of age, meaning that the effect of cognitive impairment on loneliness was similar across age. Second, the association between dementia and emotional loneliness differed by gender (b = −0.08, 95% CI [−0.14, −0.02], p = .008). As illustrated in Figure 2, men reported higher emotional loneliness if they had dementia compared to normal cognition. For women, emotional loneliness did not vary by cognition status. Third, the relation between cognitive status and loneliness was not moderated by race, but Latinx ethnicity moderated the link between dementia and change in emotional loneliness (b = 0.09, 95% CI [0.03, 0.15], p = .006). Decomposing the three-way interaction for emotional loneliness showed that Latinx persons with dementia had lower emotional loneliness at baseline and no change in emotional loneliness over the follow-up (b = .01, p= .596), whereas Latinx persons with normal cognition (b = −.05, p < .001), non-Latinx persons with dementia (b = −.03, p = .007), and non-Latinx persons with normal cognition (b = −.02, p < .001) all reported a small decrease in emotional loneliness over time. Fourth, the education level moderated the link between dementia and two measures of loneliness (overall loneliness; b = 0.01, 95% CI [0.01, 0.02], p <.001, social loneliness; b = 0.01, 95% CI [0.01, 0.02], p = .004). Those with higher education (1 SD more years than the mean = 15.9 years of education) reported higher social loneliness if they had dementia compared to those with normal cognition (b = 0.11, p < .001). For those with less education (1 SD less years than the mean = 9.8 years of education), cognitive status was unrelated to the level of social loneliness (b = 0.03, p = .07). A similar pattern was observed for overall loneliness. Additionally, the education level moderated the link between dementia and the change in emotional loneliness (b = −0.01, 95%CI [−0.01, 0.00], p = .009). Participants with dementia with higher education level had a steeper decline in emotional loneliness over time, whereas those with lower education had a more moderate decline in emotional loneliness. Among participants with normal cognition, those with lower levels of education had a steeper decline in emotional loneliness than those with higher education over time (Supplementary Figure 1).

Discussion

The current study examined the link between cognitive impairment status (normal, CIND, and dementia) and the trajectory of loneliness and the domains of emotional and social loneliness over 9 years using a national sample of older Americans. We found support that cognitive impairment was independently linked to loneliness: CIND and dementia status were both associated with higher overall, emotional, and social loneliness, accounting for demographic, physical health, social contact, and depressive symptoms indicators. Notably, however, CIND and dementia status were unrelated to change in the three measures of loneliness over time, which suggests that loneliness does not increase over time for individuals living with cognitive impairment. Furthermore, the moderation analyses indicate some modest differences by gender, Latinx ethnicity, and education.

We found that persons with CIND and dementia experienced higher levels of overall, emotional, and social loneliness compared to those with normal cognition, but the cognitive impairment status was not related to changes in loneliness over time. Combined with the literature that reports loneliness as a risk for dementia in later adulthood (Boss et al., 2015; Lara et al., 2019; Sutin et al., 2020), it is possible that those with CIND and dementia

experienced higher loneliness before developing a cognitive impairment and then maintained their relatively elevated levels of loneliness while living with the impairment. CIND or dementia did not contribute to the further exacerbation of loneliness.

The results suggest that loneliness is prominent in both a mild and relatively more severe stage of cognitive impairment. A previous study found that those with CIND reported higher loneliness in a small cross-sectional sample from Hong Kong (Yu et al., 2016). We provide corresponding evidence with a large longitudinal U.S. sample. CIND and dementia status were both linked to experiencing higher emotional loneliness. The fact that the effects of CIND and dementia on emotional loneliness were independent of marital status and frequency of social contact underscores that emotional loneliness (i.e., the discontent with one's attachment and bonding to close others) can be experienced subjectively, regardless of how they are objectively embedded in close relationships in the context of a cognitive impairment. Interestingly, among persons with dementia, higher education was linked to stronger decrease of emotional loneliness over time compared to those with lower education. When older adults are diagnosed with dementia, family members may hire home-visiting care professionals or recruit additional support from close relationships (Brown & Chen, 2008; Schulz & Martire, 2004), and the routine of dementia care may provide companionship for the older adult to not feel lonelier, and that those with higher education are more equipped to meet their emotional needs. Connecting to the recent work that found that individuals increased in loneliness when their spouse transitions into CIND (Leggett et al., 2020), future work should examine contextual factors that may be linked to both cognition and loneliness of older adults.

CIND and dementia status were also linked to higher social loneliness. Higher social loneliness experienced by individuals with CIND may stem from limitations in social engagement (Amano et al., 2020; Kotwal et al., 2016). Maintaining social relationships requires a fair amount of memory and processing capacity to remember details about other people and/or to hold coherent and enjoyable conversations. Individuals with mild impairments may find these activities cognitively challenging and trim out peripheral social relationships (Charles & Carstensen, 2010), especially if it requires active maintenance such as attending social gatherings. Indeed, previous research pointed out that individuals with declining cognitive function experience loss of outer circles of social networks rather than close relationships (Shouse et al., 2013) and persons with mild cognitive impairment were less likely to attend formal social engagement activities (Amano et al., 2020). These findings suggest that health selection processes may be present for peripheral relationships that eventually lead to higher social loneliness.

Further, dementia status was linked to higher emotional loneliness for men and higher social loneliness for those with higher education. It is possible that when a person gradually recognizes that their cognitive ability is declining (e.g., frequent memory problems), their sense of control can be greatly compromised (Hahn & Lachman, 2015). An intact sense of self-sufficiency and independence may be more important for men and those with higher education in self-perceptions of aging (Specht et al., 2013), such that the gap between what they used to be (i.e., desired) and the loss of social connections (i.e., actual) could generate stronger feelings of loneliness. A qualitative study with persons with MCI describes that the

diagnosis of MCI carries a sense of uncertainty for the meaning of the diagnosis to oneself as well as the lack of clarity of the prognosis (Gomersall et al., 2015). Future research is needed on the mechanisms that link mild cognitive impairment and social well-being, as well as identification of relevant protective factors in supporting self-identity related to the diagnosis. Lastly, while we report the moderation effect of dementia and changes in loneliness by Latinx ethnicity, we caution interpreting the effect as substantial due to the small sample size of groups in decomposing three-way interaction terms.

Clinical and Practical Implications

These findings have relevant clinical and practical implications in at least two ways. First, our findings suggest that those with CIND, a potentially transitional phase between normal cognition and dementia, experienced higher loneliness as much as those with dementia. Both in clinical and research settings, greater attention should be given to the assessment of the psychosocial health of persons diagnosed with MCI. Second, a recent study supports the need for different types of interventions to address emotional and social loneliness (Wolfer et al., 2021). For example, interventions to reduce emotional loneliness could target depressive symptoms and maladaptive social cognition (Gardiner et al., 2018), whereas interventions to reduce social loneliness for those with CIND and dementia could focus on providing opportunities for formal social engagement (Amano et al., 2020) to prevent the experience of social loneliness.

Strengths and limitations

The strengths of the present study include the use of a population-level dataset that covered about a decade-long period, distinguishing two subdomains of loneliness and clinically relevant categories of cognitive impairment, and the inclusion of relevant health and social factors as time-varying covariates to examine the independent association between cognitive status and loneliness. Nevertheless, there are limitations to consider. First, while the cut-off criteria used in the study is validated with the HRS data and is adopted widely (Crimmins et al., 2011; Sutin et al., 2020), performance-based scores are not identical to clinical diagnoses of cognitive impairment (Crimmins et al., 2011). Future research would benefit from incorporating clinical diagnostic tools to examine the link with loneliness. Second, the measure for loneliness is based on self-report and excludes participants whose cognition was assessed through proxy. Self-report is a valid method of assessment, but it would be useful to also gather informant-ratings. In addition, only participants who were healthy enough to participate completed the self-completion questionnaire. Future research could use informant-ratings of loneliness and include individuals with more advanced stages of dementia.

In conclusion, this study showed that cognitive impairment is associated with loneliness among older adults. Those with mild cognitive impairment and dementia experienced heightened emotional and social loneliness, but cognitive impairment status did not contribute to the worsening of loneliness. The results highlight the importance of examining cognitive functioning in the etiology of loneliness in older adulthood, and that the older adult’s cognitive function should be considered when designing interventions for loneliness.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Aartsen MJ, van Tilburg T, Smits CHM, & Knipscheer KCPM (2004). A longitudinal study of the impact of physical and cognitive decline on the personal network in old age. Journal of social and personal relationships, 21(2), 249–266. 10.1177/0265407504041386

Aiken LS, & West SG (1991). Multiple Regression: Testing And Interpreting Interactions (1st ed., p. 224). Sage Publications, Inc.

Amano T, Morrow-Howell N, & Park S (2020). Patterns of social engagement among older adults with mild cognitive impairment. The Journals of Gerontology: Series B, 75(7), 1361–1371. 10.1093/geronb/gbz051

Ayalon L, Shiovitz-Ezra S, & Roziner I (2016). A cross-lagged model of the reciprocal associations of loneliness and memory functioning. Psychology and aging, 31(3), 255–261. 10.1037/pag0000075 [PubMed: 26974589]

Boss L, Kang D-H, & Branson S (2015). Loneliness and cognitive function in the older adult: a systematic review. International Psychogeriatrics, 27(4), 541–553. 10.1017/S1041610214002749 [PubMed: 25554219]

Brandt J, Spencer M, & Folstein MF (1988). The telephone interview for cognitive status. Neuropsychiatry, Neuropsychology and Behavioral Neurology, 1(2), 111–117.

Brown J, & Chen S-L (2008). Help-seeking patterns of older spousal caregivers of older adults with dementia. Issues in mental health nursing, 29(8), 839–852. 10.1080/01612840802182854 [PubMed: 18649210]

Charles ST, & Carstensen LL (2010). Social and emotional aging. Annual review of psychology, 61, 383–409. 10.1146/annurev.psych.093008.100448

Coyle CE, & Dugan E (2012). Social isolation, loneliness and health among older adults. Journal of Aging and Health, 24(8), 1346–1363. 10.1177/0898264312460275 [PubMed: 23006425]

Crimmins EM, Kim JK, Langa KM, & Weir DR (2011). Assessment of cognition using surveys and neuropsychological assessment: the Health and Retirement Study and the Aging, Demographics, and Memory Study. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 66 Suppl 1, i162–71. 10.1093/geronb/gbr048

Dahlberg L, & McKee KJ (2014). Correlates of social and emotional loneliness in older people: evidence from an English community study. Aging & mental health, 18(4), 504–514. 10.1080/13607863.2013.856863 [PubMed: 24251626]

De Jong Gierveld J, & Van Tilburg T (2006). A 6-Item Scale for Overall, Emotional, and Social Loneliness. Research on aging, 28(5), 582–598. 10.1177/0164027506289723

Desmarais P, Lanctôt KL, Masellis M, Black SE, & Herrmann N (2018). Social inappropriateness in neurodegenerative disorders. International psychogeriatrics, 30(2), 197–207. 10.1017/S1041610217001260 [PubMed: 28689508]

Donovan NJ, Wu Q, Rentz DM, Sperling RA, Marshall GA, & Glymour MM (2017). Loneliness, depression and cognitive function in older U.S. adults. International Journal of Geriatric Psychiatry, 32(5), 564–573. 10.1002/gps.4495 [PubMed: 27162047]

Dyer AH, Murphy C, Lawlor B, Kennelly SP, & Study Group, for the NILVAD. (2020). Social networks in mild-to-moderate Alzheimer disease: longitudinal relationships with dementia severity, cognitive function, and adverse events. Aging & Mental Health, 1–7. Advance online publication. 10.1080/13607863.2020.1745146

Gardiner C, Geldenhuys G, & Gott M (2018). Interventions to reduce social isolation and loneliness among older people: an integrative review. Health & social care in the community, 26(2), 147–157. 10.1111/hsc.12367 [PubMed: 27413007]

Gomersall T, Astell A, Nygård L, Sixsmith A, Mihailidis A, & Hwang A (2015). Living with ambiguity: A metasynthesis of qualitative research on mild cognitive impairment. The Gerontologist, 55(5), 892–912. 10.1093/geront/gnv067 [PubMed: 26315317]

Hahn EA, & Lachman ME (2015). Everyday experiences of memory problems and control: the adaptive role of selective optimization with compensation in the context of memory decline. Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition, 22(1), 25–41. 10.1080/13825585.2014.888391

Hawkley LC, Browne MW, & Cacioppo JT (2005). How can I connect with thee? Let me count the ways. Psychological Science, 16(10), 798–804. 10.1111/j.1467-9280.2005.01617.x [PubMed: 16181443]

Hawkley LC, & Cacioppo JT (2010). Loneliness matters: a theoretical and empirical review of consequences and mechanisms. Annals of Behavioral Medicine, 40(2), 218–227. 10.1007/s12160-010-9210-8 [PubMed: 20652462]

Hawkley LC, & Kocherginsky M (2018). Transitions in Loneliness Among Older Adults: A 5-Year Follow-Up in the National Social Life, Health, and Aging Project. Research on Aging, 40(4), 365–387. 10.1177/01640275 [PubMed: 29519211]

Islam M, Mazumder M, Schwabe-Warf D, Stephan Y, Sutin AR, & Terracciano A (2019). Personality changes with dementia from the informant perspective: new data and meta-analysis. Journal of the American Medical Directors Association, 20(2), 131–137. 10.1016/j.jamda.2018.11.004 [PubMed: 30630729]

Kotwal AA, Kim J, Waite L, & Dale W (2016). Social Function and Cognitive Status: Results from a US Nationally Representative Survey of Older Adults. Journal of General Internal Medicine, 31(8), 854–862. 10.1007/s11606-016-3696-0 [PubMed: 27130624]

Langa KM, Plassman BL, Wallace RB, Herzog AR, Heeringa SG, Ofstedal MB, Burke JR, Fisher GG, Fultz NH, Hurd MD, Potter GG, Rodgers WL, Steffens DC, Weir DR, & Willis RJ (2005). The Aging, Demographics, and Memory Study: study design and methods. Neuroepidemiology, 25(4), 181–191. 10.1159/000087448 [PubMed: 16103729]

Lara E, Martín-María N, De la Torre-Luque A, Koyanagi A, Vancampfort D, Izquierdo A, & Miret M (2019). Does loneliness contribute to mild cognitive impairment and dementia? A systematic review and meta-analysis of longitudinal studies. Ageing Research Reviews, 52, 7–16. 10.1016/j.arr.2019.03.002 [PubMed: 30914351]

Lee J, & Cagle JG (2017). Validating the 11-Item Revised University of California Los Angeles Scale to Assess Loneliness Among Older Adults: An Evaluation of Factor Structure and Other Measurement Properties. The American Journal of Geriatric Psychiatry, 25(11), 1173–1183. 10.1016/j.jagp.2017.06.004 [PubMed: 28864097]

Leggett AN, Choi H, Chopik WJ, Liu H, & Gonzalez R (2020). Early Cognitive Decline and Its Impact On Spouse's Loneliness. Research in human development, 17(1), 78–93. 10.1080/15427609.2020.1750293 [PubMed: 33041699]

Liu BS, & Rook KS (2013). Emotional and social loneliness in later life. Journal of social and personal relationships, 30(6), 813–832. 10.1177/0265407512471809

Luchetti M, Terracciano A, Aschwanden D, Lee JH, Stephan Y, & Sutin AR (2020). Loneliness is associated with risk of cognitive impairment in the Survey of Health, Ageing and Retirement in Europe. International Journal of Geriatric Psychiatry. 10.1002/gps.5304

McHugh JE, Kenny RA, Lawlor BA, Steptoe A, & Kee F (2017). The discrepancy between social isolation and loneliness as a clinically meaningful metric: findings from the Irish and English longitudinal studies of ageing (TILDA and ELSA). International Journal of Geriatric Psychiatry, 32(6), 664–674. 10.1002/gps.4509 [PubMed: 27246181]

McHugh Power JE, Hannigan C, Carney S, Feeney J, Kenny RA, Kee F, & Lawlor BA (2019). Lonely SARTs: loneliness and sustained attention in the Irish longitudinal study of aging. Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition, 1–10. 10.1080/13825585.2019.1602705

McKhann GM, Knopman DS, Chertkow H, Hyman BT, Jack CR Jr, Kawas CH, ... & Phelps CH (2011). The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimer's & dementia, 7(3), 263–269. 10.1016/j.jalz.2011.03.005

National Academies of Sciences, Engineering, and Medicine (2020). Social Isolation and Loneliness in Older Adults: Opportunities for the Health Care System. Washington, DC: The National Academies Press. 10.17226/25663.

Okely JA, & Deary IJ (2019). Longitudinal associations between loneliness and cognitive ability in the lothian birth cohort 1936. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 74(8), 1376–1386. 10.1093/geronb/gby086

Ollanketo M, Korpelainen R, Jämsä TJ, Kangas M, Koivumaa-Honkanen H, Immonen MS, Enwald H, & Elo S (2019). Perceived loneliness among home-dwelling older adults with and without memory disorder: A population-based study. Nordic Journal of Nursing Research, 39(2), 205715851880026. 10.1177/2057158518800266

O'Súilleabháin PS, Gallagher S, & Steptoe A (2019). Loneliness, Living Alone, and All-Cause Mortality: The Role of Emotional and Social Loneliness in the Elderly During 19 Years of Follow-Up. Psychosomatic medicine, 81(6), 521–526. 10.1097/PSY.0000000000000710 [PubMed: 31094903]

Peerenboom L, Collard RM, Naarding P, & Comijs HC (2015). The association between depression and emotional and social loneliness in older persons and the influence of social support, cognitive functioning and personality: A cross-sectional study. Journal of Affective Disorders, 182, 26–31. 10.1016/j.jad.2015.04.033 [PubMed: 25965692]

Perlman D, & Peplau L (1982). Perlman, D., & Peplau, L. A. (1982). Theoretical approaches to loneliness. Loneliness: A sourcebook of current theory, research and therapy, 123–134.

Petersen RC (2004). Mild cognitive impairment as a diagnostic entity. Journal of Internal Medicine, 256(3), 183–194. 10.1111/j.1365-2796.2004.01388.x [PubMed: 15324362]

Peugh JL, & Enders CK (2005). Using the SPSS Mixed Procedure to Fit Cross-Sectional and Longitudinal Multilevel Models. Educational and psychological measurement, 65(5), 717–741. 10.1177/0013164405278558

Pinquart M, & Sörensen S (2000). Influences of socioeconomic status, social network, and competence on subjective well-being in later life: A meta-analysis. Psychology and Aging, 15(2), 187–224. 10.1037/0882-7974.15.2.187 [PubMed: 10879576]

Preacher KJ, Curran PJ, & Bauer DJ (2006). Computational Tools for Probing Interactions in Multiple Linear Regression, Multilevel Modeling, and Latent Curve Analysis. Journal of Educational and Behavioral Statistics, 31(4), 437–448. 10.3102/10769986031004437

Radloff LS (1977). The CES-D scale: A self-report depression scale for research in the general population. Applied psychological measurement, 1(3), 385–401. 10.1177/014662167700100306

Russell DW (1996). UCLA Loneliness Scale (Version 3): reliability, validity, and factor structure. Journal of personality assessment, 66(1), 20–40. 10.1207/s15327752jpa6601_2 [PubMed: 8576833]

Schnittger RI, Wherton J, Prendergast D, & Lawlor BA (2012). Risk factors and mediating pathways of loneliness and social support in community-dwelling older adults. Aging & mental health, 16(3), 335–346. 10.1080/13607863.2011.629092 [PubMed: 22129431]

Schulz R, & Martire LM (2004). Family caregiving of persons with dementia: prevalence, health effects, and support strategies. The American Journal of Geriatric Psychiatry, 12(3), 240–249. 10.1097/00019442-200405000-00002 [PubMed: 15126224]

Shouse JN, Rowe SV, & Mast BT (2013). Depression and cognitive functioning as predictors of social network size. Clinical gerontologist, 36(2), 147–161. 10.1080/07317115.2012.749320

Solway E, Piette J, Kullgren J, Singer D, Kirch M, & Malani P (2019, 3). Loneliness and Health. University of Michigan National Poll on Healthy Aging. https://www.healthyagingpoll.org/report/loneliness-and-health

Sonnega A, Faul JD, Ofstedal MB, Langa KM, Phillips JWR, & Weir DR (2014). Cohort profile: the health and retirement study (HRS). International Journal of Epidemiology, 43(2), 576–585. 10.1093/ije/dyu067 [PubMed: 24671021]

Specht J, Egloff B, & Schmukle SC (2013). Everything under control? The effects of age, gender, and education on trajectories of perceived control in a nationally representative German sample. Developmental Psychology, 49(2), 353–364. 10.1037/a0028243 [PubMed: 22545833]

Stickley A, & Koyanagi A (2018). Physical multimorbidity and loneliness: A population-based study. Plos One, 13(1), e0191651. 10.1371/journal.pone.0191651 [PubMed: 29364978]

Sundström A, Adolfsson AN, Nordin M, & Adolfsson R (2020). Loneliness increases the risk of all-cause dementia and Alzheimer's disease. The Journals of Gerontology: Series B, 75(5), 919–926. 10.1093/geronb/gbz139

Sutin AR, Stephan Y, Luchetti M, & Terracciano A (2020). Loneliness and risk of dementia. The Journals of Gerontology: Series B, 75(7), 1414–1422. 10.1093/geronb/gby112

van Baarsen B, Snijders TAB, Smit JH, & van Duijn MAJ (2001). Lonely but not alone: emotional isolation and social isolation as two distinct dimensions of loneliness in older people. Educational and psychological measurement, 61(1), 119–135. 10.1177/00131640121971103

Weiss RS (1973). Loneliness: The experience of emotional and social isolation. The MIT Press.

Wolfers ME, Stam BE, & Machielse A (2021). Correlates of emotional and social loneliness among community dwelling older adults in Rotterdam, the Netherlands. Aging & Mental Health, 1–13. 10.1080/13607863.2021.1875191

Yin J, Lassale C, Steptoe A, & Cadar D (2019). Exploring the bidirectional associations between loneliness and cognitive functioning over 10 years: the English longitudinal study of ageing. International Journal of Epidemiology. 10.1093/ije/dyz085

Yu J, Lam CLM, & Lee TMC (2016). Perceived loneliness among older adults with mild cognitive impairment. International Psychogeriatrics, 28(10), 1681–1685. 10.1017/S1041610216000430 [PubMed: 27073010]

Zhong B-L, Chen S-L, Tu X, & Conwell Y (2017). Loneliness and cognitive function in older adults: findings from the chinese longitudinal healthy longevity survey. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 72(1), 120–128. 10.1093/geronb/gbw037

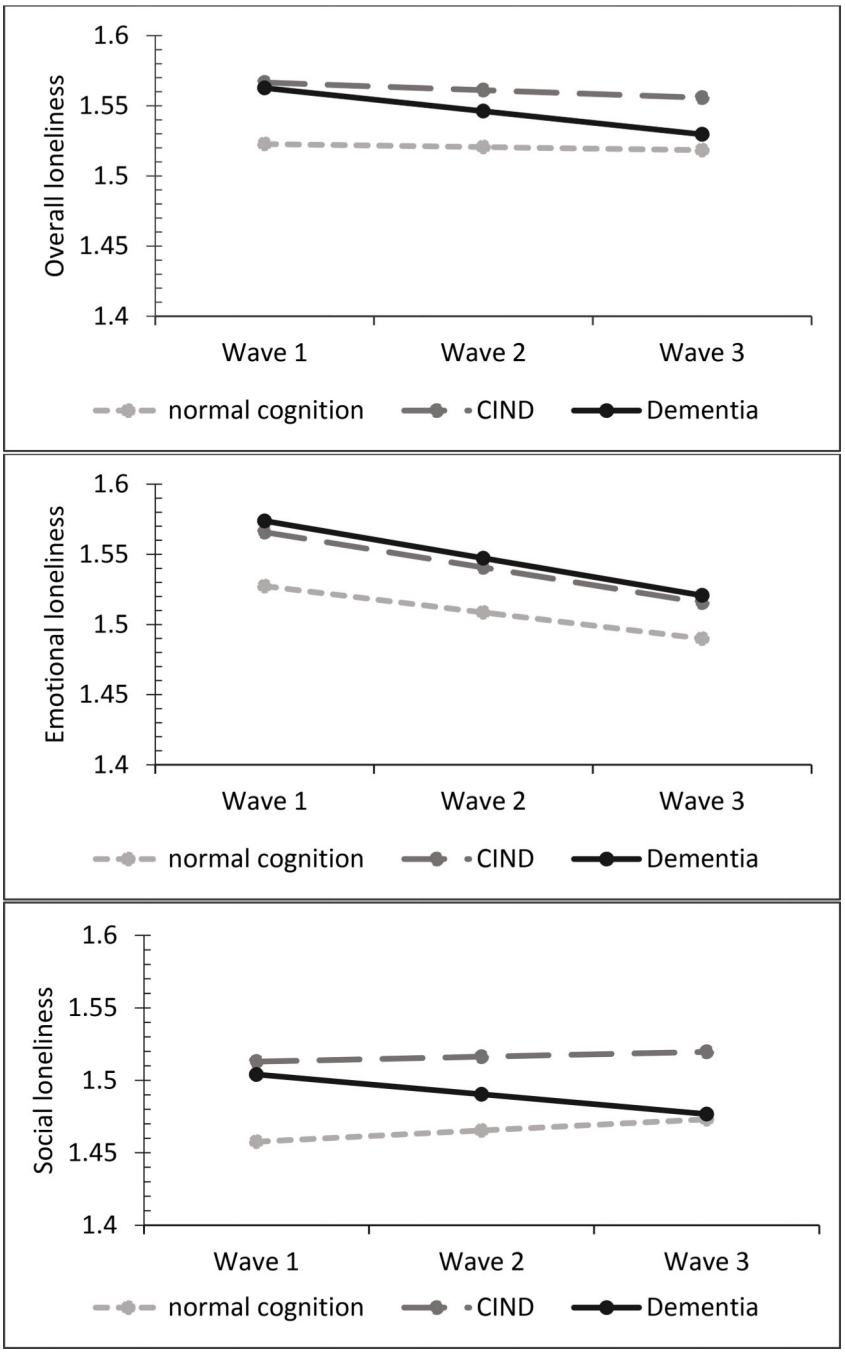

Figure 1.
Cognitive impairment status and the level and change of overall, emotional, and social loneliness

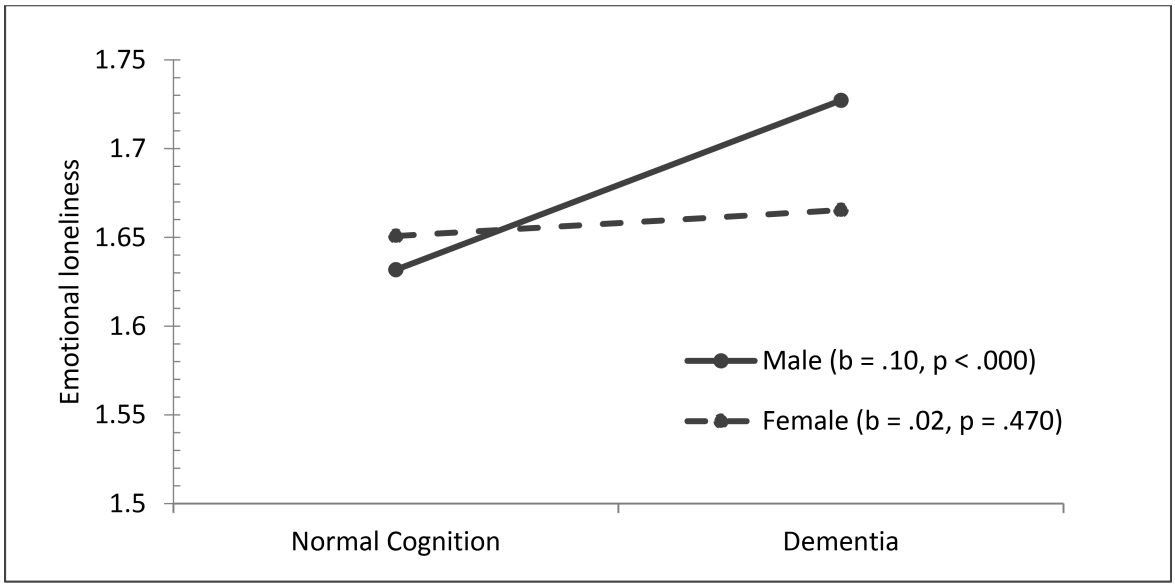

Figure 2.
The moderating effect of gender on the link between dementia status and emotional loneliness

Table 1

Descriptive Statistics for Study Variables at Waves 1 Through 3

		M (SD) or %			Bivariate correlations at Wave 1															
	Range	**Wave 1**	**Wave 2**	**Wave 3**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1. Age	50–101	66.59 (9.85)			—															
2. Female		59.2%			−.01	—														
3. Education	0–17	12.83 (3.07)			−.11**	−.05**	—													
4. Race (Black)		15.6%			−.13**	.05**	−.07**	—												
5. Race (Other)		5.8%			−.13**	.00	−.11**	−.11**	—											
6. Latinx		10%			−.12**	.01	−.34**	−.12**	.38**	—										
7. CIND		16%	17.4%	18%	.17**	−.03**	−.29**	.15**	.06**	.10**	—									
8. Dementia		3%	4.5%	4.5%	.13**	.00	−.21**	.09**	.03**	.05**	—	—								
9. Functional limitation	0–5	1.99 (1.35)	2.19 (1.37)	2.33 (1.36)	.34**	.00	−.13**	.04**	−.05**	−.07**	.12**	.08**	—							
10. Disease burden	0–7	0.18 (0.61)	0.24 (0.70)	0.29 (0.80)	.08**	.02*	−.14**	.06**	.04**	.05**	.16**	.15**	.21**	—						
11. Married		65.1%	61.3%	56%	−.17**	−.24**	.10**	−.17**	.01	.01	−.08**	−.08**	−.10**	−.10**	—					
12. Social contact	1–6	3.73 (0.86)	3.70 (0.86)	3.68 (0.87)	−.07**	.20**	.17**	−.02	−.04**	−.06**	−.12**	−.07**	−.08**	−.10**	−.03**	—				
13. Depressive symptoms	0–7	1.25 (1.73)	1.25 (1.74)	1.18 (1.68)	−.05**	.09**	−.20**	.08**	.06**	.10**	.14**	.11**	.19**	.31**	−.15**	−.11**	—			
14. Overall loneliness	1–3	1.52 (0.43)	1.52 (0.43)	1.52 (0.43)	−.04**	−.05**	−.15**	.05**	.04**	.07**	.11**	.05**	.10**	.16**	−.15**	−.29**	.37**	—		
15. Emotional loneliness	1–3	1.50 (0.54)	1.48 (0.53)	1.47 (0.53)	−.04**	.07**	−.10**	.06**	.02*	.03**	.08**	.06**	.11**	.17**	−.27**	−.16**	.40**	.78**	—	
16. Social loneliness	1–3	1.48 (0.51)	1.49 (0.52)	1.49 (0.53)	−.03**	−.10**	−.13**	.03**	.03**	.07**	.11**	.04**	.07**	.11**	−.04**	−.31**	.25**	.88**	.45**	—

Note. N= 15,352.

** $p < .01$.

CIND = Cognitive impairment not dementia. Categorical demographic variables are coded as follows: Female (0=male, 1=female), race (Black=1, or other/unknown=1 with White=0 as the reference group), and ethnicity (0=non-Latinx, 1=Latinx).

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Table 2

Multilevel models predicting overall, emotional, and social loneliness as a function of cognitive impairment over time

	Overall Loneliness			
	Model 1	Model 2	Model 3	Model 4
Fixed effects				
Intercept	1.49 [1.48, 1.51], <.001	1.51 [1.49, 1.52], <.001	1.60 [1.58, 1.61], <.001	1.52 [1.51, 1.54], <.001
Time	0.01 [0.01, 0.02], <.001	0.00 [0.00, 0.01], .135	−0.01 [−0.01, 0.00], .004	0.00 [−0.01, 0.00], .387
Age	0.00 [−0.01, 0.00], <.001	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, 0.00], <.001
Age^2	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001
Female	−0.04 [−0.06, −0.03], <.001	−0.04 [−0.06, −0.03], <.001	−0.03 [−0.05, −0.02], <.001	−0.05 [−0.06, −0.03], <.001
Education	−0.02 [−0.02, −0.01], <.001	−0.01 [−0.02, −0.01], <.001	−0.01 [−0.01, −0.01], <.001	0.00 [−0.01, 0.00], <.001
Black	0.01 [0.00, 0.03], .117	0.00 [−0.01, 0.02], .677	−0.02 [−0.04, −0.01], .008	−0.02 [−0.04, −0.01], .004
Other	0.00 [−0.03, 0.03], .812	0.00 [−0.03, 0.03], .959	−0.01 [−0.04, 0.02], .452	−0.02 [−0.04, 0.01], .174
Latinx	−0.01 [−0.03, 0.02], .680	0.00 [−0.02, 0.02], .975	0.00 [−0.02, 0.03], .765	−0.01 [−0.03, 0.01], .475
ever CIND	0.08 [0.07, 0.10], <.001	0.07 [0.06, 0.09], <.001	0.06 [0.04, 0.08], <.001	0.04 [0.03, 0.06], <.001
ever dementia	0.10 [0.08, 0.13], <.001	0.09 [0.06, 0.12], <.001	0.07 [0.04, 0.10], <.001	0.04 [0.01, 0.07], .002
Functional limitations		0.03 [0.03, 0.03], <.001	0.03 [0.02, 0.03], <.001	0.02 [0.01, 0.02], <.001
Disease burden		0.05 [0.05, 0.06], <.001	0.02 [0.01, 0.02], <.001	0.02 [0.01, 0.02], <.001
Married			−0.12 [−0.13, −0.11], <.001	−0.10 [−0.11, −0.09], <.001
Social contact			−0.11 [−0.11, −0.10], <.001	−0.10 [−0.11, −0.10], <.001
Depressive symptoms				0.06 [0.06, 0.06], <.001
Age × Time	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001
ever CIND × Time	0.00 [−0.01, 0.01], .969	0.00 [−0.01, 0.01], .676	0.00 [−0.01, 0.01], .557	0.00 [−0.01, 0.01], .524
ever dementia × Time	−0.01 [−0.03, 0.01], .298	−0.02 [−0.04, 0.00], .079	−0.02 [−0.04, 0.00], .029	−0.01 [−0.03, 0.00], .130
Random effects				
Residual var.	0.06 [0.06, 0.07], <.001	0.06 [0.06, 0.07], <.001	0.06 [0.06, 0.07], <.001	0.06 [0.06, 0.07], <.001
Intercept var.	0.12 [0.11, 0.12], <.001	0.11 [0.11, 0.12], <.001	0.10 [0.09, 0.10], <.001	0.08 [0.08, 0.09], <.001
Time var.	0.00 [−0.01, 0.00], <.001	0.00 [−0.01, 0.00], <.001	0.00 [−0.01, 0.00], <.001	0.00 [−0.01, 0.00], .001
Intercept and time covar.	0.01 [0.00, 0.01], <.001	0.01 [0.00, 0.01], <.001	0.00 [0.00, 0.01], <.001	0.00 [0.00, 0.01], <.001
2 log-likelihood	26581.318	26128.580	24270.106	22477.756

	Emotional loneliness			
	Model 1	Model 2	Model 3	Model 4
Fixed effects				
Intercept	1.39 [1.38, 1.41], <.001	1.41 [1.39, 1.43], <.001	1.63 [1.61, 1.65], <.001	1.53 [1.51, 1.55], <.001
Time	0.00 [0.00, 0.01], .238	−0.01 [−0.02, 0.00], .005	−0.03 [−0.03, −0.02], <.001	−0.02 [−0.03, −0.01], <.001
Age	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, −0.01], <.001
Age^2	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001
Female	0.07 [0.05, 0.09], <.001	0.07 [0.05, 0.08], <.001	0.03 [0.02, 0.05], <.001	0.01 [0.00, 0.03], .047
Education	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, 0.00], <.001	0.00 [−0.01, 0.00], .048	0.00 [0.00, 0.00], .085
Black	0.03 [0.00, 0.05], .025	0.01 [−0.01, 0.03], .352	−0.05 [−0.07, −0.03], <.001	−0.05 [−0.07, −0.03], <.001
Other	−0.01 [−0.05, 0.03], .603	−0.02 [−0.05, 0.02], .380	−0.03 [−0.06, 0.00], .089	−0.04 [−0.07, −0.01], .013
Latinx	−0.07 [−0.10, −0.04], <.001	−0.06 [−0.09, −0.03], <.001	−0.06 [−0.09, −0.03], <.001	−0.07 [−0.10, −0.05], <.001
ever CIND	0.09 [0.07, 0.11], <.001	0.08 [0.06, 0.10], <.001	0.06 [0.04, 0.08], <.001	0.04 [0.02, 0.06], <.001
ever dementia	0.13 [0.10, 0.17], <.001	0.11 [0.08, 0.15], <.001	0.09 [0.06, 0.12], <.001	0.05 [0.01, 0.08], .004
Functional limitations		0.04 [0.04, 0.05], <.001	0.04 [0.03, 0.04], <.001	0.02 [0.02, 0.02], <.001
Disease burden		0.08 [0.07, 0.09], <.001	0.07 [0.06, 0.08], <.001	0.03 [0.02, 0.04], <.001
Married			−0.26 [−0.28, −0.25], <.001	−0.24 [−0.25, −0.22], <.001
Social contact			−0.07 [−0.08, −0.07], <.001	−0.07 [−0.07, −0.06], <.001
Depressive symptoms				0.09 [0.08, 0.09], <.001
Age × Time	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001
ever CIND × Time	0.00 [−0.01, 0.01], .807	0.00 [−0.02, 0.01], .499	−0.01 [−0.02, 0.01], .345	−0.01 [−0.02, 0.01], .312
ever dementia × Time	0.00 [−0.03, 0.02], .791	−0.01 [−0.04, 0.01], .253	−0.02 [−0.04, 0.01], .166	−0.01 [−0.03, 0.02], .511
Random effects				
Residual var.	0.10 [0.10, 0.10], <.001	0.10 [0.10, 0.10], <.001	0.10 [0.10, 0.10], <.001	0.10 [0.10, 0.10], <.001
Intercept var.	0.18 [0.18, 0.19], <.001	0.17 [0.17, 0.18], <.001	0.15 [0.15, 0.16], <.001	0.12 [0.12, 0.13], <.001
Time var.	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.02, −0.01], <.001	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, −0.01], <.001
Intercept and time covar.	0.01 [0.01, 0.02], <.001	0.01 [0.01, 0.02], <.001	0.01 [0.01, 0.01], <.001	0.01 [0.01, 0.01], <.001
2 log-likelihood	40680.98	40077.19	38307.94	35893.25

	Social loneliness			
	Model 1	Model 2	Model 3	Model 4
Fixed effects				

Intercept	1.49 [1.48, 1.51], <.001	1.50 [1.49, 1.52], <.001	1.52 [1.50, 1.54], <.001	1.46 [1.44, 1.48], <.001
Time	0.02 [0.01, 0.03], <.001	0.01 [0.00, 0.02], .001	0.00 [0.00, 0.01], .415	0.01 [0.00, 0.01], .026
Age	0.00 [−0.01, 0.00], <.001	−0.01 [−0.01, 0.00], <.001	−0.01 [−0.01, −0.01], <.001	0.00 [−0.01, 0.00], <.001
Age^2	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001
Female	−0.11 [−0.12, −0.09], <.001	−0.11 [−0.12, −0.09], <.001	−0.07 [−0.08, −0.05], <.001	−0.08 [−0.09, −0.06], <.001
Education	−0.02 [−0.02, −0.01], <.001	−0.01 [−0.02, −0.01], <.001	−0.01 [−0.01, −0.01], <.001	−0.01 [−0.01, 0.00], <.001
Black	0.01 [−0.01, 0.03], .332	0.00 [−0.02, 0.02], .897	−0.01 [−0.03, 0.01], .336	−0.01 [−0.03, 0.01], .309
Other	0.00 [−0.03, 0.03], .965	0.00 [−0.04, 0.03], .864	−0.01 [−0.04, 0.02], .472	−0.02 [−0.05, 0.01], .272
Latinx	0.04 [0.01, 0.07], .006	0.04 [0.02, 0.07], .002	0.05 [0.02, 0.07], .001	0.04 [0.01, 0.06], .004
ever CIND	0.09 [0.07, 0.11], <.001	0.08 [0.06, 0.10], <.001	0.07 [0.05, 0.09], <.001	0.06 [0.04, 0.07], <.001
ever dementia	0.10 [0.07, 0.13], <.001	0.09 [0.06, 0.12], <.001	0.07 [0.04, 0.10], <.001	0.05 [0.01, 0.08], .004
Functional limitations		0.03 [0.02, 0.03], <.001	0.02 [0.02, 0.03], <.001	0.01 [0.01, 0.02], <.001
Disease burden		0.04 [0.03, 0.05], <.001	0.03 [0.02, 0.04], <.001	0.00 [−0.01, 0.01], .424
Married			−0.04 [−0.06, −0.03], <.001	−0.03 [−0.04, −0.01], <.001
Social contact			−0.14 [−0.15, −0.14], <.001	−0.14 [−0.15, −0.13], <.001
Depressive symptoms				0.05 [0.04, 0.05], <.001
Age × Time	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], <.001	0.00 [0.00, 0.00], .002
ever CIND × Time	0.00 [−0.02, 0.01], .732	0.00 [−0.02, 0.01], .568	0.00 [−0.02, 0.01], .555	0.00 [−0.02, 0.01], .525
ever dementia × Time	−0.02 [−0.04, 0.01], .192	−0.02 [−0.05, 0.00], .083	−0.03 [−0.05, 0.00], .036	−0.02 [−0.05, 0.00], .095
Random effects				
Residual var.	0.13 [0.12, 0.13], <.001	0.13 [0.12, 0.13], <.001	0.13 [0.13, 0.13], <.001	0.13 [0.13, 0.13], <.001
Intercept var.	0.13 [0.12, 0.13], <.001	0.12 [0.12, 0.13], <.001	0.10 [0.10, 0.11], <.001	0.09 [0.09, 0.10], <.001
Time var.	0.00 [0.00, 0.00], .737	0.00 [0.00, 0.00], .675	0.00 [0.00, 0.00], .572	0.00 [0.00, 0.00], .570
Intercept and time covar.	0.00 [0.00, 0.01], .006	0.00 [0.00, 0.01], .006	0.00 [0.00, 0.01], .013	0.00 [0.00, 0.01], .013
2 log-likelihood	41271.87	41072.12	39380.56	38673.66

Note. Values represent unstandardized regression coefficients [95% confidence interval], p-value. CIND = Cognitive impairment not dementia.