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Loneliness and Functional Decline in Aging:

A Systematic Review

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Abstract

Loneliness is prevalent in adults aged 65 years in the United States and is associated with functional decline. The purpose of the current review was to synthesize evidence on the relationship between loneliness and functional decline using Roy's Adaptation Model as a theoretical framework. A comprehensive review of PubMed, Medline, and Embase databases was performed. Inclusion criteria were samples including adults primarily aged >60 years, peer-reviewed, published in the English language, and included a measure for loneliness and function. A total of 47 studies were analyzed. Most studies examined correlates, risk factors, and predictors of loneliness, rather than the relationship between loneliness and function. Evidence suggests there is bidirectionality in the relationship between loneliness and functional decline. Loneliness is associated with functional decline in aging via multiple possible pathways. Further studies are needed to determine causality and biological mechanisms underlying the relationship.

Loneliness is defined as a negative feeling of dissatisfaction with the quality of one's social relationships (Holt-Lunstad et al., 2015). Prevalence of loneliness in adults aged 60 years ranges from 6.5% to 28.5%, and varies by age, region, and severity (Chawla et al., 2021; Surkalim et al., 2022). Loneliness is associated with several negative health outcomes, including functional decline, and mortality (Cacioppo et al., 2014; Holt-Lunstad et al., 2015; Ong et al., 2016). A better understanding of the relationship between loneliness and functional decline is needed given the recent coronavirus disease 2019 (COVID-19) pandemic that led to decreased physical and social contact, particularly among older adults (Krendl & Perry, 2021). Decreased physical and social activity are risk factors for disability and loneliness in older adults (Cunningham et al., 2020; Lebrasseur et al., 2021). Loneliness prevalence has increased since the onset of the pandemic (Kucharska-Newton et al., 2021), which can potentially lead to a rise in the associated negative health outcomes, including functional decline and disability in older adults.

The ability to complete daily routine functions, such as activities of daily living (ADLs; e.g., bathing, toileting) and instrumental activities of daily living (IADLs; e.g., cooking,

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managing money) is necessary for independent living (Lawton & Brody, 1969). Functional decline is a common, multi-factorial problem in aging associated with morbidity, disability, and mortality (Fried et al., 2001) that can be assessed subjectively or objectively.

Subjective functional decline refers to self-reported deterioration in the management of ADLs or IADLs, or self-reported decline in mobility. *Objective functional decline* refers to performance-based measures of functional deterioration, such as qualitative (e.g., apraxia) or quantitative (e.g., gait speed) assessment. Mobility decline can be subjectively reported as decline in walking or ability to complete tasks, such as stair climbing, or objectively assessed gait measures (e.g., gait speed). Here, the term functional decline will be used as an umbrella term that includes ADL/IADL disability, mobility decline, and gait decline. Loneliness is an established risk factor for functional decline (Ong et al., 2016). Yet, the causal relationship between loneliness and functional decline is not well understood.

Several reviews have focused on the relationship between loneliness and health outcomes, including cognitive function (Boss et al., 2015), chronic multimorbidity (Petitte et al., 2015), mortality (Holt-Lunstad et al., 2015), and theoretical mechanisms for loneliness-related morbidity (Ong et al., 2016). No reviews, however, have synthesized the evidence on loneliness and physical function. In addition, heterogeneity in loneliness and functional assessment measures make comparisons between studies challenging. Many studies include samples of young or middle-aged adults; thus, their findings are not generalizable to the older adult population.

THEORETICAL FRAMEWORK

The Roy Adaptation Model (RAM) is used as the theoretical framework for the current review as it a nursing model, specific to the biopsychosocial approach of the discipline. The RAM considers contextual factors that influence the ability to respond to stressors, or as they are referred to in the RAM, stimuli. Contextual factors include sociodemographics that are important for understanding the social determinants of an effective coping response. The RAM also explains how ineffective coping processes related to loneliness are manifested in four adaptive modes. The model provides an understanding of how loneliness affects the whole person across multiple systems. As a nursing model, the RAM guides the nursing process in assessing a patient's adaptation to changes in health and identifying stimuli that interfere with positive adaptation. Nursing diagnoses and interventions are then directed toward managing the stimuli to promote health and well-being (Roy & Andrews, 1991).

For the purposes of the current review, the RAM is used to understand the role of the nurse in assessing and addressing loneliness and functional decline. Given the complex, multi-factorial nature of loneliness, the holistic, biopsychosocial perspective of this model is used to understand potential causal pathways between loneliness and poor health outcomes and to identify intervention areas for nursing. The human response to loneliness based on the current research base and the effects of those responses on health and function, in the context of the RAM, is demonstrated in Figure 1. To our knowledge, this is the first time the RAM has been used in this context to provide a comprehensive understanding of causal pathways between loneliness and function, as well as overall health.

The purpose of the current review is to summarize existing evidence on the relationship between loneliness and functional decline using the RAM as a theoretical framework, to identify patterns in functional decline related to loneliness in the literature, and highlight areas for future research. The research questions addressed in this review are: (1) What are the causal pathways between loneliness and functional decline in older adults? and (2) What areas of opportunity exist for future research on the relationship between loneliness and functional decline?

METHOD

Design

The current systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) (Page et al., 2021). We evaluated studies that measured the association between loneliness and function, including objective gait parameters and ADL/IADL disability. Any quantitative loneliness measure was included as there is no gold standard for loneliness measurement and we wanted to minimize exclusion of relevant studies. Strict age criteria were not used as various age cut-offs for older adults are used in the literature.

Inclusion/Exclusion Criteria

Articles were included if they met the following criteria: (a) sample included adults primarily aged ≥ 60 years, (b) peer-reviewed, (c) published in the English language, (d) quantitative studies, and (e) included a measure for loneliness and gait/function. Articles were excluded based on the following criteria: (a) sample primarily included middle-aged, young adults or children; (b) non-English language; (c) systematic reviews, qualitative studies, study protocols, feasibility studies, conference abstracts, unpublished dissertations or commentaries, measurement tool use, or development studies; and (d) no measure for loneliness and gait/function. Qualitative studies were excluded as the focus of the current review was on quantitative measures of loneliness and function.

Search Strategy

A comprehensive search of electronic databases was conducted in June 2022 in the following databases with no limit on dates searched: PubMed, Medline, and Embase, targeting citations with keywords for “loneliness” and “gait/function” and “older adults.” A full list of search terms used are enumerated in Table A (available in the online version of this article). Alternate terms for psychosocial functioning were purposefully not used in the search as this review focused on loneliness. Reference lists of all relevant articles were also explored for inclusion based on inclusion/exclusion criteria. The preliminary search yielded 2,028 citations. Eighty-four citations were removed prior to screening based on language and peer review, resulting in 1,944 citations for initial screening. After title and abstract review, 1,761 records were excluded, and 54 full-text articles were assessed for eligibility. Following full text review, 13 articles were excluded. Additional studies were identified through a hand search of references. A total of 47 studies evaluating the relationship between loneliness and function were included in the final analysis. Figure 2 shows the PRISMA flow diagram of the study search strategy.

Data Collection/Analysis

Titles and abstracts were screened for studies that compared loneliness with any measure of gait/function. Full texts were retrieved for all studies that met inclusion/exclusion criteria. Full-text articles were uploaded into the data management software, Endnote™. Duplicate articles were removed. For each article that met all criteria, the following data were extracted: year and country of publication, study design, purpose of the study, measures used for loneliness and gait/function, sample characteristics, and results (Table B, available in the online version of this article).

RESULTS

Study Design

Most studies were cross-sectional or longitudinal. Included studies were published from 1985 (Jones et al., 1985) to 2022 (Gyasi et al., 2022; Kim et al., 2022; Miyawaki et al., 2022; Nóbrega et al., 2022; Raymo & Wang, 2022; Tsai et al., 2022; Wei et al., 2022). Older studies primarily focused on the association between loneliness and ADL/IADL disability, rather than objective functional measures. Later studies examined the association between loneliness and objective measures, in addition to subjective functional decline, such as ADL/IADL disability.

Study Samples

Articles originated from several different countries, including the United States ($n = 16$), United Kingdom ($n = 7$), the Netherlands ($n = 4$), India ($n = 3$), China ($n = 3$), Finland ($n = 2$), Israel ($n = 2$), Sweden ($n = 2$), Taiwan ($n = 2$), Brazil ($n = 1$), Ghana ($n = 1$), Nepal ($n = 1$), New Zealand ($n = 1$), Norway ($n = 1$), and Turkey ($n = 1$). Total number of participants included in the current review was 262,029. Sample sizes across studies ranged from 110 participants (Kim, 1999) to 72,262 participants (Pengpid & Peltzer, 2021). Mean reported age of study samples ranged from 56 to 90 years. Most studies that reported sample characteristics indicated samples included mostly women (Bondevik & Skogstad, 1998; Buchman, 2010; Burholt et al., 2017; Cheung et al., 2019; Chow et al., 2021; Crowe et al., 2021; Czaja et al., 2021; Dykstra et al., 2005; Fauth et al., 2008; Gyasi et al., 2022; Holmén et al., 1993; Honigh-de Vlaming et al., 2014; Kim et al., 2022; Luo et al., 2012; McCaffery et al., 2020; Miyawaki et al., 2022; Nagarkar & Kashikar, 2017; Nóbrega et al., 2022; Pengpid & Peltzer, 2021; Perissinotto et al., 2012; Philip et al., 2020; Rantakokko et al., 2014; Russell, 2009; Shankar et al., 2017; Susheela et al., 2018; Theeke, 2009; Torres et al., 2016; Wei et al., 2022). Studies were conducted in ethnically diverse populations globally. Many studies did not report ethnicity, however, and several studies from Western countries that reported ethnicity were non-diverse, with samples comprised of majority Caucasian participants (Cheung et al., 2019; Crowe et al., 2021; Czaja et al., 2021; Kuwert et al., 2014; Luo et al., 2012; McCaffery et al., 2020; Perissinotto et al., 2012; Steptoe & Di Gessa, 2021).

Theoretical Basis

Some studies included a theoretical framework for the basis of their study. The theories included Weiss' theory of social provisions, which describes six aspects of relationships that must be met to avoid feelings of loneliness (Bondevik & Skogstad, 1998); cognitive discrepancy theory, which explains cognitive processes related to loneliness (Burholt et al., 2017); model of depression and loneliness (MODEL) theory, which describes reasons for loneliness in old age (Cohen-Mansfield et al., 2009); Cohen's stress-buffering model, which posits social support buffers against loneliness (Miyawaki et al., 2022); and the International Classification of Functioning, Disability, and Health (ICF) model, which explains determinants of health outcomes (Czaja et al., 2021). Studies included common biological, social, and environmental covariates of loneliness, most commonly age; gender; education; socioeconomic status; marital status; living arrangements; ethnicity; multimorbidity; depression; body mass index; health behaviors, such as smoking and alcohol use; cognition; self-rated health; physical activity; and social network. Studies examined different aspects of loneliness in aging, most commonly risk factors for loneliness, predictors of loneliness, or loneliness-related morbidity and mortality, rather than specifically examining the relationship between loneliness and functional decline. Despite variation in aims and hypotheses, all studies included a measure and comparison for loneliness and functional decline and thus allowed for evaluation of the relationship between loneliness and functional decline.

Loneliness Prevalence

Estimated prevalence of loneliness varied across studies, ranging from 10% (Crowe et al., 2021) to 58% (Chow et al., 2021). The variability in prevalence estimates is likely explained by population measured as well as measurements used. Perceptions of loneliness may vary across cultures and life span, which reflects cultural diversity and age range of the study samples. For example, some authors posited that increased disability is associated with less loneliness as culturally, older adults are cared for by family members and increased disability results in increased exposure to care (Bondevik & Skogstad, 1998; Susheela et al., 2018). In addition, living alone is a known risk factor of loneliness; thus, in cultures where living alone (or vice versa) is common, loneliness prevalence may differ. Despite a range of estimates, it is clear loneliness affects many older adults and deserves attention as an important public health issue.

Loneliness and Functional Measures

Heterogeneity in loneliness and function definitions and measurements existed across included studies. Various subjective and objective functional measures were used. Subjective measures included ADL disability ($n = 14$), ADL/IADL disability ($n = 15$), and IADL disability ($n = 6$). Objective measures assessed function via disability scales ($n = 3$), functional limitation ($n = 3$), gait parameters ($n = 2$), Short Physical Performance Battery ($n = 1$), motor function ($n = 2$), mobility impairment ($n = 5$), self-reported disability ($n = 1$), perceived walking difficulty ($n = 1$), and a strength and mobility scale ($n = 1$).

Similarly, studies varied in their use of loneliness measures. The UCLA Loneliness Scale was the most used loneliness tool ($n = 22$). Other studies used a single item from the Center

for Epidemiologic Studies Depression Scale ($n = 4$), de Jong Gierveld Loneliness Scale ($n = 7$), Revised Social Provisions Scale ($n = 1$), and self-reported loneliness ($n = 15$). The single item loneliness questions directly inquired about loneliness; however, the question wording and response categories varied across studies.

Relationship Between Loneliness and Functional Decline

Evidence for the association between loneliness and functional decline was mixed. Most reviewed studies found a positive association between loneliness and measures of functional decline, including gait decline, IADL disability, mobility disability, and ADL disability. Seven of 47 studies found no association between ADL/IADL disability and loneliness (Bondevik & Skogstad, 1998; Guo et al., 2021; Raymo & Wang, 2022; Stessman et al., 2014; Susheela et al., 2018; Tijhuis et al., 1999; Victor & Bowling, 2012). The above-mentioned studies included various subsets of ADL and IADL tasks. The loneliness measures used in these studies also vary from a single item question, the UCLA Loneliness Scale, de Jong Gierveld Loneliness Scale, and Revised Social Provisions Scale.

Five studies examined the relationship between loneliness and objective gait measures. They reported that loneliness was associated with more rapid motor decline (Buchman et al., 2010), slower gait speed (McCaffery et al., 2020; Philip et al., 2020; Shankar et al., 2017), perceived walking difficulty (Rantakokko et al., 2014), mobility decline (Perissinotto et al., 2012), and gross/fine motor impairment (Theeke, 2009). The studies differed in their functional measures as well as their loneliness measures. Mean age of the population in these studies was 69 to 80 years and majority female. Studies that reported ethnicity were majority non-diverse (McCaffery et al., 2020; Perissinotto et al., 2012).

Longitudinal studies attempted to elucidate the direction of the relationship between loneliness and functional decline and reported mixed results. Some longitudinal studies suggested that functional decline leads to increased loneliness (Dykstra et al., 2005; Jylhä, 2004; Kim et al., 2022; Steptoe & Di Gessa, 2021). Other longitudinal studies suggested that loneliness leads to ADL/IADL disability (Crowe et al., 2021; Holmén et al., 1993; Perissinotto et al., 2012; Tsai et al., 2022; Zhang et al., 2021), reduced gait speed (Philip et al., 2020; Shankar et al., 2017), poorer physical performance (Philip et al., 2020), and more rapid functional decline over time (Buchman et al., 2010). In a unique approach, Philip et al. (2020) accounted for time varying effects of loneliness and physical function and found that loneliness was associated with poorer physical performance and slower gait speed over time. In contrast, four longitudinal studies reported no association between loneliness and ADL or IADL disability onset over 4 to 10 years (Guo et al., 2021; Stessman et al., 2014; Tijhuis et al., 1999; Victor & Bowling, 2012). Luo et al. (2012) reported evidence of a bidirectional relationship between loneliness and functional limitation.

Most studies investigated the relationship between loneliness and functional decline peripherally by identifying predictors and risk factors of loneliness and noting functional decline as one of several predictors of loneliness or loneliness as a predictor of functional decline, rather than examining the relationship directly. To synthesize our findings, we extracted common predictors and risk factors for loneliness and functional decline from the included studies and summarized these results in Figure 3. As the figure demonstrates,

several demographic, psychological, social, cognitive, physical, and biological factors are shared between loneliness and functional decline that could represent potential causal pathways.

Weaknesses in the current research base include measuring loneliness at only one point in time, thus it is not possible to comment on the direction of the relationship in those studies (Perissinotto et al., 2012). McCaffery et al. (2020) investigated the relationship between loneliness and functional decline cross-sectionally at a 15-year follow-up point; however, loneliness was not measured at baseline, therefore, directionality cannot be ascertained.

DISCUSSION

The purpose of the current review was to examine the relationship between loneliness and functional decline in older adults using the RAM as a theoretical framework to analyze potential causal pathways for loneliness and functional decline and identify opportunities for future research. To synthesize our findings, we extracted common predictors and risk factors for loneliness and functional decline from the included studies and summarized these results in Figure 3. We discuss these findings in the context of the RAM to explain potential causal pathways for loneliness and functional decline and identify areas of intervention for nursing to address loneliness and associated health problems in older adults (Figure 1).

Stimuli

Synthesis of the studies revealed several risk factors for loneliness, noted as contextual stimuli in Figure 1. Contextual stimuli exacerbate the effects of the focal stimulus (Roy & Andrews, 1991), which in this case is loneliness. Socioeconomic status is highlighted as an important risk factor for loneliness and functional decline. Poorer socioeconomic circumstances were associated with increased loneliness (Chow et al., 2021; Crowe et al., 2021; Shankar et al., 2017; Stessman et al., 2014; Torres et al., 2016; Tsai et al., 2022) and functional decline (Shankar et al., 2017). Furthermore, greater social resources and increased socioeconomic status were associated with better physical function and less loneliness (Gyasi et al., 2022; Tsai et al., 2022). Socioeconomically disadvantaged populations are identified as high risk for loneliness and functional decline. Thus, consideration of social and environmental factors as intervention areas for primary and secondary prevention of loneliness and functional decline is essential.

Coping Processes

The two coping processes described in the RAM are regulator and cognator processes (Roy & Andrews, 1991). These coping processes are physiological, cognitive, or emotional reactions to a stimulus, which in this context is loneliness. The *regulator system* responds to loneliness with physiological responses (Roy & Andrews, 1991), including immune dysregulation (Cole et al., 2007), inflammatory activation (Cole et al., 2007), increased vascular resistance (Cacioppo & Hawkley, 2009), elevated blood pressure (Hawkley, Thisted, et al., 2010), executive dysfunction (Cacioppo & Hawkley, 2009), and impaired sleep quality (Hawkley, Preacher, et al., 2010), and contribute to poor health and functional decline in different ways. Coping processes in the regulator mode can be measured by

neuroendocrine responses, such as C-reactive protein levels for inflammation, leukocytes for immune function, and blood pressure for vascular resistance. These are all examples of measurable, physiological responses triggered by loneliness. Addressing the stimulus that initiated these responses—loneliness—can promote positive adaptation in the physiological mode.

The *cognator system* is a cognitive–emotional system that responds to internal or external stimuli with perceptual and information processing, judgment, learning, and emotion (Roy & Andrews, 1991). Loneliness is associated with impaired processing of social information, such as increased sensitivity to negative social stimuli and chronic hypervigilance for social threats in the environment (Cacioppo et al., 2014) that can contribute to a negative feedback loop of more loneliness. This cognitive–emotional response to loneliness highlights an intervention area for nursing to exemplify and support healthy interpersonal relationships to promote adaptation in the interdependence mode. In addition, poor self-regulation, which is a maladaptive coping response to loneliness, independently affects health through changes in lifestyle behaviors (Shankar et al., 2011). Results of several studies support the association between loneliness and poor health habits, including decreased physical activity, smoking, and alcohol use (Buchman et al., 2010; Pengpid & Peltzer, 2021; Perissinotto et al., 2012; Philip et al., 2020; Shankar et al., 2017; Wei et al., 2022), which can lead to functional decline (Abe et al., 2022). Health behaviors are another area for nursing intervention to promote health and prevent functional decline.

Compromised Adaptive Modes

Because the definition of loneliness results in a lack of satisfactory affective relationships, it is generally translated as dysfunction in the interdependence mode. As a systematic review, the current article focuses broadly on how loneliness affects the whole person in various areas of health and function; thus, the spillover effects of loneliness in the three other modes are reflected in this discussion.

Physiological Mode.—The physiological mode of the RAM focuses on the physiological symptoms of disease in organs and body systems. Loneliness and functional decline are associated with a range of physical, biological, and behavioral symptoms, including depressive symptoms, poor overall cognition (Cacioppo & Hawkley, 2009), increased vascular resistance, and elevated blood pressure (Cacioppo et al., 2010) that may contribute to functional decline in different ways. These pathophysiological processes associated with loneliness lead to poor health outcomes, such as vascular disease (Buchman et al., 2010), depression (Luo et al., 2012), ADL/IADL disability, and multimorbidity (Pengpid & Peltzer, 2021).

Cognitive impairment is another important factor common to loneliness and functional decline. Functional decline is linked to cognitive impairment and dementia and is often clinically evident years prior to the onset of cognitive symptoms (Giebel et al., 2015). Loneliness is also associated with accelerated cognitive decline and dementia (Wilson et al., 2007) and can be a symptom of neurobiological changes related to cognitive disease (Donovan et al., 2017). The direction of these relationships, whether functional decline or

loneliness cause cognitive impairment or vice versa, is unclear. Furthermore, the effects of COVID-19 pandemic–related restrictions that led to decreased physical and social contact, particularly in older adults, are only beginning to emerge and could have implications for cognitive function in older adults in the years to come.

Although loneliness and functional decline were associated with cognitive status, most studies did not include a measure of cognitive function. Furthermore, some studies excluded participants with cognitive impairment or dementia (Buchman et al., 2010; Holmén et al., 1993; Tsai et al., 2022). In addition, studies that included comparisons of cognitive function with loneliness and functional decline (Holmén et al., 1993; Kim et al., 2022; Philip et al., 2020; Stessman et al., 2014; Wei et al., 2022; Zhang et al., 2021) did not report levels of cognitive dysfunction, rendering actual evaluation of the relationship between loneliness, functional decline, and cognition challenging. Given that cognitive function was associated with loneliness and functional decline and is highly relevant to this relationship, it seems prudent to include measures of cognitive function when studying or considering the relationship between loneliness and functional decline.

Social Modes.—The three social adaptive modes include the self-concept mode, role function mode, and interdependence mode. These modes refer to self-perceptions, fulfilment of social roles and responsibilities, and nurturing relationships with others (Roy & Andrews, 1991). Health status does not exist in a vacuum, and the impact of social factors on health cannot be discounted. In addition, according to the RAM, an alteration in one adaptive mode can affect one or all of the others (Roy & Andrews, 1991). Thus, alterations in social health affect physiological well-being and ill physical health affects social well-being.

Multiple social factors, including infrequent social contact, small social networks, low social participation, low social support, social isolation, living alone, and marital status were associated with loneliness and functional decline, as listed in Figure 3. Perceived social support (Kuwert et al., 2014) and large social networks were associated with less loneliness (Gyasi et al., 2022). Social factors are important moderators of functional decline, possibly via the social control hypothesis where an individual engages in positive health behaviors due to the influence of friends and family (Cacioppo & Hawkey, 2009). Loneliness is an indicator of poor social functioning and low social engagement; thus, according to the social control theory, lonely individuals lack the protective role of social influence in terms of positive health behaviors.

ADL/IADL disability is included in the role function mode as functional decline may alter the individual role in the family or society based on physical abilities. Functional decline may inhibit social engagement, social contact, and social participation due to structural factors, such as a physical disability that precludes getting out of the home, leading to increased loneliness.

This discussion highlights loneliness as a multidimensional, multisystem problem that affects health and function in different ways. Loneliness is framed according to the RAM, to explain how physiological and psychological responses to loneliness affect physical and social well-being across multiple systems. Furthermore, contextual factors that influence

one's life experience, such as health status, socioeconomic status, and relationship quality, impact their ability to mount an adaptive coping response. The stimuli that trigger adaptive or maladaptive coping responses highlighted in Figure 1 underscore areas of opportunity for future research of nursing interventions that promote adaptive functioning in those areas.

IMPLICATIONS FOR FUTURE RESEARCH

Most studies investigated the relationship between loneliness and functional decline peripherally by identifying predictors and risk factors of loneliness. Although this establishes that there is a relationship between loneliness and functional decline, it precludes a more nuanced understanding of their interrelationships. In addition, the research base clearly establishes the association between loneliness and ADL/IADL disability. Further studies of the associations between loneliness and objective functional measures, such as gait, may shed light on measures of function that can be identified in clinical settings and present an opportunity for early intervention before a decline in function progresses to ADL disability.

The evidence for the direction of the relationship between loneliness and functional decline is mixed. Studies suggest functional decline leads to increased loneliness in the future (Cohen-Mansfield et al., 2009; Dykstra et al., 2005; Jylhä, 2004). Dykstra et al. (2005) note a consistent decrease in function over 7 years, which is associated with increased loneliness over time. Luo et al. (2012) specify the increase in loneliness associated with older age is not related to age per se, but with age-related decline in function. Other longitudinal studies suggest exposure to loneliness leads to decline in function over time (Crowe et al., 2021; Philip et al., 2020). Further studies that measure loneliness at baseline as well as several time intervals can better clarify the direction of the relationship, including possible reverse causality and bidirectionality.

Measures of loneliness and function vary across studies. Consistent measures across studies are essential for comparison between studies and for clinical application. In addition, few studies include measures of cognitive function, or consider cognitive function as a possible mediator or confounder in their analyses. As cognitive status may independently affect loneliness and physical function, it should be considered in studies of loneliness and functional decline.

In addition, consideration for possible mediators or confounders was inconsistent across studies in terms of which variables were considered and reported. Race/ethnicity and measures of socioeconomic status should be routinely reported, as discrimination, health disparities, and socioeconomic status related to systemic racism have a significant impact on health outcomes (Mackenbach et al., 2008; Williams et al., 2019). It is essential for research studies to include populations that reflect the society in which we live so that results are generalizable and relevant for public health in general. Other mediating/confounding variables, including demographics, depression, and social factors, including social network size, social isolation, social engagement, and social support, must be taken into consideration as well to provide an accurate picture of results.

CONCLUSION

Loneliness is associated with functional decline in aging via multiple possible pathways. The RAM provides a holistic view of how loneliness and functional decline affect physical and social health across multiple systems. The bulk of existing literature establishes loneliness as a predictor of functional decline, possibly in a bidirectional relationship. Further study is necessary to determine causality and biological mechanisms underlying the relationship between loneliness and functional decline. Studies should be performed in diverse populations with validated, quantitative measures for loneliness and functional decline for clinical relevance of research.

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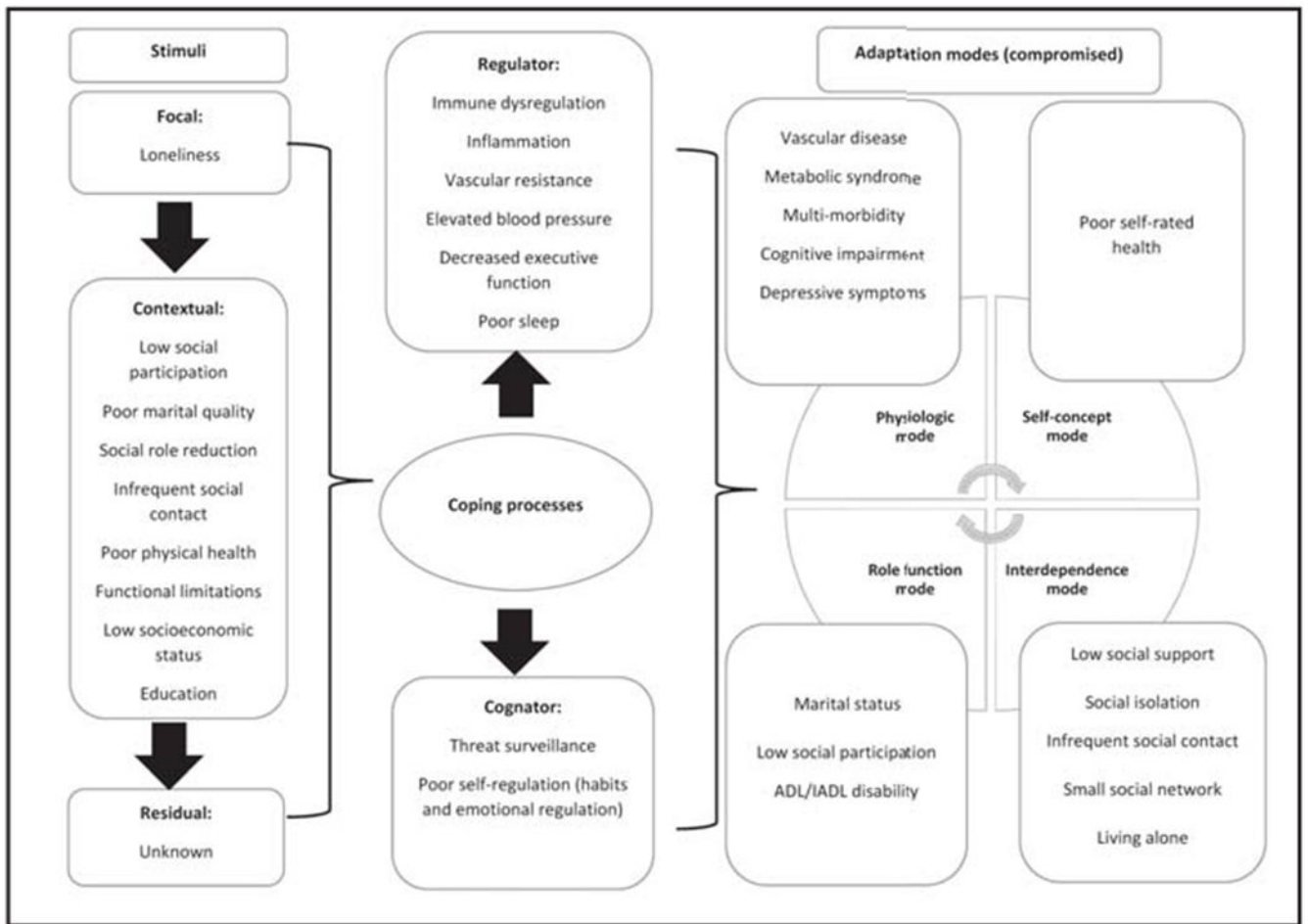


Figure 1. Stimuli, coping processes, and maladaptive behaviors of loneliness based on Roy's Adaptation Model (Roy & Andrews, 1991).

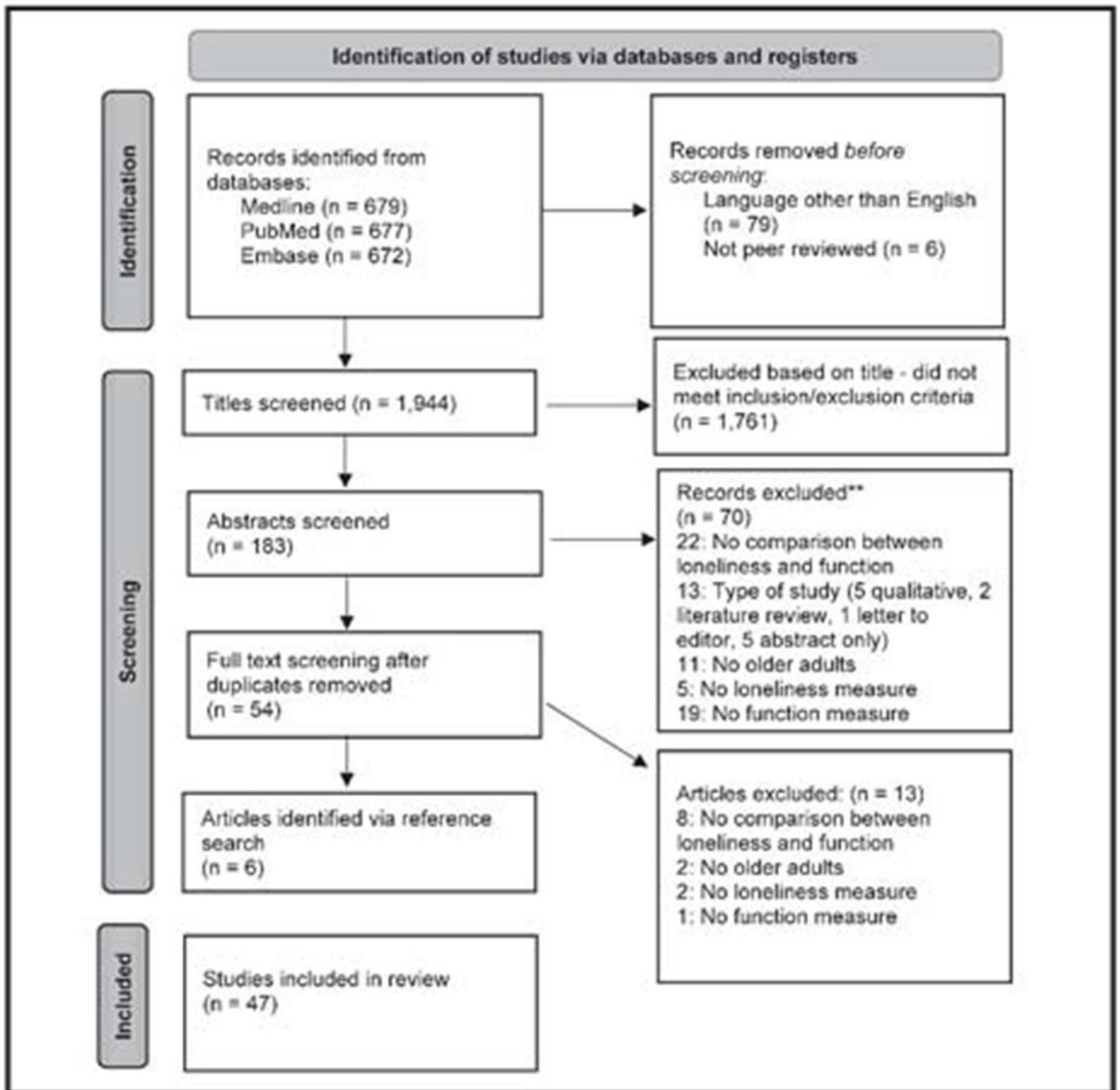


Figure 2.
Flow diagram of study selection.

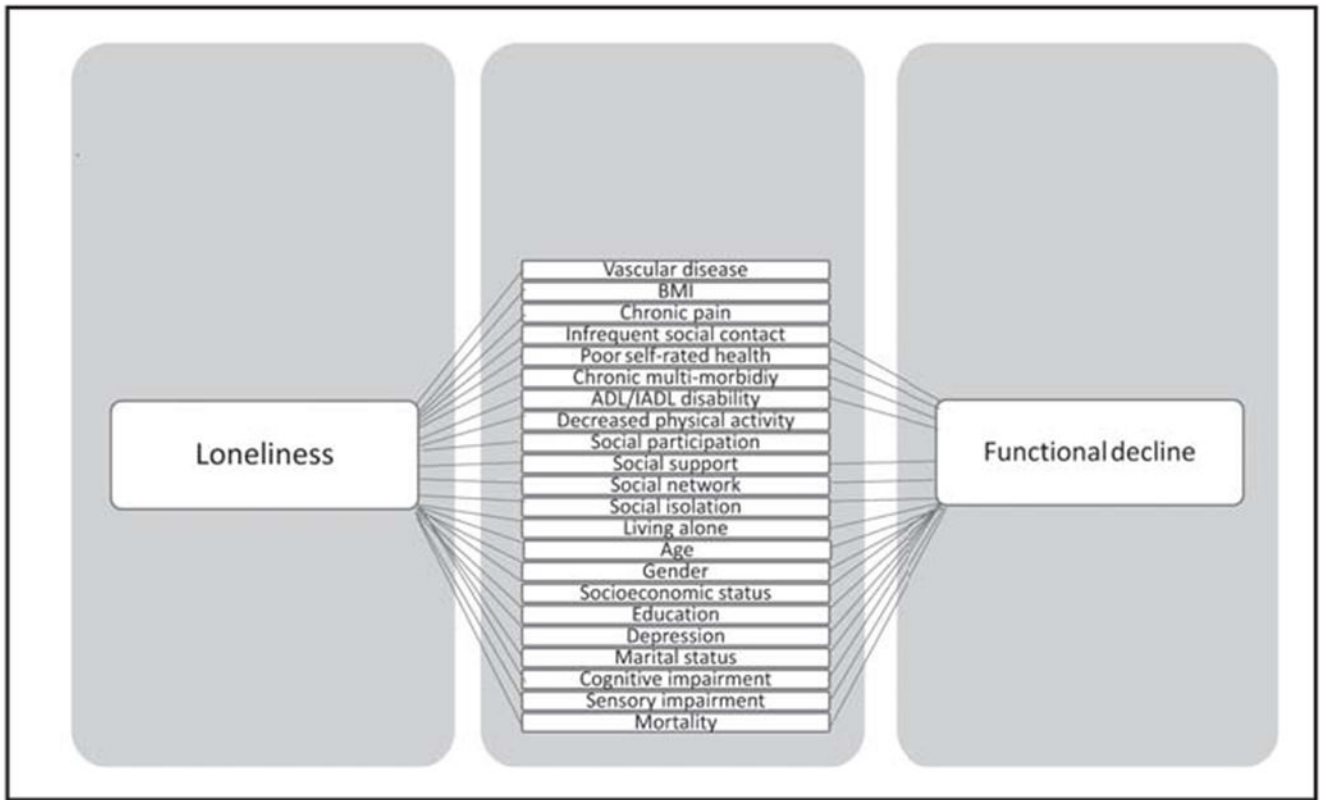


Figure 3. The interrelationships between loneliness and functional decline discussed in the current review.

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Table A.

Search terms

Loneliness	Gait/Function	Older adults
Loneliness	Clinical gait	Aged
Feeling lonely	abnormalities	Aged, 80 and over
Lonely	Gait impairments Gait speed Dual-task gait Quantitative gait Gait speed decline Quantitative gait decline Mobility disability Mobility impairment Neurological gait Non-neurological gait Stride length Step length Cadence Double support time Walking abnormalities Walking speed Dual-task walking Gait Gait abnormalities Gait decline Gait changes Gait velocity Timed gait Walking impairment Walking decline Walking changes Disability ADL disability Activities of daily living IADL Instrumental activities of daily living	Frail elderly Older adults

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Table B.

Summary of Included Literature

Authors, Year, Country	Design	Purpose	Measures (Function/loneliness)	Sample	Results
(Bondevik & Skogstad, 1998, Norway)	Correlational/comparative design	To explore the influence of ADL on loneliness and assess influence of social contact frequency on this relationship.	<ul style="list-style-type: none"> Modified KATZ Index of Independence in Activities of Daily Living Revised Social Provisions Scale 	<ul style="list-style-type: none"> Convenience sample 221 Participants aged 80-105. Mean age 88 85% female Ethnicity not reported. 	ADL dependence was not associated with loneliness. Frequency of social contact buffered effect of ADL dependence on loneliness.
(Buchman et al., 2010), United States	Longitudinal cohort study	Test if feeling alone is associated with rate of motor decline in old age.	<ul style="list-style-type: none"> Composite measure of global motor function based on a number of motor tests. Modified de Jong-Gierveld Loneliness Scale (5 items) 	<ul style="list-style-type: none"> 985 participants drawn from the Rush Memory and Aging Project. Mean age 80 75% female Ethnicity not reported. 	Loneliness was associated with more rapid motor decline after controlling for social isolation, depression, cognition, physical and cognitive activities and chronic conditions.
(Burholt, Windle, & Morgan, 2017), United Kingdom	Cross sectional study	To evaluate the relationship between loneliness and disability with cognitive function as a moderating variable and social resources as a mediating variable.	<ul style="list-style-type: none"> Modified Townsend Disability Scale De Jong-Gierveld Scale 	<ul style="list-style-type: none"> 3,314 community dwelling adults aged 65 and older drawn from the Cognitive Function and Aging Study (CFAS) Wales. Mean age 75 54% female Ethnicity not reported. 	Greater disability was significantly associated with greater levels of loneliness.
(Chalise, Saito, & Kai, 2007), Nepal	Cross sectional study	To identify significant factors for loneliness in older adults in Nepal.	<ul style="list-style-type: none"> IADL disability 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> 195 Nepalese adults aged 60 and older. Mean age 69 48% female 	IADL disability was associated with higher levels of loneliness. This association was not significant after adjusting for confounders.
(Cheung, Wright-St Clair, Chacko, & Barak, 2019), New Zealand	Cross sectional study	To investigate the relationship between sociodemographic, health, functional and psychosocial factors and loneliness in community dwelling older adults.	<ul style="list-style-type: none"> ADL Hierarchy Lonely (yes/no) 	<ul style="list-style-type: none"> 51,239 adults aged 65 and older Mean age 82 61% female 87.3% European. 	Higher score on ADL hierarchy or higher level of functional impairment was associated with less loneliness.
(Chow, Wong, & Choi, 2021), Taiwan	Cross sectional study	To examine the relationship between loneliness, IADL and SRH (self-rated health) among community dwelling older adults in Hong Kong.	<ul style="list-style-type: none"> Lawton Instrumental Activities of Daily Living scale 6 item de Jong Gierveld Loneliness Scale 	<ul style="list-style-type: none"> 143 adults, aged 65 and older, living in the community. 34.3% aged 65-70 32.9% aged 71-75 55% female. Ethnicity not reported. 	Increased IADL disability was associated with increased loneliness.
(Cohen-Mansfield, Shmotkin, & Goldberg, 2009), Israel	Longitudinal cohort study (longitudinal and cross-sectional analyses)	To examine whether loneliness increases with age, characterize the lonely older population and identify predictors of becoming lonely in old age.	<ul style="list-style-type: none"> Lawton Instrumental Activities of Daily Living scale Single item from the Center for Epidemiological Studies Depression Scale (CESD) 	<ul style="list-style-type: none"> 1,147 adults aged 75 and older Mean age 83 45% female 37% European/American born 32.7% Middle Eastern/North African born 30.3% Israeli born. 	IADL disability was associated with higher levels of loneliness.

Authors, Year, Country	Design	Purpose	Measures (Function/loneliness)	Sample	Results
(Crowe et al., 2021), United States	Longitudinal cohort study	Test associations of longitudinal loneliness and social isolation phenotypes with disability, morbidity, mortality and biological aging.	<ul style="list-style-type: none"> • ADL and IADL limitations • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 11,302 adults aged 50-95, drawn from the Health and Retirement Study. • Mean age 56 • 60.4% female • 75% White/non-Hispanic. 	Loneliness was associated with higher levels of ADL/IADL disability compared to non-lonely individuals. Persistent loneliness was associated with increased risk for ADL/IADL disability compared to intermittent loneliness.
(Czaja, Moxley, & Rogers, 2021), United States	Cross sectional study	To examine the relationships between social network size, social support, social isolation and loneliness.	<ul style="list-style-type: none"> • Mobility and functional disability • UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 300 adults aged 65-98 • Mean age 76 • 78% female • 54% White/non-Hispanic. 	Functional limitation was associated with higher levels of loneliness.
(Dykstra, van Tilburg, & de Jong Gierveld, 2005) the Netherlands	Longitudinal cohort study	To examine loneliness and its correlates over a seven year period.	<ul style="list-style-type: none"> • ADL/IADL disability • De Jong Gierveld Loneliness Scale 	<ul style="list-style-type: none"> • 3,805 adults, drawn from the Longitudinal Aging Study Amsterdam • Mean age 67 • 55.6% female • Ethnicity not reported. 	Greater decline in functional capacity was associated with higher levels of loneliness over 7 years.
(Fauth, Zarit, & Malmberg, 2008), Sweden	Cross sectional study	To replicate past findings on the mediating relationships between main pathway variables in the Disablement Process model and observe how intra-individual factors mediate main pathway components.	<ul style="list-style-type: none"> • Physical limitation scale; Katz Index of Independence in Activities of Daily Living, Lawton Instrumental Activities of Daily Living scale; Mobility impairment • 5 item loneliness measure (four items from UCLA Loneliness Scale, one item from Malmberg) 	<ul style="list-style-type: none"> • 149 Swedish adults aged 86,90 or 94 living in the community or in institutions. • Mean age 90 • 69.8% female • Ethnicity not reported. 	Loneliness was a direct mediator between physical and cognitive functional limitation and ADL disability.
(Guo, An, Luo, & Yu, 2021), China	Longitudinal cohort study	Investigate the association of loneliness or social isolation with functional disability onset over 4 years among Chinese older adults.	<ul style="list-style-type: none"> • ADL/IADL disability • Single item from the Center for Epidemiological Studies Depression Scale (CESD) 	<ul style="list-style-type: none"> • 5,154 adults aged 50 and older, drawn from the Chinese Health and Retirement Longitudinal Study. • Mean age 61 • 47.7% female • Ethnicity not reported. 	Social isolation, not loneliness, was associated with new onset ADL/IADL disability in women, not men.
(Gyasi et al., 2022), Ghana	Cross sectional study	To examine the association of loneliness with physical function impairment and the modifying effect of perceived health status.	<ul style="list-style-type: none"> • Physical function impairment scale (mobility, ADL) • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 1,201 adults 50 and older • Mean age 66 • 63% female 	Loneliness was associated with increased physical functional impairment, with perceived health status as a modifier of the relationship.
(Hacihasano lu, Yildirim, & Karakurt, 2012), Turkey	Cross sectional study	To investigate the level of loneliness and level of dependence in ADLs in older adults.	<ul style="list-style-type: none"> • ADL disability • UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 830 adults aged 65 and older • 36.5% aged 65-69, 28.3% aged 70-74, 21.6% aged 75-79, 13.6% aged 80 and over • 44.2% female • Ethnicity not reported. 	ADL disability was associated with higher levels of loneliness.

Authors, Year, Country	Design	Purpose	Measures (Function/loneliness)	Sample	Results
(Holmén, Ericsson, Andersson, & Winblad, 1993), Sweden	Longitudinal cohort study, cross-sectional analyses	Investigate the relationship between loneliness and ADL dependence in older adults with and without cognitive impairment.	<ul style="list-style-type: none"> • ADL/IADL disability; ADL staircase • “Do you experience loneliness?” (Often, sometimes, seldom, never) 	<ul style="list-style-type: none"> • 264 adults aged 75 and older living in the community. • Mean age 84 • 80% female • Ethnicity not reported. 	Loneliness was associated with increased ADL dependence. Cognitive impairment was associated with increased loneliness and ADL dependence.
(Honigh-de Vlaming, Haveman-Nies, Bos-Oude Groeniger, de Groot, & van 't Veer, 2014), The Netherlands	Cross sectional study	To investigate the influence of socio-demographics, health, and municipal characteristics on loneliness trends in community dwelling elderly.	<ul style="list-style-type: none"> • Organisation for Economic Co-operation and Development (OECD) disability indicator • De Jong Gierveld Loneliness Scale 	<ul style="list-style-type: none"> • Data from two independent cross-sectional surveys: • 4,868 non-institutionalized adults aged 65 and older in 2005 • 4,773 non-institutionalized adults aged 65 and older in 2010. • Mean age 74 • 54% female in 2005 • 50% female in 2010 • Ethnicity not reported. 	In individuals with one or more activity limitation, loneliness increased over time.
(Jones, Victor, & Vetter, 1985), United Kingdom	Cross sectional study	To investigate the problem of loneliness among elderly people living independently within the community in both, a rural and urban setting.	<ul style="list-style-type: none"> • IADL disability • One item question whether participant felt lonely (sometimes, often always) 	<ul style="list-style-type: none"> • Two samples aged 70 and older • 630 participants from rural area • 656 participants from urban area • Descriptive characteristics of sample not available. 	Mobility and IADL disability were associated with higher levels of loneliness.
(Jylhä, 2004), Finland	Longitudinal cohort study	To examine whether older age is associated with loneliness in adults aged 60 and over.	<ul style="list-style-type: none"> • ADL and IADL disability • “Do you feel lonely?” (often, sometimes, never). 	<ul style="list-style-type: none"> • 1,059 adults aged 60 and older from the Tampere Longitudinal Study on Aging – TamELSA. • Descriptive characteristics of sample not available. 	Individuals with functional disability were more likely to report loneliness and more likely to become lonely in the future.
(O. Kim, 1999), United States	Correlational study	To examine the predictors of loneliness in elderly Korean immigrant women.	<ul style="list-style-type: none"> • Instrumental Activities of Daily Living Scale adapted from the Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire • UCLA Loneliness Scale 	<ul style="list-style-type: none"> • Convenience sample of 110 Korean immigrant women aged 60 and older. • Mean age 73 	Higher levels of IADL disability was associated with increased loneliness.
(J. Kim, Angel, & Rote, 2022), United States	Longitudinal cohort study	To investigate the longitudinal patterns and impact of IADL transitions on older Mexican Americans over time and identify risk factors and consequences of IADL transitions on depression, and self-rated health.	<ul style="list-style-type: none"> • IADL disability • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 1,078 Mexican Americans aged 65 and older, drawn from the Hispanic Established Populations for the Epidemiologic Study of the Elderly • Mean age 85 • 65% female • 45% Mexican born 	Increased IADL disability was associated with higher levels of loneliness.

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(Korporaal, Broese van Groenou, & van Tilburg, 2008), the Netherlands	Cross sectional study	To examine the effects of own and spousal disability on social and emotional loneliness among married adults aged 65 and older.	<ul style="list-style-type: none"> • ADL disability • 11 item de Jong Gierveld Loneliness Scale 	<ul style="list-style-type: none"> • 710 men and 379 women aged 65 and older who are married and living in the community from the Living Arrangements and Social Networks of Older Adults study. • Descriptive characteristics of sample not available 	Own disability and spousal disability was associated to higher levels of emotional loneliness among men and women.
(Kuwert, Knaevelsrud, & Pietrzak, 2014), United States	Cross sectional study	To examine the prevalence and correlates of loneliness in a nationally representative sample of older US veterans.	<ul style="list-style-type: none"> • ADL/IADL disability • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 2,025 veterans aged 60 and older, drawn from the National Health and Resilience in Veterans study. • Mean age 71 • 96.2% male • 84.7% white/non-Hispanic. 	ADL disability was associated with loneliness.
(Luo, Hawkey, Waite, & Cacioppo, 2012), United States	Longitudinal cohort study	To examine the relationship between loneliness, health and mortality in a nationally representative sample of adults aged 50 and over in the United States.	<ul style="list-style-type: none"> • 12 items regarding functional limitations • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 2,101 adults aged 50 and older, drawn from the Health and Retirement Study. • Mean age 67 • 59.6% female • 87.3% White/non-Hispanic. 	Increased loneliness was associated with increased functional limitation. Increased functional limitation was associated with increased loneliness.
(McCaffery et al., 2020), United States	Cross sectional study	To characterize the prevalence of loneliness among individuals with type 2 diabetes and overweight/obesity in the Look AHEAD cohort and to determine the cross-sectional associations of loneliness with self-reported disability, objective mobility and other health indicators.	<ul style="list-style-type: none"> • Pepper Assessment Tool for Disability (PAT-D), SPPB • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 3,187 adults aged 61-92 with type 2 diabetes and overweight/obesity, drawn from a RCT from the Look AHEAD cohort. • Mean age 73 • 61.9% female • 60.8% White. 	Loneliness was associated with greater self-report of disability and slower gait speed after controlling for depression and antidepressant medication use.
(Miyawaki, Liu, Park, Tran, & Markides, 2022), United States	Cross sectional study	To examine how social support moderates the relationship between physical disability and mental health in older Vietnamese immigrants in the United States.	<ul style="list-style-type: none"> • KATZ Index of Independence in Activities of Daily Living • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 132 community dwelling Vietnamese immigrants aged 65 and older. • Mean age 75 • 54.5% female • 100% Vietnamese-born. 	ADL disability was associated with higher levels of loneliness, where the more disabilities a participant had, the higher levels of loneliness they experienced. This relationship was moderated by social support.
(Nagarkar & Kashikar, 2017), India	Prospective cohort study	To identify predictors of functional decline in older adults in India.	<ul style="list-style-type: none"> • Pune-FAAT (functional assessment questionnaire including IADL/ADL disability and mobility) • Feeling lonely (yes/no) 	<ul style="list-style-type: none"> • 1,140 adults aged 60 and older • Mean age 70 • 51% female 	Loneliness was associated with increased odds of disability.
(Nóbrega et al., 2022), Brazil	Cross sectional study	To evaluate how psychosocial aspects and support networks influence disability in	<ul style="list-style-type: none"> • Katz Index of Independence in Activities of Daily Living 	<ul style="list-style-type: none"> • 417 adults aged 80 and older • Majority female (55% in backlands) 	Loneliness was associated with increased ADL/IADL disability in older

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		the oldest old living in the backlands of Paraiba, Brazil, compared to oldest old in an urban city in Sao Paulo, Brazil.	<ul style="list-style-type: none"> • Lawton Instrumental Activities of Daily Living Scale • Loneliness (yes/no) 	group, 71% urban group)	adults living in an urban city.
(Pengpid & Peltzer, 2021), India	Cross sectional study	Examine the associations between loneliness, poor physical health, poor mental health and health risk behaviors in community-dwelling, middle-aged and older adults in a national population survey in India.	<ul style="list-style-type: none"> • Katz Index of Independence in Activities of Daily Living • Lawton Instrumental Activities of Daily Living Scale • One item from the CES-D scale 	<ul style="list-style-type: none"> • 72,262 middle-aged and older adults (aged 45 and older and their spouses, regardless of age). • 54.1% aged 45-59 • 45.9% aged 60 and over. • 58% female. • Ethnicity not reported. 	Loneliness was associated with ADL and IADL disability.
(Perissinotto, Stijacic Cencer, & Covinsky, 2012), United States	Longitudinal cohort study	To examine the impact of loneliness on functional decline and mortality in older adults over the age of 60 in the United States over 6 years.	<ul style="list-style-type: none"> • ADL disability, gait decline • 3 item UCLA loneliness scale 	<ul style="list-style-type: none"> • 1,604 adults aged 60 and older, drawn from the Health and Retirement Study. • Mean age 71 • 59% female • 81% White. 	Loneliness was associated with all measures of functional decline (ADL, stair climbing, mobility). The association between loneliness and mobility decline was nearly significant in adjusted analysis.
(Philip, Polkey, Hopkinson, Steptoe, & Fancourt, 2020), United Kingdom	Longitudinal study	To assess the relationship between loneliness, different aspects of social isolation and physical performance over time.	<ul style="list-style-type: none"> • Short Physical Performance Battery • 3 item UCLA loneliness scale 	<ul style="list-style-type: none"> • 8,780 adults aged 50 and older, drawn from the English Longitudinal Study of Ageing • Mean age 69 • 54% female 	Higher levels of loneliness were longitudinally associated with poorer physical performance, including significant association with sit to stand and slower walking speed.
(Rantakokko et al., 2014), Finland	Cross sectional analysis	To describe loneliness among community dwelling older adults and examine its association with perceived environmental barriers to outdoor mobility.	<ul style="list-style-type: none"> • Perceived walking difficulty, 2 km • Feels lonely (seldom/never, sometimes, often) 	<ul style="list-style-type: none"> • 848 community dwelling adults aged 75-90 drawn from the Life-Space Mobility in Old Age project. • Mean age 80 • 62% female • Ethnicity not reported. 	Increased walking difficulty was associated with higher levels of loneliness.
(Raymo & Wang, 2022), United States	Demographic study with longitudinal design	To describe the demography of loneliness at older ages.	<ul style="list-style-type: none"> • ADL disability • Single item from the CES-D index; 3 item UCLA Loneliness Scale • 11 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 23,981 adults aged 55 and older, drawn from the Health and Retirement Study. • Descriptive characteristics of sample not reported. 	Loneliness was not associated with disability onset.
(Russell, 2009), United States	Cross sectional study	To assess risk for loneliness according to living arrangements in community dwelling older adults with and without a physical disability and evaluate the mediating role of social integration and support.	<ul style="list-style-type: none"> • Self-report of physical disability • 3 survey questions regarding loneliness 	<ul style="list-style-type: none"> • 868 adults aged 60 and older. • Mean age 72 • 56% female • 28% White/non-Hispanic. 	Living arrangements are a significant predictor of loneliness and risk for loneliness is conditioned by the presence of physical disability. Physically disabled older adults living alone reported higher levels of loneliness compared to those without physical disability who lived alone or those with a

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					physical disability who lived with a spouse.
(Shankar, McMunn, Demakakos, Hamer, & Steptoe, 2017), United Kingdom	Longitudinal cohort study	To examine the association of isolation and loneliness with 2 measures of functional status (gait speed and ADL disability) in older adults over a 6-year period.	<ul style="list-style-type: none"> Gait speed ADL disability 3 item UCLA loneliness scale 	<ul style="list-style-type: none"> 3,070 adults aged 60 and older, drawn from the English Longitudinal Study of Ageing. Mean age 69 56% female. Ethnicity not reported. 	Loneliness was associated with ADL disability, and reduced gait speed, with stronger effects among socioeconomically disadvantaged older adults.
(Steptoe & Di Gessa, 2021), United Kingdom	Longitudinal cohort study	To evaluate the emotional and social experience of older people with physical disabilities during the early months of the COVID-19 pandemic in England.	<ul style="list-style-type: none"> Katz Index of Independence in Activities of Daily Living Lawton Instrumental Activities of Daily Living 3 item UCLA loneliness scale 	<ul style="list-style-type: none"> 4,887 adults aged 50 and older, drawn from the English Longitudinal Study of Ageing. 94% White 	ADL/IADL disability and mobility impairment were significantly associated with higher rates of reported loneliness compared to participants without ADL disability.
(Stessman, Rottenberg, Shimshilashvili, Ein-Mor, & Jacobs, 2014), Israel	Longitudinal cohort study	To examine the association of subjective loneliness with subsequent health, function, mood and longevity.	<ul style="list-style-type: none"> Katz Index of Independence in Activities of Daily Living One item interview question "How often do you feel lonely?" 	<ul style="list-style-type: none"> 340, 520, 705 community dwelling adults aged 70 and older at ages 70, 78, and 85 respectively, drawn from the Jerusalem Longitudinal Cohort Study. Descriptive characteristics of sample not reported. 	Loneliness was not associated with new onset ADL dependence/difficulty or functional decline over 7 years.
(Susheela, Valsaraj, & Savitha, 2018), India	Cross sectional study	To determine the prevalence of depression, perceived loneliness, and partial functional impairment among older adults and to examine the relationship between these variables.	<ul style="list-style-type: none"> ADL/IADL disability UCLA Loneliness scale 	<ul style="list-style-type: none"> 600 adults aged 60 and older. 65.7% aged 60-70 25% aged 71-80 8% aged 81-90 1.3% aged >90 57.8% female Ethnicity not reported. 	Loneliness was not associated with ADL disability.
(Theeke, 2009), United States	Cross sectional study	To analyze multiple sociodemographic and health related variables as predictors of loneliness in a large, random sample of older community dwelling US adults.	<ul style="list-style-type: none"> Gross/fine motor impairment Lonely (yes/no) 	<ul style="list-style-type: none"> 8,932 adults Aged 65 and older drawn from the Health and Retirement Study Mean age 74 59% female Ethnicity not reported 	Individuals with gross motor impairment and fine motor impairment were more likely to be lonely.
(Tijhuis, De Jong-Gierveld, Feskens, & Kromhout, 1999), the Netherlands	Longitudinal cohort study (longitudinal and cross-sectional analyses)	To investigate whether loneliness increases in old age and if so, it's related factors and to examine the relationship between loneliness and changes in institutionalization, partner status, and health.	<ul style="list-style-type: none"> ADL/IADL disability De Jong Gierveld Loneliness Scale 	<ul style="list-style-type: none"> 939 men Mean age 73 Ethnicity not reported. 	Change in ADL limitation was not associated with loneliness.
(Torres, Lima-Costa, Marmot, & de Oliveira, 2016), United Kingdom	Longitudinal cohort study	To explore socio-economic inequalities in disability, accounting for depression and social support, among different	<ul style="list-style-type: none"> Katz Index of Independence in Activities of Daily Living 	<ul style="list-style-type: none"> 5,506 adults aged 50 and older, drawn from the English Longitudinal Study of Ageing 	Lower level of function was associated with higher levels of loneliness. Low socioeconomic status

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		socioeconomic groups of older English adults	<ul style="list-style-type: none"> • Lawton Instrumental Activities of Daily Living • 3 item UCLA loneliness scale 	<ul style="list-style-type: none"> • Mean age 66 • 54% female 	was associated with greater loneliness.
(Tsai et al., 2022), Taiwan	Longitudinal cohort study	Explore the relationship between loneliness and social isolation on stress-related biomarkers, depressive symptoms and disability.	<ul style="list-style-type: none"> • 9-item strength and mobility scale • One item interview question regarding feelings of loneliness (never, rarely, sometimes, often) 	<ul style="list-style-type: none"> • 629 adults aged 60 and older, drawn from the Social Environment and Biomarkers of Aging Study, an extension of the Taiwan Longitudinal Study on Aging. • Mean age 66 • 41% female • Ethnicity not reported. 	Higher levels of loneliness and social isolation were associated with higher levels of ADL/IADL disability 6 years later. The effect was not significant after adjusting for confounders.
(Victor & Bowling, 2012), United Kingdom	Longitudinal cohort study	To examine loneliness prevalence trends and risk factors over time.	<ul style="list-style-type: none"> • ADL disability • Self-rated loneliness scale (always, often, sometimes, never). 	<ul style="list-style-type: none"> • 999 community dwelling adults aged 65 and over in the United Kingdom at baseline and 287 participants at follow up. • Mean age 80 at follow up. • 48% female at baseline 54% female at follow up. • Ethnicity not reported. 	Change in ADL disability was not significantly associated with loneliness.
(Warner & Adams, 2012), United States	Longitudinal cohort study	To investigate the influence of non-spousal social support on the associations between marital quality, physical disability, and loneliness among married older adults.	<ul style="list-style-type: none"> • ADL disability • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 1,474 adults aged 57-85, drawn from the National Social Life, Health and Aging Project. • Descriptive characteristics of sample not reported. 	Non-spousal social support mediated the relationship between functional limitation and loneliness.
(Warner & Adams, 2016), United States	Longitudinal cohort study	To investigate how changes in social relations affect the link between functional limitations and increased loneliness among married older men and women.	<ul style="list-style-type: none"> • ADL disability • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 914 married/partnered adults aged 57-85, drawn from the National Social Life, Health and Aging Project. • Mean age 67 • Gender not reported. • Ethnicity not reported. 	Functional limitation was associated with increased loneliness. Changes in marital/nonmarital relationships did not mediate the link between functional limitation and loneliness. Increased social support was associated with increased loneliness in individuals with functional limitations.
(Warner, Adams, & Anderson, 2019), United States	Longitudinal cohort study	To examine the influence of marital quality on the association between disability and loneliness among married older adults.	<ul style="list-style-type: none"> • ADL disability • 3 item UCLA Loneliness Scale 	<ul style="list-style-type: none"> • 1500 married adults aged 57-85, drawn from the National Social Life, Health and Aging Project. • Mean age 67 • Gender not reported. • Ethnicity not reported. 	Functional limitation was associated with increased loneliness; marriage quality did not mediate the association between functional limitation and loneliness. Positive marital quality moderated the association between

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(Wei et al., 2022), China	Longitudinal cohort study	To investigate whether the associations of loneliness with adverse health outcomes differ in community-dwelling older adults according to different living arrangements	<ul style="list-style-type: none"> • Katz Index of Independence in Activities of Daily Living • IADL disability • Feeling lonely (always, often, sometimes, seldom, never) 	<ul style="list-style-type: none"> • 13,738 adults aged 65 and older, drawn from the Chinese Longitudinal Healthy Longevity Survey • Mean age 86 • 55% female 	functional limitation and loneliness. Loneliness was associated with decreased cognitive and physical function. Living arrangements modified this association.
(Zhang, Hu, & Feng, 2021), China	Longitudinal cohort study	To investigate the associations between various dimensions of social isolation and health outcomes.	<ul style="list-style-type: none"> • ADL/IADL disability • Subjective social isolation (felt lonely, had no one to talk to, had no one to seek for help). 	<ul style="list-style-type: none"> • 5,419 adults aged 65 and older, drawn from the Chinese Longitudinal Healthy Longevity Survey. • Descriptive characteristics of sample not reported. 	Increased loneliness was associated with increased ADL/IADL disability compared to those were not lonely.