

Review Article

Loneliness in Adults: A Narrative Review

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Abstract

This narrative review is a summary of literature on loneliness in adults that was published in 2024. In this research, the prevalence of loneliness worldwide widely ranged from 13 to 64%. Negative effects of loneliness included inferior cognitive performance, dysfunctional relationships, depression, sleep disturbances, diseases and issues of death anxiety, suicidality and mortality. The risk factors for loneliness included gender and age, early maltreatment, inactivity, excessive Internet use, partner conflict, loss of partner, retirement, COVID-19, social isolation and stress in general. Potential underlying biological mechanisms for loneliness included low EEG Beta activity, low oxytocin levels, elevated pro-inflammatory cytokines, DNA methylation, low gray matter volume and genetic alterations. Effective interventions included psychotherapy, reminiscence therapy, technological skill-building, exercise, leisure travel, time in nature, and social robots. Methodological limitations included cross-sectional studies, self-report measures, and lack of randomized controlled trials and active comparison groups for intervention studies.

1. Introduction

Loneliness research has been increasingly prevalent since the surgeon general of the U.S. suggested that it was a major health problem (2023). Over 1100 loneliness studies have appeared in the literature in this past year (2024). Although loneliness can occur across the lifespan, especially in younger and older people, this narrative review is focused specifically on loneliness in adults.

The empirical studies and review papers summarized here were derived from entering the terms loneliness in adults and the year 2024 on PubMed and PsycINFO. Exclusion criteria for this review included proposed protocols, case studies and non-English language papers. The publications can be categorized as negative effects of loneliness, predictors/risk factors, potential underlying biological mechanisms and interventions. Accordingly, this review is divided into sections that correspond to those categories. Although some papers can be grouped in more than one category, 32 papers are focused on the negative effects of loneliness, 29 papers on predictors/risk factors for loneliness, 8 papers on potential underlying biological mechanisms and 20 papers on interventions. A discussion on methodological limitations of this literature follows those sections.

1.1 Prevalence of Loneliness

Surprisingly, the prevalence of loneliness has been highly variable

in terms of prevalence rates ranging from 13% to 64% in this current literature. In a study from Taiwan, loneliness and suicide risk were studied before and during the first year of COVID-19 (N=8460) [1]. The prevalence of loneliness in this sample was 13%. The odds of loneliness increasing lifetime suicide ideation was 4.9, the odds for an attempt was 5.1, and the odds for future intent was 9.2. Suicidality decreased during the pandemic was "no one trustworthy to talk to". Increased loneliness during COVID would be expected, especially for those living alone. Surprisingly, in at least one study, those at greatest risk were young adults versus old adults living alone (Field et al, 2023). This finding is likely related to old adults being accustomed to living alone, so COVID was not as great an adjustment for them.

A greater prevalence of loneliness was noted at 22% in a study that explored the association of state and chronic loneliness with interpretation bias (N= 591) [2]. In this study, an interpretation task was given before and after undergoing a state of loneliness induction. In this sample, chronic loneliness was associated with anxiety and depression symptoms. This was virtually the only study in this current literature that involved a loneliness induction.

The greatest prevalence of loneliness was noted in a sample of mental health users in the U.S. In this sample, loneliness was more

prevalent in sexual and gender minority groups [3]. Loneliness was most prevalent in bisexual (57%) and transgender (56–64%) groups. Depression was also most prevalent in bisexual (34–54%) and transgender groups (36–67%).

2. Negative Effects of Loneliness

Many negative effects of loneliness have been addressed in this literature. They include inferior cognitive performance, internet addiction, relationship conflicts, sleep disturbances, mental health problems especially depression, physical health problems including diseases, death anxiety and mortality issues.

2.1 Inferior Cognitive Performance

Loneliness has been related to **inferior cognitive performance** among older adults (N=333 70–90-year-old participants) [4]. In this study, cognitive tests were given via smartphones five times daily for 14 days. Loneliness was negatively related to cognitive performance on the same day and subsequent day. Inferior cognitive performance contributed to greater loneliness as soon as 3 to 4 hours later, but not vice versa. This finding suggests that loneliness and cognitive performance are bi-directional in the short term, but in the long term, loneliness has a unidirectional effect on cognitive performance.

In another study on loneliness and cognition in older adults (N= 4772 adults 50-years-old and older), 18% of the participants had high levels of loneliness and a similar number of participants (17%) had low levels of loneliness [5]. In this sample, the relationship between loneliness and cognitive function was mediated by leisure activities that reduced the negative effect of loneliness on cognitive performance. The leisure activities were likely distracting and stress- reducing.

In still another loneliness and cognition study entitled "Loneliness and socioemotional memory", autobiographical episodes were collected from a sample of older adults (N = 4095) [6]. As might be expected, those who reported lonely autobiographical episodes had **less positive memories**.

In a review of eight studies (N =45,032), loneliness was associated with a more serious form of **mild cognitive impairment** in 25% of the sample [7]. Because this was a cross-sectional study, it's not possible to determine the directionality of these effects. It could be that loneliness resulted for those with mild cognitive impairment or those with loneliness spent less time with people suggesting that they were less engaged in conversation and could develop mild cognitive impairment from not being cognitively involved.

2.2 Internet Addiction

Loneliness has also been associated with **Internet addiction**. In a meta-analysis of 32 studies (N= 35,623), internet addiction was the most frequent effect of loneliness [8]. Although this result was based on cross-sectional studies which cannot conclude directionality or causality, loneliness and internet addiction were likely bi-directional with loneliness leading to internet addiction for wanting to be connected and internet addiction exacerbating loneliness because the internet connections were not satisfying.

Alternatively, the moderate use of the internet for social connections could lead to less loneliness. Internet use, for example, decreased loneliness in a study on Chinese adults who were older than 65-years (N=8059) [9]. In this sample, new internet and continuous internet users were less lonely. Internet users in wave 1 who quit in wave 2 were lonelier. These results combined suggested that internet use can decrease loneliness.

In another study on the relationship between Internet use and loneliness, middle age and older adults from China were surveyed (N =550, mean age = 45) [10]. Internet use occurred in 58% of the respondents who spent more than one hour per day on the internet and were less lonely. The internet was primarily used to contact relatives and friends, to read the newsand to manage their assets.

2.3 Relationship Conflicts

In a review entitled "How loneliness undermines close relationships", surprisingly, only three studies were included (N= 1197 participants) [11]. It's not clear whether studies on loneliness and relationships were rare or whether very few studies on that topic met the systematic review criteria. These negative effects of loneliness on **close relationships** were interpreted as "negative biases in perceiving relationship partners' regard and care". Depression that often results from loneliness would likely lead to strained relationships or at least negative biases about relationship partners.

2.4 Sleep Disturbances

The relationship between loneliness and **sleep disturbances** has been the focus of at least five studies in this current literature. In one study, loneliness led to several sleep disturbances including shorter sleep duration, lower quality sleep and daytime fatigue [12]. The loneliness related to less activity and engagement with people and the resulting depression would be expected to lead to sleep disturbances. Unfortunately, as in many of these studies, the data are based on subjective not objective measures. This was surprising given that the more objective technology of Fitbits and actigraphy have been frequently used in sleep studies.

In a paper entitled "Loneliness and marital quality as predictors of older adults' insomnia symptoms", data were taken from the National Social Life, Health and Aging Project (N= 559) [13]. In this study, both subjective and objective measures were taken of sleep. The subjective measures suggested that greater loneliness led to insomnia, but only when spousal support was low, suggesting that the participants were attributing their insomnia to spousal problems. The objective measures suggested that more affectionate touch led to less frequent "wake after sleep onset" episodes. The results of the objective measures were not surprising given that touching has led to more efficient sleep in many studies because it relaxes the nervous system enabling better sleep (Field, 2024).

In another study on the associations between loneliness, emotional support and sleep, less loneliness led to greater sleep quality and efficiency (N=388 participants 40–64-years-old) [14]. Bidirectional effects were examined in still a third study on loneliness, social connectedness, and sleep [15]. The results suggested similar bidirectional relationships between loneliness, social connectedness and sleep. Again, social connectedness would be expected to lead to more activity which in turn would facilitate better sleep.

In a study exploring loneliness, sleep and **stress**, daily diaries were written for seven days (N= 174) [16]. Based on the daily diaries and UCLA Loneliness Scale scores, loneliness was correlated with pre-sleep arousal, inferior sleep quality and morning tiredness. These relationships between loneliness and inferior sleep qualities were mediated by prior daily stress and hassles. Loneliness and daily hassles were also mediated by daytime stress prior to sleep. Again, these data suggest the bidirectional relationships between loneliness, stress and sleep problems. Loneliness would be expected to lead to stress that is arousing that, in turn, would lead to sleep problems.

2.5 Depression

Loneliness and **depression** have been the focus of at least seven studies in this current literature, highlighting the prevalence of that relationship. In a study called the Share Project, older adultsin 26 European countries were included (N=41,372) [17]. In this sample, loneliness increased the odds of depression by a ratio of 3.6 in men and 3.3 in women. The relationship between loneliness and depression was mediated (reduced) by "meaning of life" in 83% of the men and 81% of the women. These results suggest that adults attempt to reduce both their loneliness and depression by finding "meaning in life".

In a paper entitled "How social networks, perception of social isolation and loneliness affect depressive symptoms", Japanese researchers reported relationships between the **perception of social isolation** in a large social network that led to loneliness, which, in turn, led to depression (N =3,315) [18]. That perception of social isolation would lead to loneliness and then depression is not surprising given that social isolation is a major contributor to loneliness and loneliness frequently leads to depression.

In a rare longitudinal study, loneliness, depression, anxiety and quality of life were assessed in 12 European countries (N=7456, mean age = 70) [19]. These data from the Share Project suggested that past loneliness, depression and quality of life contributed to future episodes of depression two years later. For males there was a bidirectional relationship between loneliness and depression two years later. In contrast, for females, loneliness and depression were related at baseline, but not two years later. This gender difference is difficult to interpret.

In research on loneliness and depression in elder Spanish nursing home residents (N= 887), 58% of those experiencing loneliness ultimately experienced depression [20]. Those residents who were university graduates, however, had 47% less risk of developing depression, possibly because they were more confident about

connecting with others in the nursing home.

In a meta-analysis on 53 studies (N=40,929), loneliness led to depression, but both loneliness and depression were decreased by **social support and resilience.** [21]. These results were not surprising given that social support and resilience would be expected to reduce loneliness and depression.

In a study on loneliness and its association with mental health outcomes in adults from the UK (N=503), the association between loneliness, depression and anxiety was greater in **females** [22]. This finding was not surprising given that depression and anxiety are typically more prevalent in females and both depression and anxiety as well as comorbid anxiety and depression would be expected to exacerbate loneliness in the females.

In a study that compared **emotional loneliness** and social loneliness in adults from China who were experiencing late life depression (101 adults with depression and 81 healthy adults), late life depression contributed to emotional loneliness, but depression, surprisingly, did not predict social loneliness [23]. Emotional loneliness was the only predictor of suicidal ideation, and it explained as much as 27% of the variance in "suicidal ideation. In this sample, medical comorbidity also led to emotional loneliness, which, in turn, led to severe depression.

2.6 Physical Health Problems

In an umbrella review of 13 systematic reviews, the results suggested a significant impact of loneliness on **both mental and physical health outcomes** [24]. These results, however, could not confirm a causal association because the studies were cross-sectional, as are most studies in the current literature on loneliness in adults.

The physical health outcomes are evidenced in a study entitled "Loneliness dynamics and physical health symptomatology", involving the daily collection of diary health data (N= 1538) [25]. Examples of the symptoms were headaches and nausea. Fewer **physical health symptoms** were reported by the less than lonely and on the less than lonely days. Another symptom that has resulted from loneliness is sarcopenia (the loss of strength and muscle mass with aging). Relationships between social isolation, loneliness and **sarcopenia** have been reported for a sample from China [26]. In this sample, social isolation and loneliness at baseline contributed to sarcopenia in this sample.

Longer treatment duration for medical problems is another measure of the physical effects of loneliness. For example, Dutch mental health users were assessed for the effects of their loneliness and social relationship dissatisfaction (N=15,502) [27]. These participants experienced longer treatment durations for their medical problems.

Number of physician visits is still another measure of the physical effects of loneliness. In a rare longitudinal study on

loneliness, social isolation and healthcare data from the Health and Retirement Study were analyzed (N= 6832 participants) [28]. The results suggested that loneliness was correlated with the number of physician visits, and nursing home care decreased loneliness.

The severity of loneliness effects is suggested by the link between loneliness and **chronic diseases**. In a paper entitled "The silent epidemic: exploring the link between loneliness and chronic diseases in China", a survey was given to an aging sample from urban and rural China (N= 22,179, age = 60 years or older) [29]. Loneliness led to a greater incidence of chronic diseases, including gastric problems, osteoarthritis, COPD, asthma, tumors and reproductive system diseases.

The morbidity associated with chronic diseases is evidenced in a scoping review of research on social isolation, loneliness and morbidity. In this review, social isolation and loneliness led to morbidity [30]. This resulted in 6.7 billion annual **Medicare costs**.

2.7 Death Anxiety and Mortality

Given the chronic diseases, morbidity and Medicare costs associated with loneliness, it is not surprising that death anxiety and mortality would also be issues associated with loneliness. In a paper entitled "The relationship between fear of old age, loneliness, and death anxiety in adults (N =1074), loneliness led to **death anxiety**, which, in turn, led to fear of old age [31]. In a 17-year longitudinal study entitled "Neuroticism, loneliness, all – cause and cause – specific mortality", those who scored one standard deviation above the mean on the neuroticism scale had a 10% greater risk of dying [32]. Loneliness was associated with **premature mortality**, including mortality from intentional self– harm, respiratory and digestive system causes of death.

3. Predictors/Risk Factors for Loneliness

Many predictors/risk factors for loneliness have also been addressed in this current literature. They include gender and age, early maltreatment, inactivity including mobility issues and lack of exercise, excessive Internet use, partner conflict, loss of a partner, retirement, COVID-19, social isolation and stress in general.

3.1 Gender as a Risk Factor

Data on gender as a risk factor has been mixed. In the Swedish Panel Study of Living Conditions of the Oldest Old, 13% of the sample experienced loneliness and 6% were severely isolated [33]. Loneliness was more common in **women** and in those who were older than 85, as well as those who only had a basic education, and those who had psychological distress, mobility limitations, and were living alone. However, there was no increased loneliness in those who were already lonely. While this database suggests that women are at greater risk, other data suggest that older men are at greater risk. In a paper entitled "Interactions of widowhood, gender, and age predict loneliness", **widowhood** increased loneliness across gender and age groups. In this sample (N= 22,777), **old men who were widowers** were lonelier than women.

In a sample of exclusively older men from the English Longitudinal

Study of Aging (N= 6936), men older than 50 were less likely to directly state that they were lonely, although they were more dependent on their partners/spouses and their use of alcohol [34].

Loneliness was greater in **sexual and gender minority groups** in at least one study [3]. Loneliness was highest in bisexual (57%) and transgender (56–64%) groups. Depression was also highest in bisexual (34–54%) and transgender groups (36–67%).

3.2 Age as a Risk Factor

An interesting U-shaped curve was presented for **age differences** in loneliness in data analyses of nine longitudinal studies from more than 20 countries (N= 128,118 participants, age range= 13 to 103) [35]. Loneliness followed a U-shaped curve with a decrease from young adulthood to midlife and an increase in older adulthood. Other risk factors were gender, marital status, physical function, and education, but these risk factors did not moderate the loneliness trajectory.

3.3 Retirement as a Risk Factor

Not surprisingly, **retirement** has also been a predictor/risk factor for loneliness given that work relationships are often lost. In a longitudinal comparative analysis of data from Australia, China and the U.S., retirees had the highest loneliness scores [36]. In Australia, 19.4% of retirees were lonely versus 17% who were not lonely, and in the U.S., 19% of retirees were lonely versus 16% who were not lonely. These are clearly low levels on a continuum of loneliness/non-loneliness. Surprisingly, there was a very low rate of loneliness in retirees in China, perhaps because voluntary retirement is the typical form of retirement there. Across countries, the highest loneliness scores occurred for those who were involuntary retirees, and the lowest loneliness scores occurred for the voluntary retirees.

In contrast, in a study on the impact of retirement on loneliness in Europe, data taken from the Survey of Health, Aging and Retirement in Europe suggested that retirement resulted in decreased loneliness in the long run [37]. The authors suggested that individuals adapted to retirement by increasing their activity levels. Increased activity levels, in turn, led to reduced social isolation and loneliness. This sample was largely comprised of retirees which supports the data on the relationship between retirement and loneliness just presented.

3.4 Loss of a Partner as a Risk Factor

Living alone frequently results from loss of a partner and loss of a partner invariably leads to living alone. In another longitudinal study over a 15-year period on men and women in the second part of life (N= 2,315, 40-to-80-year-old adults), the Norwegian Life Course Aging and Generation study database was explored [38]. In this study, females were lonelier than males. The **loss of a partner** and poor mental health were the most significant predictors of loneliness. Additional risk factors were **singlehood** and **poor physical health**. These variables were related to loneliness for females, but not for males. These gender differences are, again, difficult to interpret.

3.5 Social Isolation as a Risk Factor

Social isolation has been a significant risk factor for loneliness. In one study, social isolation was researched in a sample of adults older than 60 (N=3681) [39]. Social isolation led to loneliness and depression in this sample which was largely comprised of retirees, supporting the data on the relationship between retirement and loneliness just presented.

In a rare longitudinal study, cross-lagged effects of loneliness were noted across 16 years in China [40]. Social isolation led to loneliness more often than loneliness led to social isolation. In a comparison between a group of folks living alone versus a group of folks not **living alone** (N=45), those living alone had less face-to-face interaction which led to greater loneliness [41]. The living alone group also had higher hair cortisol levels, suggesting greater stress.

3.6 Low Emotional Competencies as Risk Factor

Emotional competencies have also been explored for their contribution to loneliness and psychological distress (N=298) [42]. In this study, low emotional competencies, including low emotional regulation and low empathy led to loneliness and depression, which, in turn, led to psychological distress. In a study on loneliness as a dysfunction, loneliness was thought to result from "repulsion tendencies that led to an inability to align properly with others" [43].

3.7 Stressful Experiences as Risk Factors

Stressful events like early maltreatment and terror experiences have also been risk factors for loneliness. In a study on **child maltreatment** and loneliness across the lifespan, a meta-analysis was performed on 52 studies (mean age= 31) [44]. In a moderator analysis, medium effect sizes were noted for greater loneliness resulting from early maltreatment. The effect sizes were greater for emotional abuse and neglect than other forms of maltreatment, and the effect size was lower for older participants.

Loneliness has been a mediator in an association between **exposure to terror** and psychological distress in older adults (N= 686, mean age= 73) [45]. In another study, **perceived stress** was associated with loneliness and depressive symptoms [46]. In this sample (N= 734 participants 18-to-87-years-old), each one-point increment in the stress score led to an increase in the loneliness and depression scores. In addition, sleep quality mediated the association between stress, loneliness, and depression.

In another study entitled "A lonely world after COVID-19", a sample from Slovenia (N= 440) was assessed for social and emotional loneliness as well as suicidal ideation [47]. After **COVID**, social and emotional loneliness increased, especially emotional loneliness. No changes were noted in suicidal ideation after COVID, although well-being decreased.

3.8 Inactivity as a Risk Factor

Inactivity, specifically from mobility limitations and lack of exercise, is noted as a risk factor for loneliness in this current literature, although inactivity and loneliness are likely bidirectional as is apparent in a recent longitudinal study. **Mobility limitations** resulted in loneliness and suicidal ideation in this longitudinal study (N=50,423) [48].

Inactivity or the lack of exercise may have resulted from mobility limitations or any of the other risk factors for loneliness. Inactivity or lack of exercise were addressed in four studies in the current literature on loneliness.

In a serial mediation model on physical exercise and loneliness in older adults (N= 516), structural equation modeling revealed that less physical exercise led to loneliness [49]. The relationship between less physical exercise and loneliness was mediated by social support and resilience with both of those factors reducing the relationship between less physical exercise and loneliness.

Another research group addressed the bidirectional relationships between loneliness, social isolation and physical inactivity (N = 17,303, mean age =46) [50]. In this sample, physical inactivity led to loneliness, but loneliness, surprisingly, did not predict physical inactivity.

In still another study on the influence of physical activity on loneliness, older adults from Nigeria comprised the sample (N = 369) [51]. Loneliness led to depression, and greater physical activity reduced the loneliness effect on depression. In a sample from the Health and Retirement Study (N = 20,134), moderate intensity but not vigorous intensity exercise contributed to less loneliness in the future [52].

3.9 Multiple Risk Factors

In a multiple risk cross-lagged panel study on how variables relate to each other over time, loneliness was related to many variables based on the UCLA Loneliness Scale (N= 8470 adults 65-yearsold) [53]. Loneliness was related to older age, not being married, being male, low self-reported health and depression. Only the older age and the less self-reported health variables were related to cognitive function.

In an unusual study entitled "Loneliness and low fruit and vegetable consumption among adults in Japan", 5% of the sample (N=3410) were said to have low fruit and vegetable consumption [54]. A strong relationship was reported between loneliness and low fruit and vegetable consumption.

4. Potential Underlying Biological Mechanisms for Loneliness Several potential underlying biological mechanisms have been suggested for loneliness. They include low EEG Beta wave activity, low oxytocin levels, elevated pro-inflammatory cytokines, DNA methylation, reduced gray matter and genetic origins.

In a study on brain rhythm activity in a resting state, EEG signals were sampled (N = 139) [55]. Loneliness scores and decreased beta band power were noted, indicating negative emotions. Although physical inactivity was not included in the list of potential correlates, **lower Beta activity** has been associated with physical inactivity which, in turn, has been associated with loneliness in

this current literature.

In a study entitled "A translation neuroscience perspective on loneliness: a narrative review focusing on social interaction, illness, and loneliness", lonely individuals were said to have abnormal behaviors based on dysfunctional social conditions [56]. The authors noted that social touch regulates oxytocin signalling and suggested that lonely individuals have an **oxytocin imbalance** which leads to poor health and less well-being. They concluded that psychopathology is both a cause and a consequence of loneliness.

A link has also been shown between loneliness and biological measures of inflammation in 12 studies [57]. In this research, scores on the UCLA Loneliness Scale were associated with increased **pro-inflammatory cytokines, including C-reactive protein and IL-6.** In another narrative review, the relationship between loneliness and inflammatory disease has been demonstrated [58]. In this review based on 18 studies (15 cross-sectional and 3 longitudinal), loneliness was associated with greater disease activity in patients with irritable bowel syndrome. Inflammation has also been said to mediate the relationship between loneliness and gait speed [59]. In this sample (N= 822 adults 26 to 78-years-old), loneliness and BMI (body mass index) along with depression contributed to elevated IL -6, which, in turn, reduced gait speed. Reduced gait speed could also lead to elevated IL-6 via reduced activity.

Loneliness has also been associated with DNA methylation [60]. In this study (N= 4018), loneliness led to **decreased DNA methylation** (essential for normal development) which, in turn, led to multi-morbidity. The authors suggested, however, that specific intermediary physiological mechanisms required further research.

In a sample from the Rush Memory and Aging Project (N=2130), loneliness led to depression, and **decreased gray matter volume**, which resulted in cognitive decline [61]. In those who had higher levels of BDNF (brain derived neurotrophic factor), there was less cognitive decline.

In a sample from the UK Biobank, 30 diseases were associated with loneliness [62]. Non—causal associations between **genetic liability to loneliness** were reported for 20 of 26 diseases, including cardiovascular, obesity and diabetes were reported. Genetic liability to loneliness, however, was only associated with six of those diseases. The authors suggested that loneliness was a surrogate marker versus a causal risk factor for most diseases. These authors further suggested that socioeconomic factors, health behaviors, baseline depression and comorbidities largely explained the associations between loneliness and diseases.

5. Interventions for Loneliness

The interventions that have appeared in this current literature on loneliness have widely varied. They include psychotherapy, reminiscence therapy, mindfulness, skill-building, internet training, exercise, social robots, having animals, being in nature, and leisure travel. In a systematic review of 19 reviews of 101 primary interventions across 21 nations, 63% of the interventions were considered effective [63]. Those interventions that included **animals**, **psychotherapy and skill building activities** were more successful than those focused on social facilitation or health promotion.

In a systematic review on 12 studies, **reminiscence interventions** reduced loneliness in older adults [64]. Simple reminiscence therapy and life review in a group format was the most effective therapy for reducing loneliness.

Mindfulness has also reduced loneliness in a study on retired adults from China (N=748 adults greater than 60-years-old), Mindfulness decreased loneliness and that effect was mediated by positive affect [65].

As already mentioned, **skill-building activities** were among the most effective therapies in a systematic review of reviews [63]. Social skills training was also notably effective for reducing loneliness in an umbrella review of 29 systematic reviews, including 16 meta analyses on randomized controlled trials [66].

These data were consistent with those from a study called "Facing the next geriatric giant: a meta-analysis on interventions" (Buffet et al, 2024). In this meta-analysis of 67 studies (N= 1756), 56% of the intervention studies for loneliness were effective and 58% of the intervention research groups reported sustained intervention effects. **The non-technological interventions** had greater effect sizes including three components that were effective. These were promoting social contact, transferring knowledge and skills, and addressing social cognition.

In a systematic review and meta-analysis of 11 randomized control trials and five observational studies, several types of interventions were effective for reducing loneliness [67]. This included **group-based psychotherapy, internet training, and group exercises**.

In a meta-analysis of eight randomized controlled trials, **social robots** decreased loneliness and depression in older residents in long-term care facilities [68]. Group robot activity was even more effective and for a longer duration.

In a study entitled "Contact with nature, nature prescriptions and loneliness, participants were surveyed in Australia, India, Singapore, the UK and the U.S. (N= 2100) [69]. Less loneliness was reported by those in Australia and less odds of social loneliness but greater odds of emotional loneliness were reported by those in India. Social loneliness occurred less often in those who visited **nature** regularly and spent more than two hours per week in nature. Emotional loneliness occurred more often in those who spent more time in nature.

In a study on relationships between **leisure travel** and loneliness, depression, and cognitive function in older adults, the Health and Retirement Study data were analyzed after controlling several variables [70]. Leisure travel decreased loneliness and depression

and improved cognitive function.

6. Methodological Limitations of this Literature

Several limitations of this literature could be noted. These include the reliance on self-report survey and archival data, the almost exclusive sampling of older adults, the lack of cross-cultural comparisons, the inconsistency of gender effects, the exclusive focus on single variables, and the difficulty determining direction of effects given that the studies were more frequently crosssectional versus longitudinal.

Most of the samples were exclusively older adults, which is not surprising given that at least one research group reported that loneliness was especially prevalent in older adults. This likely resulted from loss of a partner, although loss of a partner was a risk variable in only one of the studies. This exclusive focus on older adults would typically be considered a lack of generalizability of the findings to different age groups. However, if loneliness is rarely found in younger adults, it would be difficult to identify lonely samples in that age range. Alternatively, younger adults may not have been surveyed because of the concern that younger adults would be less responsive to surveys given their preoccupation with careers and raising families.

Given that most of the samples were older old adults (older than 60 years) who would likely be less internet sophisticated, it was surprising that large samples of old adults were collected via online surveys. However, the interventions that were focused on teaching Internet technology to older adults as well as Internet addiction that was noted as both a negative effect and a risk factor for loneliness suggests that the older adults knew enough Internet technology to respond to surveys.

Although these studies were conducted in several different countries, only a few studies included samples from a few countries for cross-cultural comparisons. This was surprising given that online surveys were the most prevalent research method which could have been used more widely to assess cross-cultural differences as another way of identifying risk factors and designing interventions.

A wide variety of variables were assessed as either negative effects of loneliness (15 different variables) or risk factors (19 different variables). Typically, the studies focused on a single variable as opposed to being a multivariate study that could determine the relative significance of the different variables. At least two variables were considered both negative effects and risk factors, including negative relationships and excessive Internet use, raising the question of directionality of those variables. In contrast, although depression was a negative effect, it was surprising that it didn't appear as a risk factor, as one might expect that being depressed would lead to loneliness as well as loneliness leading to depression. Similarly, it's surprising that inactivity was a risk factor for loneliness, but not a negative effect of loneliness. One might expect that the depression resulting from loneliness would lead to inactivity. The absence of bi-directionality in these variables may simply result from the studies being primarily focused on single variables.

The research on potential underlying biological mechanisms for loneliness revealed neurological and neurochemical problems including low EEG beta activity, low oxytocin levels, high proinflammatory levels and low gray matter volume. These problems could have also derived from the depression that resulted from loneliness. Again, directionality cannot be determined from these typically cross-sectional studies. Only one gene study appeared in this literature on loneliness, although several gene studies have appeared in the recent literature on the related problem of depression (Field, 2024).

Surprisingly, several intervention studies (20) appeared in this current literature including a wide variety of activities that have not been typically researched as therapies including leisure travel and social robots. Exercise was the most frequently studied therapy, which was not surprising given that the lack of exercise was a risk factor for loneliness in several studies. Surprisingly, cognitive behavioral therapy studies did not appear in this literature, as they have frequently appeared in literature on related problems like depression. Many of these intervention studies have the methodological limitations of not being randomized controlled trials and lacking active control groups.

Despite these methodological limitations, this current literature on loneliness has helped inform the intervention research by identifying many negative effects and risk factors for loneliness. The severe negative effects of loneliness on both mental and physical health highlight the need for further research on the effects and risk factors for loneliness as well as effective therapy protocols [71-76].

Negative Effects	First Authors
Inferior cognitive performance	Kang, Du, Igarashi, Fan
Internet addiction	Wang
Relationship conflicts	Lemay
Sleep disturbances	Johnson, Lawrence, Dickman, Dworschak, O' Connor
Depression	Nascimento, Kushibiki, Hsueh, Sanchez-Moreno, Wen, Lazaras, Ngan
More physical health problems	Gasuli-Molinera, Itzel, Tu
Longer treatment durations	Velhorst
Greater number of physician visits	Gao
More chronic diseases	Meng, Holloway
Death anxiety	Cifter
Premature mortality	Deason

Table 1: Negative Effects of Loneliness (and First Authors)

Predictors/risk factors	First Authors
Gender-women	Dahlberg
-men	Jiao, Ratcliffe
-minorities	Bruss
Age-U-shaped curve	Graham
Retirement	Hagani,Guthmuller
Social isolation	Li, Pan, Batallas
Loss of a partner	Nicholaisen
Low emotional competencies	Ghiggia, Shama-Tsoory
Child maltreatment	deHeer
Exposure to terror	Faran
Perceived stress	Wang
COVID-19	Postuvan
Mobility limitations	Torres
Inactivity or lack of exercise	Gu, Smith, Farombi, Surkalim
Low fruit and vegetable consumption	Stickley
Multiple factors	Abaei

Table 2: Predictors/Risk Factors for Loneliness (and First Authors)

Mechanisms	First Authors
Low EEG beta activity	Hu
Low oxytocin levels	Barton
Elevated pro-inflammatory cytokines	Kim, Ross, MacAulay
DNA methylation	Freilich
Low gray matter	Dabiri
Genetic liability	Liang

Table 3: Potential Underlying Biological Mechanisms (and First Authors)

Interventions	First Authors
Animals, psychotherapy and skill-building	Patil
Reminiscence therapy	Castillo-Hornero
Mindfulness	Xie
Skill-building activities	Patil, Hansen
Non-technological interventions	Buffet
Grou-based psychotherapy, internet training & group exercises	Shekelle
Social robots	Yen
Nature therapy	Astell-Burt
Leisure travel	Cole

Table 4: Interventions for Loneliness (and First Authors)

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