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LONELINESS AS A PUBLIC HEALTH CHALLENGE: INNOVATIVE STRATEGIES FOR IMPROVING HEALTH AND WELL-BEING

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ABSTRACT

Loneliness has emerged as one of the most significant public health challenges of the 21st century, affecting individuals across all age groups and contributing to substantial medical, psychological, and socioeconomic burdens. Increasing evidence indicates that loneliness is associated with a higher risk of cardiovascular diseases, metabolic disorders, cognitive decline, depression, and premature mortality, highlighting its importance as a modifiable determinant of health. The aim of this narrative review is to summarize current evidence regarding the epidemiology, biological mechanisms, clinical consequences, and public health implications of loneliness, with particular emphasis on innovative strategies for its prevention and management. Relevant publications were identified through searches of PubMed, Scopus, Web of Science, and Google Scholar, with a primary focus on studies published between January 2020 and March 2026. Priority was given to systematic reviews, meta-analyses, clinical studies, and reports from international health organizations. The reviewed evidence demonstrates that loneliness contributes to adverse health outcomes through multiple biological pathways, including chronic stress activation, immune dysregulation, systemic inflammation, and behavioral changes. Emerging approaches, such as social prescribing, digital health technologies, telemedicine, wearable devices, artificial intelligence, and community-based interventions, offer promising opportunities to improve social connectedness and overall well-being. Addressing loneliness requires a multidisciplinary approach integrating healthcare, public health, technological innovation, and social policy. Future efforts should prioritize early identification, personalized interventions, and evidence-based strategies that combine innovative technologies with meaningful human relationships.

KEYWORDS

Loneliness, Public Health, Health Promotion, Digital Health, Artificial Intelligence, Social Connectedness

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1. Introduction

1.1. Understanding Loneliness

Loneliness is increasingly recognized as an important determinant of health that extends far beyond an unpleasant emotional experience. Contemporary research defines loneliness as the subjective perception that an individual's social relationships are insufficient in quality or quantity to meet personal expectations. Consequently, loneliness reflects how people perceive their social connections rather than the objective number of interactions they maintain. This distinction explains why individuals with extensive social networks may still experience profound loneliness, whereas others with relatively few social contacts may report high levels of life satisfaction and social fulfillment (Holt-Lunstad, 2024; World Health Organization [WHO], 2025).

It is important to distinguish loneliness from social isolation, although these terms are often used interchangeably. Social isolation refers to an objective lack of social contacts or limited participation in social activities, while loneliness represents a subjective emotional response to perceived inadequacies in interpersonal relationships. Although related, these conditions are not synonymous and may occur independently. Emerging evidence suggests that both loneliness and social isolation are associated with adverse health outcomes through partly distinct biological and behavioral pathways, emphasizing the need for separate assessment and intervention strategies (National Academies of Sciences, Engineering, and Medicine [NASEM], 2020; WHO, 2025).

Loneliness is commonly described as comprising emotional and social dimensions. Emotional loneliness results from the absence of a close, intimate relationship that provides affection, trust, and emotional security, whereas social loneliness reflects a lack of belonging to a broader social network or community. Recognizing these dimensions is clinically relevant, as they may require different preventive and therapeutic approaches, ranging from strengthening close interpersonal relationships to promoting community engagement and social participation.

Growing evidence indicates that loneliness should be regarded not only as a psychosocial concern but also as a significant medical and public health issue. Persistent loneliness has been associated with chronic stress, immune dysregulation, systemic inflammation, and unhealthy behavioral patterns, which collectively contribute to an increased risk of cardiovascular disease, type 2 diabetes, depression, cognitive decline, frailty, and premature mortality (Holt-Lunstad, 2024; Surkalim et al., 2022). In response to its far-reaching consequences, international organizations, including the WHO, now recognize loneliness as a global public health priority that requires coordinated action across healthcare systems, communities, and policy sectors (WHO, 2025).

1.2. Why Loneliness Matters Today

Loneliness has become an increasingly important public health concern due to profound demographic, social, and epidemiological changes occurring worldwide. Population aging represents one of the most significant drivers of this phenomenon, as older adults are more likely to experience widowhood, retirement, declining physical function, chronic illnesses, and reduced social networks. At the same time, increasing life expectancy has resulted in a growing number of individuals living alone, making social connection an essential determinant of healthy aging rather than merely a social issue (WHO, 2025).

Rapid urbanization has further transformed patterns of social interaction. Although urban environments provide greater access to healthcare, education, and employment opportunities, they may also contribute to weaker neighborhood relationships, reduced community engagement, and greater social fragmentation. Similarly, the widespread adoption of digital communication has changed the way people establish and maintain relationships. While digital technologies facilitate communication, they cannot always replace meaningful face-to-face interactions, and excessive reliance on virtual communication may contribute to perceived loneliness in some individuals (Holt-Lunstad, 2024).

Another factor contributing to the growing importance of loneliness is the increasing prevalence of chronic diseases. Individuals living with cardiovascular diseases, diabetes, cancer, neurodegenerative disorders, or physical disabilities often experience reduced mobility, functional limitations, and diminished social participation, which may increase their vulnerability to loneliness. Conversely, loneliness itself has been identified as an independent risk factor for poorer health outcomes, creating a bidirectional relationship between chronic illness and social disconnection (NASEM, 2020; Surkalim et al., 2022).

The COVID-19 pandemic further highlighted the health consequences of loneliness. Public health measures, including lockdowns, social distancing, and prolonged isolation, substantially disrupted interpersonal relationships and community participation. Although many restrictions have been lifted, numerous studies suggest that the psychological and social effects of the pandemic continue to influence population health, particularly among older adults, adolescents, and individuals with pre-existing health conditions (Office of the Surgeon General, 2023).

Reflecting the growing body of scientific evidence, international organizations have increasingly recognized loneliness as a global public health priority. In 2023, the World Health Organization established the Commission on Social Connection to address the health, social, and economic consequences of loneliness and social isolation. Its 2025 report emphasizes that strengthening social connection should become an integral component of public health policy, healthcare delivery, and community-based interventions. This shift underscores the need for multidisciplinary approaches that integrate medicine, public health, social sciences, and innovative technologies to effectively reduce loneliness and improve population well-being (WHO, 2025).

1.3. Health Consequences of Loneliness

The health consequences of loneliness extend far beyond emotional distress and have become an important focus of contemporary medical research. Accumulating evidence indicates that persistent loneliness is associated with increased morbidity, premature mortality, impaired quality of life, and a substantial burden on healthcare systems. These findings have shifted the perception of loneliness from a psychosocial concern to a significant, modifiable determinant of health requiring multidisciplinary prevention and intervention strategies.

Loneliness has been consistently associated with an increased risk of developing numerous chronic conditions, including cardiovascular diseases, hypertension, type 2 diabetes, obesity, depression, anxiety disorders, cognitive impairment, and dementia. The underlying mechanisms involve chronic activation of the stress response, immune dysregulation, systemic low-grade inflammation, and adverse health behaviors such as physical inactivity, poor sleep quality, unhealthy dietary habits, and reduced adherence to medical treatment. Consequently, individuals experiencing persistent loneliness often present with multiple comorbidities and poorer long-term health outcomes (Holt-Lunstad, 2024; Surkalim et al., 2022).

In addition to increasing morbidity, loneliness has been identified as an independent predictor of premature mortality. Recent evidence suggests that its impact on mortality is comparable to that of well-

established health risk factors, including obesity and physical inactivity. Although the relationship is influenced by age, socioeconomic status, and pre-existing medical conditions, loneliness remains a significant predictor of all-cause mortality after adjustment for these variables, emphasizing its independent contribution to population health (WHO, 2025).

Beyond physical health, loneliness profoundly affects overall quality of life. Individuals experiencing chronic loneliness frequently report lower psychological well-being, decreased life satisfaction, impaired daily functioning, and reduced resilience when facing stressful life events or chronic illnesses. Moreover, loneliness negatively influences treatment adherence, recovery following hospitalization, and successful aging, thereby reducing both healthy life expectancy and overall well-being.

The consequences of loneliness also extend to healthcare systems and society. Individuals experiencing loneliness are more likely to visit primary care physicians, require emergency medical services, experience prolonged hospitalizations, and utilize healthcare resources more frequently than socially connected individuals. As the prevalence of loneliness continues to increase alongside population aging and the growing burden of chronic diseases, healthcare systems are expected to face rising economic costs and increasing demand for integrated medical, psychological, and community-based interventions. These observations further support the recognition of loneliness as a major public health challenge requiring coordinated action across clinical practice, public health policy, and innovative health technologies.

1.4. Aim of the Review

The aim of this narrative review is to provide a comprehensive overview of the current evidence regarding loneliness as an emerging public health challenge and its implications for health and well-being. Specifically, the review summarizes the epidemiology of loneliness, discusses the biological and pathophysiological mechanisms underlying its effects on physical and mental health, and examines the clinical consequences associated with persistent loneliness across different populations. Furthermore, it reviews contemporary and innovative strategies for the prevention and management of loneliness, with particular emphasis on digital health technologies, artificial intelligence, social prescribing, and community-based interventions. Finally, the review highlights current research gaps and future perspectives, emphasizing the importance of multidisciplinary collaboration between healthcare professionals, public health experts, policymakers, and technology developers to develop effective, evidence-based approaches that strengthen social connectedness and improve population health.

2. Review Methods

This study was conducted as a narrative review to provide a comprehensive overview of current evidence regarding loneliness as a public health challenge and its implications for health and well-being. Unlike a systematic review, the objective was to critically synthesize and interpret the available literature, identify current trends, and discuss emerging approaches for the prevention and management of loneliness.

A comprehensive literature search was performed using four electronic databases: PubMed, Scopus, Web of Science, and Google Scholar. The search primarily included publications published between January 2020 and March 2026 to ensure that the review reflected the most recent evidence. Earlier publications were considered only when they represented seminal works defining key concepts related to loneliness or provided important theoretical frameworks.

The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords, including "loneliness," "social isolation," "social connection," "public health," "health outcomes," "well-being," "digital health," "artificial intelligence," "telemedicine," "social prescribing," "healthy aging," and "prevention." Boolean operators ("AND" and "OR") were applied to optimize the search and identify relevant publications.

Priority was given to systematic reviews, meta-analyses, randomized controlled trials, large observational studies, clinical guidelines, and reports published by international organizations, particularly the World Health Organization (WHO). Studies focusing exclusively on highly specific populations or lacking methodological quality were considered only when they provided unique or clinically relevant information. Articles published in English were included.

The selected literature was analyzed thematically and organized into five major domains: epidemiology, biological mechanisms, clinical consequences, innovative prevention and management strategies, and future perspectives. This narrative approach enabled an integrated discussion of medical, public health, technological, and social aspects of loneliness.

3. Epidemiology and Determinants of Loneliness

3.1. Global Epidemiology

Loneliness has become a widespread phenomenon affecting populations across all regions of the world. Although its prevalence varies considerably depending on the population studied, the measurement tools used, and cultural contexts, recent evidence indicates that loneliness is no longer limited to older adults but represents a growing concern across the entire lifespan. According to recent reports from the World Health Organization (WHO), approximately one in six people worldwide experiences loneliness, highlighting its significance as a global public health issue (WHO, 2025). Similarly, systematic reviews have demonstrated substantial heterogeneity in prevalence estimates, reflecting differences in demographic characteristics, socioeconomic conditions, and healthcare systems (Surkalim et al., 2022).

Regional differences further illustrate the complex nature of loneliness. In Europe, the prevalence of loneliness varies considerably between countries, with generally lower rates reported in Northern Europe and higher rates observed in several Southern and Eastern European nations (Surkalim et al., 2022; WHO, 2025). These disparities are thought to reflect differences in social welfare systems, cultural norms regarding family support, levels of social trust, and economic inequality. In North America, loneliness has emerged as a growing concern among both older adults and younger populations, while many Asian countries face increasing challenges associated with rapid population aging, urbanization, and changing family structures. Similar trends have also been reported in Australia and other high-income countries, although cross-national comparisons remain difficult due to methodological differences in loneliness assessment.

Over the past decade, the epidemiology of loneliness has evolved considerably. Before the COVID-19 pandemic, many countries had already reported gradual increases in loneliness, particularly among older adults living alone and young adults experiencing social disconnection. The pandemic accelerated this trend by introducing prolonged periods of social distancing, quarantine, and reduced face-to-face interactions. Although loneliness levels have partially declined following the easing of public health restrictions, recent evidence suggests that they remain elevated in several vulnerable populations, including older individuals, adolescents, people living with chronic diseases, and those experiencing socioeconomic disadvantage. These observations indicate that loneliness is not merely a temporary consequence of the pandemic but a persistent public health challenge requiring long-term prevention strategies and coordinated policy responses.

3.2. Demographic Determinants

The prevalence and experience of loneliness vary considerably across demographic groups, highlighting the complex interaction between biological, social, and environmental factors. Although loneliness can affect individuals at any stage of life, evidence suggests that certain demographic characteristics substantially increase vulnerability to social disconnection.

Age is one of the strongest determinants of loneliness. Older adults are traditionally considered the population at greatest risk due to retirement, bereavement, declining physical health, reduced mobility, and shrinking social networks. However, recent studies indicate that loneliness is also highly prevalent among adolescents and young adults, particularly during periods of major life transitions, educational changes, and early career development. This emerging "U-shaped" distribution suggests that loneliness is not exclusively a consequence of aging but a challenge affecting multiple generations (Surkalim et al., 2022; WHO, 2025).

Gender has also been associated with differences in loneliness, although findings remain inconsistent across studies. Women often report higher levels of emotional loneliness, which may reflect greater willingness to disclose emotional experiences and stronger expectations regarding interpersonal relationships. In contrast, men may experience higher levels of social isolation while being less likely to seek emotional support or professional help. These differences are influenced by cultural norms, gender roles, and social expectations rather than biological sex alone (Office of the Surgeon General, 2023).

Marital status is another important determinant. Individuals who are widowed, divorced, separated, or have never married consistently report higher levels of loneliness than those living with a partner. The loss of a spouse not only reduces emotional support but may also lead to decreased participation in social activities and diminished social networks. Similarly, living alone has been identified as a significant risk factor for loneliness, particularly among older adults and individuals with chronic illnesses. Nevertheless, living alone should not be considered synonymous with loneliness, as many individuals maintain strong social relationships despite residing in single-person households. Conversely, loneliness may also occur among people living with family members or partners when meaningful emotional connections are lacking (Holt-Lunstad, 2024; WHO, 2025).

3.3. Socioeconomic and Medical Determinants of Loneliness

Socioeconomic circumstances play a fundamental role in shaping the risk of loneliness throughout the lifespan. Educational attainment is closely associated with health literacy, employment opportunities, and the ability to establish and maintain social relationships. Individuals with lower levels of education are more likely to experience unemployment, financial hardship, and limited social participation, all of which contribute to an increased risk of loneliness (WHO, 2025). Similarly, income represents an important determinant of social connectedness. Financial insecurity may restrict participation in community activities, reduce access to transportation and healthcare services, and limit opportunities for meaningful social engagement. Conversely, higher socioeconomic status is generally associated with broader social networks and greater access to supportive resources (Office of the Surgeon General, 2023).

Employment also influences loneliness through multiple pathways. Beyond providing financial stability, the workplace serves as an important source of social interaction, daily structure, and a sense of purpose. Unemployment, prolonged sick leave, or retirement may therefore reduce opportunities for interpersonal contact and increase feelings of social disconnection. Housing conditions represent another significant determinant. Individuals living alone, residing in deprived neighborhoods, or experiencing housing instability are more likely to report persistent loneliness than those living in socially cohesive communities. Recent public health initiatives increasingly recognize that the built environment, including access to green spaces, community centers, and age-friendly infrastructure, may influence opportunities for social participation and reduce loneliness at the population level (WHO, 2025).

Medical conditions further contribute to the development and persistence of loneliness. Chronic diseases such as cardiovascular disease, diabetes, chronic respiratory disorders, and cancer frequently limit physical functioning, reduce mobility, and restrict participation in social activities. As disease severity progresses, patients often experience shrinking social networks and increasing dependence on caregivers, creating a cycle in which poor health and loneliness reinforce one another (Holt-Lunstad, 2024).

Disability represents another major determinant of loneliness. Physical, cognitive, or functional impairments may create barriers to communication, employment, and community participation, particularly when appropriate environmental and social support is lacking. Sensory impairments, especially hearing and vision loss, have received growing attention in recent years because they substantially reduce interpersonal communication and increase the likelihood of social withdrawal. These conditions are particularly prevalent among older adults and have consistently been associated with poorer mental health and reduced quality of life.

Mental disorders demonstrate one of the strongest relationships with loneliness. Depression, anxiety disorders, and cognitive impairment not only increase the likelihood of experiencing loneliness but may also be exacerbated by prolonged social disconnection, creating a bidirectional relationship. Emerging evidence suggests that early recognition of loneliness in individuals with chronic medical conditions or mental health disorders should become an integral component of patient-centered healthcare, allowing healthcare professionals to implement timely interventions aimed at improving both social connectedness and overall health outcomes (Donovan & Blazer, 2020; WHO, 2025).

3.4. Lifestyle and Environmental Determinants

Lifestyle and environmental factors have emerged as important contributors to loneliness, reflecting the close relationship between individual health behaviors and the surrounding social environment. Although loneliness is often perceived as a consequence of social circumstances, growing evidence suggests that modifiable lifestyle factors may both contribute to and result from persistent social disconnection.

Physical inactivity is consistently associated with higher levels of loneliness across different age groups. Regular physical activity not only improves physical health but also promotes social interaction through participation in recreational, sports, and community activities. Conversely, sedentary behavior may reduce opportunities for interpersonal engagement, leading to increased social withdrawal and poorer psychological well-being. Recent studies suggest that physically active individuals generally report lower levels of loneliness and greater life satisfaction than their inactive counterparts (WHO, 2025).

Sleep disturbances represent another important determinant. Individuals experiencing chronic loneliness frequently report insomnia, poor sleep quality, and fragmented sleep patterns. The relationship appears to be bidirectional, as inadequate sleep may impair emotional regulation and social functioning, while persistent loneliness contributes to chronic stress and sleep disruption. This reciprocal association may further increase the risk of both physical and mental health disorders (Holt-Lunstad, 2024).

The rapid expansion of digital technologies has also transformed the way people establish and maintain social relationships. Social media platforms may facilitate communication and reduce geographical barriers; however, excessive or passive use has been associated with increased loneliness, social comparison, and reduced psychological well-being. In contrast, digital exclusion, particularly among older adults and socioeconomically disadvantaged populations, may further limit access to social support, healthcare services, and community resources. These findings suggest that the impact of digital technologies on loneliness depends largely on how they are used rather than on technology itself (Office of the Surgeon General, 2023).

Urbanization represents an additional environmental determinant of loneliness. Despite offering greater access to healthcare, education, and employment, densely populated urban areas may paradoxically foster social fragmentation, weaker neighborhood relationships, and reduced community cohesion. Consequently, contemporary public health strategies increasingly emphasize the importance of creating age-friendly cities, accessible public spaces, and community environments that encourage social participation and meaningful interpersonal interactions.

3.5. High-Risk Populations

Although loneliness can affect individuals at any stage of life, certain population groups are particularly vulnerable due to the combined influence of biological, psychological, social, and environmental factors. Identifying these high-risk populations is essential for developing targeted prevention strategies and implementing timely interventions within healthcare systems (Barjaková et al., 2023).

Older adults remain one of the most extensively studied groups at risk of loneliness. Age-related factors such as retirement, bereavement, declining physical function, sensory impairments, multimorbidity, and shrinking social networks substantially increase susceptibility to social disconnection. However, it is important to recognize that loneliness is not an inevitable consequence of aging, as many older adults maintain strong social relationships and active community engagement (Holt-Lunstad, 2024; WHO, 2025).

Recent evidence has also highlighted the growing prevalence of loneliness among adolescents and young adults. Educational transitions, academic pressure, uncertainty regarding future employment, social comparison, and increased reliance on digital communication may contribute to feelings of loneliness despite frequent online interactions. Recent scoping reviews indicate that loneliness has become increasingly prevalent among emerging adults, particularly following the COVID-19 pandemic, emphasizing the need for age-specific prevention strategies (Kirwan et al., 2025; Office of the Surgeon General, 2023).

Individuals living with chronic diseases constitute another important high-risk group. Conditions such as cardiovascular disease, diabetes, cancer, chronic respiratory disorders, and neurodegenerative diseases often limit physical activity, reduce independence, and restrict opportunities for social participation. Similarly, people living with disabilities frequently encounter physical, communication, and environmental barriers that increase the likelihood of social exclusion. Recent reviews suggest that these medical conditions often coexist with loneliness, creating a reciprocal relationship in which poor health increases loneliness while loneliness further contributes to disease progression (Donovan & Blazer, 2020; Lim et al., 2020).

Informal caregivers also represent an often-overlooked population at increased risk. The emotional burden of caregiving, financial stress, reduced personal time, and limited opportunities for social interaction may substantially increase vulnerability to persistent loneliness. Collectively, these findings demonstrate that loneliness should be recognized as a multidimensional public health challenge requiring targeted interventions tailored to the specific needs of vulnerable populations rather than a universal approach applicable to all individuals (Barjaková et al., 2023).

4. Biological and Clinical Mechanisms Linking Loneliness to Disease

Loneliness may influence health through several interconnected biological and behavioral pathways. Although it is often perceived primarily as an emotional or social experience, prolonged loneliness can act as a chronic psychosocial stressor that affects neuroendocrine regulation, inflammatory activity, immune function, cardiometabolic health, neurological processes, and health-related behaviors. These mechanisms are not independent; rather, they interact with one another and may contribute to the development and progression of chronic diseases over time (Holt-Lunstad, 2024).

4.1. Neuroendocrine and Stress Response

One of the central mechanisms linking loneliness to disease is chronic activation of the stress response. Persistent feelings of social disconnection may be interpreted by the body as a state of threat or reduced safety, leading to repeated activation of the hypothalamic–pituitary–adrenal axis and the sympathetic nervous system. In the short term, this response is adaptive because it prepares the organism to cope with stress. However, when loneliness becomes chronic, prolonged activation of these systems may contribute to physiological dysregulation (Slavich, 2020).

Cortisol dysregulation is particularly important in this context. Under normal conditions, cortisol follows a circadian rhythm and helps regulate metabolism, immune responses, and cardiovascular function. Persistent psychosocial stress may disrupt this rhythm, leading either to elevated cortisol exposure or to a blunted stress response. Both patterns may impair immune regulation and increase vulnerability to chronic disease. In parallel, sympathetic nervous system activation may increase heart rate, blood pressure, vascular tone, and catecholamine release. Over time, this may contribute to endothelial dysfunction, hypertension, and increased cardiometabolic risk (Holt-Lunstad, 2024).

4.2. Inflammation and Immune Dysfunction

Loneliness has also been linked to chronic low-grade inflammation, which is increasingly recognized as a biological pathway connecting psychosocial stress with physical disease. Inflammatory markers such as interleukin-6, C-reactive protein, and tumor necrosis factor- α are commonly discussed in this context. A systematic review and meta-analysis suggested that loneliness and social isolation may be associated with systemic inflammation, although findings differ depending on the marker studied and the methodological quality of included studies (Smith et al., 2020). This means that inflammation should be presented as a plausible and important pathway, but not as a fully established or uniform mechanism.

The relationship between loneliness and inflammation may be partly explained by the concept of social safety. According to this framework, the perception of being socially connected is biologically protective, whereas perceived social threat or disconnection may promote inflammatory activity and stress-related immune changes (Slavich, 2020). More recent work in social psychoneuroimmunology also emphasizes that social experiences can influence immune function, while immune activity may in turn affect mood, behavior, and social engagement (Muscatell, 2021).

Immune dysfunction represents another relevant pathway. Chronic loneliness may be associated with reduced immune competence, altered antiviral responses, and greater susceptibility to infections. Vaccine response provides a useful model for understanding this relationship because it reflects the ability of the immune system to mount a protective antibody response. A meta-analysis found that stronger social support was generally associated with more favorable antibody responses to vaccination, although effect sizes varied across studies (Uchino et al., 2020). Similarly, research conducted during the COVID-19 pandemic suggested that lower social cohesion was associated with poorer antibody response after vaccination, and that loneliness may partly mediate this relationship (Gallagher et al., 2022).

Taken together, these findings suggest that loneliness may contribute to disease through a self-reinforcing biological cycle. Chronic social disconnection activates stress pathways, which may promote inflammation and immune dysregulation. These changes can increase vulnerability to chronic diseases and infections, while illness itself may further reduce social participation and intensify loneliness. For this reason, loneliness should be understood not only as a psychological or social issue, but also as a clinically relevant factor influencing physical health.

5. Clinical Consequences of Loneliness

Loneliness is increasingly recognized as a clinically relevant factor associated with a wide range of adverse health outcomes. Although it is often discussed in relation to emotional well-being, its consequences extend beyond mental health and affect cardiovascular, metabolic, cognitive, functional, and oncological domains. Importantly, loneliness should not be interpreted as a single-cause explanation for disease, but rather as a factor that may interact with biological vulnerability, health behaviors, socioeconomic disadvantage, and pre-existing medical conditions.

5.1. Cardiometabolic Consequences

Cardiovascular disease represents one of the most consistently described clinical consequences of loneliness and social disconnection. Evidence suggests that loneliness and social isolation are associated with poorer cardiovascular and brain health, including higher risk of coronary artery disease, stroke, and cardiovascular mortality (Cené et al., 2022). These associations may be explained by several overlapping mechanisms, including chronic stress activation, systemic inflammation, endothelial dysfunction, hypertension, and unhealthy lifestyle behaviors. Patients experiencing loneliness may also be less likely to maintain regular physical activity, follow dietary recommendations, attend medical appointments, or adhere to prescribed treatment, which may further worsen cardiovascular outcomes.

Loneliness may also contribute to metabolic dysregulation. Socially disconnected individuals are more likely to experience physical inactivity, poor sleep quality, emotional eating, and reduced motivation for self-care, all of which may increase vulnerability to obesity, insulin resistance, type 2 diabetes, and metabolic syndrome. In this context, loneliness may act both as a risk factor and as a consequence of chronic disease, creating a self-reinforcing cycle in which poor health reduces social participation, while reduced social participation further worsens health outcomes (Holt-Lunstad, 2024).

5.2. Mental Health Consequences

The relationship between loneliness and mental health is particularly strong and bidirectional. Loneliness is consistently associated with depressive symptoms, anxiety, emotional distress, and reduced psychological well-being. At the same time, depression and anxiety may increase social withdrawal, reduce motivation to maintain relationships, and intensify feelings of isolation. This reciprocal relationship is clinically important because loneliness may both precede and perpetuate mental health problems.

Persistent loneliness is also relevant to suicide prevention. A systematic review and meta-analysis of prospective studies indicated that loneliness may predict suicidal ideation and behavior, although the strength of this relationship varies across populations and study designs (McClelland et al., 2020). More recent evidence from a large cohort using the All of Us dataset suggested that loneliness partially mediates the relationship between anxiety symptoms, depressive symptoms, and suicidal ideation (Musacchio Schafer et al., 2026). These findings suggest that reducing loneliness may represent a transdiagnostic strategy supporting mental health promotion and suicide prevention.

5.3. Cognitive Decline and Neurodegenerative Disorders

Loneliness is also increasingly discussed as a potentially modifiable risk factor for cognitive decline and dementia. Several mechanisms may explain this association, including chronic stress exposure, inflammation, sleep disturbance, reduced cognitive stimulation, and lower participation in socially and intellectually engaging activities. In older adults, loneliness has been associated with poorer global cognition and impairment across several cognitive domains, although the magnitude of these associations may vary depending on measurement tools and study populations (Harrington et al., 2023).

Recent meta-analytic evidence further supports the relevance of loneliness for dementia prevention. Luchetti et al. (2024) reported that loneliness was associated with increased risk of all-cause dementia, Alzheimer's disease, vascular dementia, and cognitive impairment. These findings are particularly important in the context of aging populations, as they suggest that social connection may be relevant not only for emotional well-being but also for long-term brain health. However, loneliness should be understood as one component of a broader risk profile that includes vascular risk factors, depression, physical inactivity, sensory impairment, and socioeconomic determinants.

5.4. Functional Decline, Cancer Care, and Healthy Aging

Loneliness may also contribute to functional decline and poorer healthy aging. In older adults, loneliness, social isolation, and living alone have been associated with increased risk of all-cause mortality, with evidence also suggesting links to frailty, disability, reduced independence, and poorer recovery after illness (Nakou et al., 2025). These outcomes may reflect both biological mechanisms and behavioral pathways, including lower physical activity, poorer nutrition, reduced treatment adherence, and delayed help-seeking.

In cancer care, loneliness and social isolation are particularly relevant because diagnosis and treatment often disrupt daily routines, employment, body image, family roles, and social participation. Social isolation among cancer patients may be influenced by cancer-related factors, physical condition, psychological distress, social support, and coping strategies (Wang et al., 2024). Similarly, psychosocial factors such as depression, anxiety, distress, impaired social functioning, and reduced social support are associated with poorer quality of life during cancer treatment (Marzorati et al., 2025). Therefore, loneliness should be considered in survivorship care, rehabilitation, and supportive oncology, not only as an emotional problem but also as a factor that may influence treatment adherence, quality of life, and long-term well-being.

Overall, the clinical consequences of loneliness are multidimensional. They affect physical health, mental health, cognitive function, functional independence, and quality of life. This supports the view that loneliness should be assessed and addressed within routine healthcare, particularly among patients with chronic diseases, older adults, individuals with mental health problems, and people undergoing complex treatments such as cancer therapy.

6. Innovative Strategies for Prevention and Management

Effective prevention and management of loneliness require an integrated approach that combines healthcare, public health, community resources, psychology, and emerging technologies. Because loneliness is influenced by biological, psychological, social, and environmental factors, no single intervention is likely to be sufficient for all individuals. Instead, the most promising strategies are those that identify loneliness early, match interventions to individual needs, and strengthen meaningful social connection while addressing wider determinants of health (Holt-Lunstad, 2024; WHO, 2025).

6.1. Early Identification and Clinical Screening

Early identification is a key step in preventing loneliness from becoming chronic and clinically harmful. Healthcare settings offer an important opportunity for screening because loneliness frequently coexists with chronic disease, disability, mental health problems, frailty, and poor treatment adherence. Primary care is particularly relevant, as general practitioners often encounter patients whose symptoms are partly shaped by psychosocial difficulties, including social disconnection, financial stress, bereavement, or lack of practical support.

Routine screening does not need to be complex. Brief validated tools, such as short loneliness scales or single-item screening questions, may help clinicians identify individuals who would benefit from further assessment. However, screening should distinguish loneliness from social isolation. A patient may live alone without feeling lonely, while another may live with family but lack meaningful emotional connection. Therefore, screening should assess both subjective loneliness and objective social support.

Specific clinical settings may be especially appropriate for systematic assessment. In geriatric care, loneliness screening can be integrated into comprehensive geriatric assessment, alongside evaluation of frailty, cognition, function, nutrition, and sensory impairment. In oncology and chronic disease clinics, loneliness may affect treatment adherence, rehabilitation, quality of life, and survivorship. In mental health services, loneliness should be considered not only as a symptom but also as a factor that can worsen depression, anxiety, and suicidal ideation. Early identification should therefore be linked to referral pathways; otherwise, screening may identify unmet needs without offering meaningful solutions.

6.2. Social Prescribing and Community-Based Interventions

Social prescribing is one of the most widely discussed approaches to addressing loneliness within healthcare systems. It enables healthcare professionals to refer patients to non-medical community resources, often with support from a link worker who helps identify individual needs and connect patients with appropriate services. These may include community groups, volunteering opportunities, exercise programs, arts and cultural activities, peer-support groups, educational courses, or nature-based activities. In this way, social prescribing bridges the gap between clinical care and the social determinants of health (Napierala et al., 2022).

The value of social prescribing lies in its person-centered nature. Rather than treating loneliness as a uniform condition, it attempts to match the intervention to the individual's interests, capacities, barriers, and local environment. For example, an older adult experiencing social loneliness may benefit from group-based activities or volunteering, whereas a patient with chronic illness may require supported access to community exercise or peer-support programs. Similarly, people experiencing bereavement, retirement, disability, or social anxiety may need different forms of support.

Evidence regarding social prescribing is promising but not yet definitive. Systematic reviews suggest that social prescribing may improve loneliness, well-being, self-efficacy, and quality of life, but many studies remain limited by heterogeneous designs, short follow-up, lack of control groups, and variable outcome measures (Napierala et al., 2022; Reinhardt et al., 2021; Vidovic et al., 2021). Therefore, social prescribing should be presented as a promising and scalable strategy, but not as a fully established solution. Future programs should include rigorous evaluation, longer follow-up, and clearer outcome measures.

Community-based interventions are closely related to social prescribing. Programs involving shared activities, peer support, intergenerational contact, group exercise, arts participation, and volunteering may reduce loneliness by increasing opportunities for meaningful interaction and strengthening a sense of belonging. Nature-based or "green" prescribing may be especially useful because it combines social participation, physical activity, exposure to natural environments, and stress reduction. These interventions are particularly relevant for public health because they can be implemented outside hospital settings and adapted to local community resources.

6.3. Lifestyle and Psychological Interventions

Lifestyle medicine can contribute to loneliness prevention because many health behaviors influence both physical health and social participation. Physical activity is especially important. Exercise programs may reduce loneliness not only by improving cardiometabolic health, mobility, and mood, but also by creating opportunities for structured social contact. Group-based physical activity may be particularly valuable because it combines behavioral activation with social engagement.

Sleep optimization, stress management, and healthy diet may also support well-being in individuals experiencing loneliness. Poor sleep and chronic stress can worsen emotional regulation, increase irritability, and reduce motivation for social interaction. Similarly, unhealthy diet, alcohol use, and physical inactivity may contribute to poorer health, which can further limit participation in social life. Although lifestyle interventions alone may not fully resolve loneliness, they can reduce vulnerability and improve the individual's capacity to engage with social and psychological support.

Psychological interventions are particularly relevant when loneliness is maintained by maladaptive thoughts about the self, others, or social relationships. Cognitive behavioral therapy may help individuals identify negative expectations, fear of rejection, hypervigilance to social threat, and avoidance behaviors that prevent meaningful social connection. Acceptance and commitment therapy may support individuals in clarifying values, tolerating difficult emotions, and taking action toward social engagement despite discomfort. Group therapy and psychoeducation may also reduce loneliness by normalizing experiences, improving social skills, and increasing perceived support.

Recent reviews suggest that interventions targeting maladaptive social cognition, psychological skills, and multiple mechanisms may be more effective than interventions that only increase social contact (Patil & Braun, 2024). This is clinically important because loneliness is not simply a lack of people nearby. Some individuals remain lonely even when social opportunities are available because they feel unsafe, unwanted, misunderstood, or unable to connect. Therefore, effective intervention should address both external opportunities and internal psychological barriers.

6.4. Digital Health, Artificial Intelligence and Policy-Level Innovation

Digital health has become an increasingly important area in loneliness prevention and management. Telemedicine, mobile health applications, online support groups, virtual communities, wearable devices, and remote patient monitoring may help identify individuals at risk and provide support to those who face barriers to in-person participation. Digital interventions may be particularly useful for older adults with mobility limitations, patients with chronic diseases, people living in rural areas, and individuals who experience social anxiety or stigma.

However, digital health should be approached critically. Systematic reviews suggest that digital interventions for loneliness show mixed results, with effectiveness depending on intervention type, user engagement, digital literacy, duration, and study quality (Shah et al., 2021). Some technologies may facilitate

connection, while others may increase passive consumption, comparison, or dependence on virtual interaction. Therefore, digital tools should be designed to complement, rather than replace, human relationships. They are most promising when they help users access real support, maintain existing relationships, participate in communities, or receive timely professional guidance.

Artificial intelligence represents one of the most innovative but also most ethically complex approaches. AI may support loneliness prevention by predicting risk based on electronic health records, social determinants of health, behavioral data, or digital biomarkers. Machine learning models may help identify individuals at increased risk of loneliness or social isolation, allowing earlier and more personalized intervention (Torres et al., 2024). In clinical practice, AI-based decision support could help healthcare professionals identify patients who may benefit from social prescribing, mental health support, or community referral.

Conversational AI, virtual assistants, and relational agents are another emerging area. These tools may provide reminders, emotional support, companionship, health coaching, or signposting to services. A recent systematic review and meta-analysis suggested that relational agents may reduce loneliness across age groups, although the evidence base remains limited by small samples, short follow-up, and risk of bias (Sha et al., 2024). For this reason, AI-based companionship should be understood as a potential adjunct, not a substitute for human relationships or professional care.

Ethical considerations are central to the use of AI and digital health. Privacy, data security, algorithmic bias, unequal access to technology, digital exclusion, and overdependence on artificial companionship must be carefully addressed. Vulnerable groups, including older adults, people with cognitive impairment, socially isolated individuals, and those with mental health problems, may be particularly sensitive to both benefits and harms. Digital interventions should therefore be transparent, evidence-based, accessible, and embedded within broader systems of human support.

Finally, loneliness prevention requires policy-level innovation. Age-friendly cities, accessible public spaces, safe transport, community centers, intergenerational programs, public health campaigns, and national loneliness strategies can create environments that make social connection easier. Policies should recognize social connection as a determinant of health and integrate it into primary care, public health planning, urban design, and social care. The most effective future approach is likely to combine clinical screening, social prescribing, lifestyle and psychological support, digital innovation, and community policy into a coordinated model of care.

7. Discussion and Future Perspectives

This review highlights loneliness as a multidimensional public health challenge with important medical, psychological, social, and technological implications. The available evidence suggests that loneliness should not be interpreted solely as an emotional experience, but rather as a modifiable determinant of health associated with stress-related biological pathways, chronic inflammation, immune dysregulation, adverse health behaviors, and increased vulnerability to chronic diseases. This perspective is clinically important because it supports the integration of loneliness assessment into routine healthcare, particularly in primary care, geriatric assessment, mental health services, oncology, and chronic disease management.

A key implication of the reviewed literature is that loneliness requires targeted rather than universal interventions. Different populations may experience loneliness for different reasons, including bereavement, disability, chronic illness, mental health problems, socioeconomic disadvantage, digital exclusion, or lack of meaningful community participation. Therefore, interventions should be tailored to individual needs and local contexts. Social prescribing, community-based programs, psychological interventions, lifestyle medicine, and digital health tools may each contribute to reducing loneliness, but their effectiveness is likely to depend on appropriate patient selection, accessibility, engagement, and long-term follow-up.

At the same time, the evidence base remains uneven. While associations between loneliness and adverse health outcomes are well documented, more high-quality longitudinal studies, randomized controlled trials, and implementation studies are needed to determine which interventions are most effective, for whom, and under what conditions. Particular attention should be paid to cost-effectiveness, health equity, long-term outcomes, and potential unintended consequences, especially in relation to digital and AI-based interventions.

Future research should increasingly adopt a precision public health approach (Buckeridge, 2020). Rather than applying the same intervention to all individuals, future programs should identify specific risk profiles and match interventions to individual needs.

Digital biomarkers, wearable technologies, electronic health records, patient-reported outcomes, and artificial intelligence may support earlier identification of individuals at risk (Macias Alonso et al., 2024; Smuck et al., 2021).

However, these tools should be used to support clinical judgment and strengthen human connection, not to replace interpersonal relationships or professional care.

The future management of loneliness should be based on integrated models linking healthcare, social care, community organizations, urban planning, public health policy, and digital innovation. Effective prevention will require collaboration between clinicians, public health professionals, psychologists, social workers, policymakers, technology developers, and local communities. In this model, technology should function as an enabler of human connection, while policy-level action should address the broader social and environmental conditions that make meaningful social participation possible.

8. Conclusions

Loneliness is an important and modifiable public health challenge with substantial implications for individual health, healthcare systems, and society. Although it has traditionally been viewed primarily as an emotional or psychosocial experience, current evidence indicates that its impact extends far beyond mental health. Persistent loneliness is associated with biological stress activation, inflammation, immune dysfunction, unhealthy behaviors, and increased vulnerability to multiple chronic diseases. Its consequences may include poorer cardiovascular and metabolic health, cognitive decline, depression, anxiety, functional deterioration, reduced quality of life, and increased mortality risk.

These findings support the need to recognize loneliness as a clinically relevant determinant of health rather than a marginal social problem. Early identification should become part of routine clinical practice, especially in primary care, geriatric assessment, mental health services, oncology, and chronic disease management. Screening should distinguish between subjective loneliness and objective social isolation, as both may require different forms of support. Importantly, identification must be followed by clear referral pathways and access to appropriate interventions; otherwise, screening alone is unlikely to improve outcomes.

Prevention and management of loneliness require a multidimensional approach. Social prescribing, community-based programs, lifestyle medicine, psychological interventions, digital health tools, and policy-level strategies may all contribute to strengthening social connection and improving well-being. However, interventions should be tailored to the needs, preferences, health status, and social circumstances of individuals rather than applied as universal solutions. Particular attention should be given to high-risk groups, including older adults, adolescents and young adults, people with chronic diseases, individuals with disabilities, caregivers, and socioeconomically disadvantaged populations.

Innovative technologies have considerable potential to support loneliness prevention and management. Telemedicine, mobile applications, wearable devices, digital monitoring, artificial intelligence, and virtual support tools may help identify risk, deliver personalized interventions, and improve access to care. Nevertheless, technology should support—not replace—human relationships. Ethical concerns related to privacy, digital exclusion, algorithmic bias, and overdependence on artificial companionship must be carefully considered.

Effective responses to loneliness will require collaboration between healthcare professionals, public health specialists, psychologists, social workers, policymakers, urban planners, community organizations, and technology developers. Future strategies should integrate medical care, social support, digital innovation, and public health policy into coordinated models of prevention and intervention. By recognizing social connection as a core component of health, societies can develop more effective, equitable, and sustainable approaches to improving health and well-being.

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