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Suicide in geriatric populations

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Published in
Frontiers in Psychiatry

ISSN 1664-8714
ISBN 978-2-8325-7024-1
DOI 10.3389/978-2-8325-7024-1

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Suicide in geriatric populations

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Citation

De Luca, V., Cheung, G., Damanhuri, H. A., Gonda, X., eds. (2025). *Suicide in geriatric populations*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-7024-1

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frontiers | Frontiers in Psychiatry

TYPE Editorial
PUBLISHED 07 October 2025
DOI 10.3389/fpsyt.2025.1670613

OPEN ACCESS

EDITED AND REVIEWED BY
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RECEIVED 21 July 2025
ACCEPTED 06 August 2025
PUBLISHED 07 October 2025

CITATION
De Luca V, Gonda X, Damanhuri H and Cheung G (2025) Editorial: Suicide in geriatric populations. *Front. Psychiatry* 16:1670613. doi: 10.3389/fpsyt.2025.1670613

Editorial: Suicide in geriatric populations

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KEYWORDS

suicide, aging, mental health, neurodegenerative disorders, euthanasia

Editorial on the Research Topic
Suicide in geriatric populations

Late-life suicide, particularly in men, is a significant public health issue in many parts of the world and it can have many devastating consequences for families, communities and health professionals (1). There is consensus that the spectrum of suicidality in late life (i.e., from death wish, suicidal ideation to completed suicide) is different from younger populations. Although there have been advances in identifying risk and protective factors for late-life suicide, there is still uncertainly about the precision of these predictions, particularly when applied at an individual level.

In older adults, epidemiological evidence showed ample differences in late-life suicide incidence across the globe and the role of sociocultural determinants in the development of suicidal behavior cannot be underestimated. Another important observation is the rising incidence of late-life suicide in some parts of the world over the last decades, despite the continuous progress made in screening and prevention. This paradox may be partially explained as increased susceptibility to suicide may be the consequence of marked cultural and environmental changes in the past two generations.

In this context, our Research Topic aimed to discuss the most important issues regarding suicide in this vulnerable population. To introduce this Research Topic, Sadek et al. provide a thorough narrative review of the current knowledge on late-life suicide. These authors provide an excellent overview of the current challenges, highlighting both risk and protective factors for suicide in the older population and summarizing the recent literature on fatal and non-fatal suicidal behavior, risk screening and suicide prevention.

The characterization of effective screening strategies for older people with prominent suicidal ideation and behavior represents one of the more relevant unmet needs of geriatric psychiatry. Nonetheless, investigations on new treatments aiming to reduce suicidal ideation are strictly intermingled with the characterization of the primary psychiatric diagnosis, and the elucidation of the biological underpinnings of both suicidal ideation and the primary disorder. These elements cannot be separated from each other, and their combined evaluation has been one of the main themes of this Research Topic. For example,

Ramm et al. depict an intriguing topic article explaining that demoralization can be associated with suicidal ideation in older people.

In this Research Topic, we also have a contribution from Ethiopia where Siraj et al. present data from an African population emphasizing that there are few studies on suicide risks in Africa; therefore, the extent of late-life suicide in this continent may be underestimated. Siraj et al. found the risk factors for non-fatal late-life suicidal behavior in Ethiopia include being unmarried, chronic illness and elderly mistreatment. Using a large European sample, Conejero et al. confirm that previous suicide attempts are an important predictor of future suicidal acts and that health care cost can be different across different psychiatric diagnosis among older people, suggesting elevated suicide risk in older people may increase the burden for the health care system. Both observational studies from Africa and Europe suggest that parsing patient data considering specific age range is crucial to achieve more accurate prediction of suicide risk and similar approaches may pave the way to data-driven prediction in older populations to reduce suicide burden.

To complement the abovementioned quantitative studies, Hed et al. used a qualitative approach to examine the precipitants of late-life suicide attempts by interviewing older people in Sweden who have recently attempted suicide. They highlight that age-related losses may be exacerbated by negative interactions with the health system.

The factors associated with completed suicide are discussed in the contribution by Chan et al., where all deaths by suicide in people aged 60+ treated by the mental health services of the province of Alberta in Canada, during the last 25 years were reviewed to confirm that late-life suicide risk is different between males and females.

Similarly, Escher et al. have attempted to delineate the distinctive features of death by suicide in Honduras during the last 14 years, showing a post-COVID-19 pandemic increase in incidence, which is contrary to the global trend.

However, studies on completed suicide often face methodological limitations including small sample size and low statistical power; therefore, in their topic contribution, Meda et al. examined a large European dataset from the Survey of Health, Ageing, and Retirement in Europe (SHARE) study using a machine learning strategy. They found that the most important variables in the prediction model for late-life suicide were length of illness prior to suicide, number of offspring still alive and frequency of contact with next of kin, proposing that the risk for late-life suicide can be attributed to the construct of social connectedness.

The same SHARE prospective dataset was also analyzed in another remarkable Research Topic contribution by Zong and Wang, applying an XGBoost model to predict suicidal ideation among individuals over the age of 50. They found that childhood socioeconomic status is a specific predictor in this sample.

Regarding the neurobiological mechanisms of suicidal ideation and behavior in older people, Sessa et al. reviewed the current findings on monoamine systems and the hypothalamus-pituitary-adrenal axis in late-life suicide focusing on genetic and biomarker studies. Based on previous experimental studies, they suggest that the neurobiology of late-life suicide may stem from neurotransmitter imbalance and neuro-inflammation.

The theory of neurotransmitter imbalance related to suicidal ideation and behavior in older people is very relevant since antidepressants alleviate suicidal ideation in this population, whereas they can induce suicidal ideation in children and adolescents likely through increasing serotonin release and post-synaptic neuron activation. An age dependent mechanisms, due to multiple factors (i.e., reduced serotonin transporter expression as a consequence of age specific gene expression, or biological aging) may lead to the differential age effect of antidepressant on suicidal ideation (2–4).

The review by Sessa et al. addresses another important biological factor associated with late-life suicidal behavior such as neurodegeneration. Indeed, the relationship between cognitive impairment and late-life suicidal behavior has not been widely studied. Depression can worsen cognitive functioning in older adults, particularly in those who have a pre-existing neurodegenerative disorder. The traditional models of late-life suicide may have limitations when explaining suicide ideation in older people who have cognitive impairment. There could be a role for cognitive interventions such as cognitive stimulation, cognitive training and cognitive rehabilitation for older people with cognitive impairment who are at risk of suicide. However, the relationship between the severity of cognitive impairment and suicide risk is still unclear in existing literature.

Further research is urgently needed to explore specific models and neurobiological markers of suicidal ideation in older people, which may support the development of targeted therapies.

Sessa et al. also highlight the risk for suicide may change across the lifespan depending on multiple factors such as adverse life events and these factors can be different in the older population. For instance, older people are exposed to emergent medical issues and physical limitations, causing worsening of suicidal risk and making more difficult to predict suicidal behavior in this age group.

The issue of suicide prevention has been addressed in multiple articles. Pereira et al. describe the effect of a campaign in Brazil called Setembro Amarelo aimed to disseminate information related to suicide prevention. They found no difference in suicide rates in the 60+ population over a 12-years period. However, this study did not investigate the effect of the campaign on non-fatal suicidal behavior or other related outcomes such as hospital admissions related to suicidal behavior and ideation. This observation has a place into the current debate on understanding the effectiveness of culturally tailored prevention programs on late-life suicide.

Although the recommendation of guidelines for late-life suicide prevention programs is beyond the scope of this Research Topic, more focused efforts should be considered when designing suicide prevention program for this population, particularly for older men. This recommendation should be specifically applied to older people presenting with specific risks for suicidal behavior and medical burden, in contrast to younger people. Furthermore, this contribution strongly encourages systematic evaluation of suicide prevention programs across different countries.

Regarding medical assistance in dying (MAiD) that was one of the sub-themes of this Research Topic, the contribution of Castelli Dransart and Scozzari illustrates the results of a qualitative study about assisted suicide in old people living in long-term care

facilities. Their results raised many questions about the most appropriate ethical, professional and organizational way to respond to the requests for suicide assistance and provide specific support to older people, families, and staff.

In summary, this Research Topic supports the distinction in suicidality between the older and younger populations; however, it also enlightens one of the limitations of current suicide prevention efforts as most of relevant strategies for preventing suicidal ideation and behavior are not tailored for age, gender and culture that are notoriously important factors in determining effectiveness.

Author contributions

VL: Writing – original draft, Writing – review & editing. XG: Writing – review & editing. HD: Writing – review & editing. GC: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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TYPE Review
PUBLISHED 10 May 2024
DOI 10.3389/fpsyt.2024.1395462

OPEN ACCESS

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RECEIVED 04 March 2024
ACCEPTED 29 April 2024
PUBLISHED 10 May 2024

CITATION
Sadek J, Diaz-Piedra B, Saleh L and MacDonald L (2024) A narrative review: suicide and suicidal behaviour in older adults. *Front. Psychiatry* 15:1395462. doi: 10.3389/fpsyt.2024.1395462

A narrative review: suicide and suicidal behaviour in older adults

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Globally, suicide is a public health concern that claims the lives of many each year. The complex etiology and factors contributing to the risk of suicide make it hard to predict the likelihood of death by suicide. Suicide rates have been increasing over the past 25 years in patients aged 65 years and older, and with the expected increases in the size of the older adult population and the under-detection of suicide risk, these rates may continue to increase. To mitigate and attempt to limit this expected increase, it is important to understand the risk and protective factors of suicide in older adults. This narrative review focuses on individuals above the age of 65 and encompasses relevant peer-reviewed publications from the past 25 years to cover fatal and non-fatal suicidal behaviour. It summarizes several important risk factors for suicide and suicidal behaviors while considering how risk can be detected, assessed, prevented, and mitigated. Screening methods to detect suicide and depression in older adults were examined based on their effectiveness and suitability for use in this population. Lastly, the impacts of the COVID-19 pandemic on suicide rates in older adults were described.

KEYWORDS

elderly/geriatric suicide, self-harm, risk factor, prevention, screening, assessment

Introduction

The World Health Organization states that suicide is a global public health concern, accounting for approximately 700,000 deaths per year. The majority of completed suicides occur in low-and-middle-income countries (77%), which accounts for 84% of the world's total population (1). Globally, suicide mortality rates have been decreasing over the past 20 years (2), however, the rates of suicide in adults aged 60 or older in the Americas have been gradually increasing (3). Mental health disorders are a major risk factor that contributes to these increasing rates. With disorders such as depression becoming more prevalent in the Americas, some populations are more at risk than others. Older adults who are depressed are more likely than those who are not depressed to harm themselves or attempt suicide (4). Old age is characterized by losses in physical and cognitive functioning, self-determination, and increases in social isolation. The process of aging is often associated with a decrease in

physical and functional capabilities, however, one's age may not coincide with their abilities and may more accurately be considered a social construct (5). The World Health Organization defines old age as commencing when one becomes eligible for retirement and various medical-related benefits, which occurs upon finishing your 60th year of life (6). The inability to depict a universal elderly age may be attributable to varying socio-demographic and quality-of-life-related factors (7). Such factors exacerbate feelings of anxiety and helplessness in older adults and are strongly correlated with depression arising from a perceived decline in quality of life (8). Non-suicidal self-injury (NSSI) refers to behaviors with the intent of harming oneself without the intention of killing oneself such as cutting or self-harming. Patients who had suicide attempts may have thought of permanent relief by death.

Methods

The literature review was conducted in the following databases: Medline/Pubmed, Google Scholar and PsycINFO. Search terms used were suicide and elderly; older adults; suicide attempts and elderly; suicidal behaviour and elderly; COVID-19 and suicide; geriatric suicide; suicide prevention and elderly; geriatric suicide; older adults and suicide; older adults and self-harm; geriatric self-harm; and risk factors.

Publication dates were restricted to a period from January 1, 1998, to October 1, 2023, and the language was filtered to include articles written in English.

Following the literature search, identified articles were subjected to a screening process. Initially, duplicate records were removed. Subsequently, two independent reviewers (science students) manually screened the titles and abstracts of the remaining articles. Full-text peer-reviewed articles deemed potentially relevant based on the screening of abstracts were retrieved for further assessment. Qualitative studies were not included in the search and selection process.

Results

Suicide epidemiology in older adults

The number of deaths caused by suicide in older adults has been steadily increasing over the past 19 years in the United States. In 2001, the population was 285,470,493 and suicide accounted for the death of 6,725 adults aged 60 or older leading to a rate of 2.3 in 100,000. Since then, this number has greatly increased to 12,470 deaths by suicide in 2020 with a population of 335,942,003 with a rate of rate of 3.7 in 100,000 (9). The rates are roughly getting close to doubling over 19 years and are likely to continue growing if no actions are taken. Table 1 shows the increase in the number of deaths caused by suicide for adults aged 60 or older. Due to the increasing number of deaths and the lethality of old age suicide, it is important to focus on older adults.

Currently, there are roughly 1 billion people aged 60 or older in the global population. As the baby boom generation continues to age, this number is expected to increase to about 1.4 billion by the year 2030 (6). This growth in the geriatric population means that the deaths caused by suicide in the geriatric population could also increase drastically. Older males have higher rates of death by suicide than older females. Common methods of suicide include hanging, using firearms, jumping from high places, overdoses, and drowning. Suicide rates may vary depending on the geographical location (10). Rates of elderly suicide were reported to be 18–22 per 100,000 older men and 3.5 to 4.5 in 100,000 older females.

To combat the expected increase in geriatric suicides, it is necessary that instruments to both assess and manage suicide are developed and implemented in clinics and emergency settings. Moreover, due to the fatality of suicides in older adults compared to younger adults, more attention should be directed toward these populations (11). The need for additional attention is especially important because it has been estimated that by the year 2050, there are going to be about 2.1 billion adults aged 60 years or older, which is close to double the current geriatric population (6). Regarding the prevalence of suicidal ideation in older adults, a study by Fässberg et al. (12) provides insight into the epidemiology of suicidal feelings in an aging Swedish population, ranging from old to very old age in the Gothenburg H70 Birth Cohort Studies. This study sheds light on the frequency and nuances of suicidal ideation in older individuals, contributing valuable data to our understanding of this critical

TABLE 1 Number of Older Adult Suicides in the United States.

Year	Deaths by Suicide
2001	6,725
2002	6,980
2003	6,777
2004	6,860
2005	7,137
2006	7,090
2007	7,528
2008	8,008
2009	8,175
2010	8,618
2011	9,034
2012	9,492
2013	10,189
2014	10,935
2015	11,193
2016	11,588
2017	12,131
2018	12,890
2019	12,839
2020	12,470

Number of deaths by suicide in the United States from 2001 to 2020 in adults older than 60 from the WISQARS Injury Mortality Report Visualization Tool (9).

issue. The lifetime prevalence of suicidal feelings was 25.2% and prevalence rates increased with age in older females but not older males.

Overview of risk factors for suicide in older adults

Various categories of risk factors can increase the probability that older adults may attempt suicide. Reasons for attempted suicide in late life include "desire to escape, reduced functioning and autonomy, psychiatric disorders, somatic problems, and physical pain, perceived burdensomeness, social problems, family, conflict, lack of meaning in life, and some patients had no specific reason" (13). Limited social connectedness is associated with suicidal ideation, non-fatal suicidal behaviour, and suicide in later life (14). Despite older adults being at significant risk for suicide, they rarely receive the awareness and harm reduction interventions necessary to be preventative in nature (15). Rather, feelings of depression stemming from loneliness and isolation have become normalized in the aging population, facilitating a significant increase in suicide among these individuals (16). The common risk factors that make the geriatric population susceptible to suicidal behaviour consist of social isolation, existing mental health implications with special emphasis on major depressive disorder, suicidal ideation and previous suicide attempts, geographical location, socioeconomic status, drug use, physical health problems such as cancer, and the normalization of ageism in modern society.

Social isolation has been a longstanding concern among individuals in the geriatric population and COVID-19 restrictions within recent years have only exacerbated this effect, significantly impacting the quality of life of older adults (17). With higher rates of suicides, and increased likelihood of death from suicide in this population, there are specific implications that need to be considered. Loss or degradation of interpersonal relationships through a variety of means, especially loss of a spouse, is a major contributor to social isolation in the geriatric population (18). Not only are spouses an enormous social support themselves, but individuals are frequently connected to social communities and other interpersonal relations through their spouses, which can be majorly affected following death or loss (17).

When it comes to why suicidal ideation is a frequent occurrence in older adults, social isolation is only one of many contributors. An exploratory study published in the Canadian Journal of Aging found that thoughts of suicide in elderly individuals are a means of alleviating psychological suffering that occurs because of lost loved ones and other stressors (19). They also identified three basic needs that affect the tendency of some older adults to think about self-harm and suicide: the need to self-actualize, the need to belong, and the need to feel safe. Failure to meet any of these goals is a significant contributing factor to thoughts of suicide experienced by the aging population (19).

Depression has long been associated with an increased risk of suicidal thoughts, and suicide attempts, and the presence of depression in geriatric patients is no exception (20). There are some affective symptoms, however, there are unique findings in patients of advanced age, one of the most prominent being perceived burdensomeness (21). Perceived burdensomeness refers to a perception that one is a burden or drain on their loved ones, and this is a feeling that plagues many older adults who rely on their spouses, children, and other significant others for certain aspects of living (21). One small study with 106 older adults in the primary care setting found that this affective symptom of perceived burdensomeness accounted for 68.3% of the variance in suicidal ideation experienced by older adults at risk of depression (22).

Psychiatric disorders

Major depressive disorder (MDD) is an increasingly prevalent disorder that has been projected by the World Health Organization to become the leading global burden of disease by the year 2030 (23). Moreover, in adults aged 18 years and older living in Canada as of 2021, 15.2% have screened positive for MDD (24). Given the overwhelming presence of major depression today, it is worthwhile to understand the criteria that must be met to achieve a diagnosis of this debilitating disorder. MDD has a biopsychosocial etiology. It is found to be heavily influenced by external factors, such as environmental, and psychosocial factors in addition to internal genetic and biological factors (25). MDD is characterized by at least 2 weeks of consistently low or irritable mood, a decline in interest in previously gratifying activities, reduced energy, feelings of worthlessness, poor concentration, irritability, appetitive changes, suicidal ideation and behaviors, and disrupted sleep presenting either as insomnia or oversleeping To date, MDD is diagnosed based on the diagnostic criteria outlined in the current version of the DSM-5 (26).

MDD is an imperative indicator of suicide in the geriatric population (8). MDD has been depicted as the most prevalent psychiatric diagnosis among old age individuals who die from suicide and there is a significant positive correlation between the presence of MDD and suicide attempts among elderly members of society (8). Comprehension of the concurrency of these two factors is critical for early intervention and prevention of suicide among older individuals. Recent research highlights the importance of considering the implications of cognitive impairment and depression on the progression of dementia. Seeing as depressive disorders and dementia are two of the most common diagnoses made among the geriatric population, exploring how depression and its wide range of symptoms play a role as a risk factor for various types of dementia is a vital domain of research. The presence of symptoms of depression is frequently detected in the early stages of asymptomatic Alzheimer's disease, or AD (27). The stage of neurological decline that precedes dementia is referred to as mild cognitive impairment, or MCI, and has been found to be concurrent with depression in old age individuals (28). Moreover, the incidence of depression in late life is a vital predictor of the progression of MCI in otherwise healthy individuals (29).

Patients diagnosed with dementia generally have an elevated risk of suicide (30), as recent research suggests that the risk of suicide increases within one year after the diagnosis of dementia (31). A Swedish national-based study suggested that suicidal

behaviour increases in patients who had previous self-harm, had serious depression, used anxiolytics or hypnotics, and those who have milder dementia and higher frailty scores (32). To assess the relationship between depression and the progression of dementia, amyloid beta peptides and tau proteins are Alzheimer's biomarkers that have been designated as predictors with research depicting that increased quantities of these biomarkers may be associated with depression (33). Moulinet et al. conducted a study to analyze the association between depression and Alzheimer's biomarkers across both preclinical and clinical stages of the disease in older adults (2022). The participants varied in that a subset were healthy controls. (HC), some presented with subjective cognitive decline (SCD) with no probable AD, and the remainder were older adults on the Alzheimer's continuum (ADC) with probable AD. The results of this study depicted that depressive symptoms were higher in all patients with SCD and ADC compared to HC. Moreover, depressive symptoms were correlated with greater quantities of amyloid-beta in the SCD group, but not in the HC or ADC group (34). These results reveal the relationship existing between Alzheimer's biomarkers and depression in patients with pre-existing cognitive decline (34).

Some older adults with MDD may experience a variety of different cognitive deficits. These deficits occur in different neuropsychological domains, such as working memory, executive functioning, visual and verbal memory, cognitive control, and attention (35). Specifically, deficiencies in cognitive control can increase the risk of suicide in geriatric patients with late-life depression (35–37). Cognitive control refers to the ability to coordinate and regulate any thoughts or actions that are in line with behavioural goals (38). Patients with MDD might experience declines in their cognitive control, subsequently hindering their ability to regulate their suicidal thoughts or intentions and therefore causing increases in the risk of suicide (37). Additionally, these age-related declines reduce the ability of older adults to adapt and respond to stressors, increasing the likelihood of them seeing suicide as the only feasible solution (36, 39). Pu et al. used the Brief Assessment of Cognition in Schizophrenia (BACS) to examine the six cognitive domains (working memory, verbal memory, motor speed, verbal fluency, attention, and speed of information processing) of their outpatient study participants (2017). They determined that there was a negative correlation between executive functioning, motor speed, composite scores, and suicidal ideation. This relationship indicates that decreases in these cognitive domains are associated with increases in suicidal ideation and potentially even suicide (35). Another study used the Montreal Cognitive Assessment (MoCA) to assess the cognitive integrity of geriatric patients with late-life depression. Their results revealed that poorer performance on the MoCA was associated with suicidal ideation in geriatric patients (37). Cognitive assessments should not replace suicide screening methods but should be used as a tool to identify lower cognitive scores before thoroughly assessing suicidal behaviors.

Other psychiatric disorders that are associated with suicide include schizophrenia, bipolar disorder, alcohol, and substance use disorders (10).

Substance use

The baby boom generation has significantly higher rates of marijuana and illicit drug use when compared to other generations (40). As this generation continues to age, drug use in older adults is expected to increase, which poses a risk to the physical and mental well-being of people in this age group. Moreover, due to physiological changes associated with aging and diseases, drug pharmacokinetics may be affected, leading to longer-lasting and greater drug serum levels in the body (41). These changes can also increase the risk of there being adverse drug reactions (41). Marijuana is typically considered to be more therapeutic and pleasurable rather than harmful in the geriatric population (42). As the THC content of cannabis preparations increases, the adverse effects in older adults also increase. Some of these risks include worsening cognitive decline and medical conditions, interacting with other medications, and increasing the risk of falls (42). Additionally, the use of marijuana increases the risk of major depressive episodes (MDE) and suicidal ideation. The risk of having either MDE or suicidal ideation was linearly associated with marijuana use frequency, meaning that more frequent use of marijuana increases suicidal risk (42). Meanwhile, using marijuana in conjunction with other illicit drugs significantly increased the odds of both MDE and suicidal thoughts. Substance use may also increase the risk of suicide through cognitive effects such as increased impulsivity, and decreased inhibitory control. Consequently, primary care physicians need to screen for drug use in older adults to identify risks and provide acceptable treatment. The relationship between marijuana use and suicidal behaviors is understudied and would benefit from additional research.

In psychological autopsy studies set in Western countries, alcohol use disorder is the second most common diagnosis among older adults who die by suicide. Alcohol use disorder increases the risk of suicide in both older men and older women (43). In a study of older hospitalized patients after suicide attempts, half of the patients who had the diagnosis of alcohol use disorder had at least one prior suicide attempt versus one-third who did not have alcohol use disorder (44). Within older adults, alcohol consumption has been increasing because adults have been living longer and healthier lives (45). For those aged 65 or older, binge drinking has been increasing by about 3.4% per decade, which has resulted in alcohol use disorders also rapidly increasing (46). Alcohol generally has greater negative effects on older adults because of physiological changes that occur with aging (47). These changes result in alcohol being metabolized more slowly, leading to higher blood alcohol levels with the same or lower levels of consumption (46, 47). Older adults who are high- or low-alcohol consumers have an elevated risk of experiencing depressive episodes. However, moderate consumers had a lower risk of depressive episodes (46). The lower risk of depressive episodes in moderate consumers may be caused by the stress-response-dampening effects of alcohol (48). Regardless of these dose-dependent effects, all quantities of alcohol had some effect on the risk of depressive episodes, and indirectly suicide risk. With the older adult population increasing and the rising use of alcohol, this poses a significant risk to the prevalence of suicide attempts in this

age group. Consumers should be regularly questioned regarding their alcohol consumption to reduce the risk of depressive episodes and suicide attempts.

In hand with the increasing population of older adults, there is an increase in the number of them requiring long-term care. Drugs and medications often have greater adverse effects on these populations because of their greater frailty, medical comorbidities, and greater degrees of polypharmacy (49). Drugs such as antidepressants and psychoactive medications are frequently used in long-term care facilities. For those prescribed antidepressants, there is a decreased risk of suicide. However, long-term care patients who were prescribed hypnotics, a commonly administered drug, had twice the risk of suicide (50). The increased risk may be associated with the drug's ability to worsen judgement, depression, and cause behavioural confusion. Additionally, the hypnotics may impair normal cognitive functioning (51) leading to pharmacological overdose (52). Pharmacological overdoses are not overly common in older adults as prescription drug misuse (PDM) is less likely in those who are 65 or older compared to those who are 50–64 (52). Regarding PDM, there is an inverse relationship between PDM and age, such that as aging occurs, the likelihood of PDM decreases. This relationship could be caused by the elevated risk of adverse health effects, which can produce a physiological signal indicating that drug use needs to be reduced (52).

Medical illness & social factors

In examining the complexities of late-life suicide, it is imperative to consider the interplay between physical illness, functional disability, and suicidal behaviour among older adults. Research by Fässberg et al. (53) emphasizes the significance of this relationship, highlighting how physical illness and functional limitations can significantly contribute to suicidal ideation and behaviour in older individuals. Chronic health conditions, mobility impairments, and limitations in activities of daily living can exacerbate feelings of hopelessness and despair, thereby increasing vulnerability to suicide. Furthermore, functional disability may act as a barrier to seeking and receiving appropriate mental health care, further compounding the risk of suicidal behaviour among older adults. Suicidal behaviour, maybe associated with functional decline and some medical problems, such as malignancy, chronic pain, COPD, liver and kidney disease, male genital disorders, neurological disorders, and arthritis. (53).

In addition to physical health factors, social determinants play a crucial role in late-life suicide risk. Bereavement, in particular, has been identified as a significant risk factor for suicidal behaviour among older adults. Erlangsen et al. (54) conducted a population-based register study highlighting the heightened suicide risk among the oldest old following the loss of a partner. This underscores the profound impact of social losses on mental well-being and emphasizes the importance of targeted interventions to support bereaved individuals in coping with their grief and reducing suicide risk.

Furthermore, social factors beyond bereavement contribute to the complexity of late-life suicide. Fässberg et al. (14) conducted a systematic review exploring the relationship between various social factors and suicidal behaviour in older adulthood. Their findings underscored the significance of social support, social isolation, and interpersonal relationships in influencing suicide risk among older individuals. Addressing social determinants of health, such as enhancing social connectedness and reducing social isolation, is essential in comprehensive suicide prevention efforts targeting the geriatric population.

Moreover, personality traits (particularly Borderline and other cluster B personality disorders) and characteristics have garnered attention in understanding late-life suicide and suicide attempts. Studies have explored the influence of personality factors such as neuroticism, impulsivity, and resilience on suicidal behaviour among older adults. Understanding the interplay between personality traits and other risk factors can provide valuable insights into tailored interventions and strategies for suicide prevention in this vulnerable population.

In summary, a comprehensive understanding of late-life suicide necessitates an exploration of physical health, social determinants, and personality factors. By addressing these multifaceted dimensions, clinicians and researchers can develop targeted interventions and strategies to mitigate suicide risk and promote mental well-being among older adults.

Impacts of COVID-19 on suicide rates

In 2020, the World Health Organization declared COVID-19 a pandemic, which changed the lives of many and resulted in approximately 7,000,000 deaths (55). With increased social isolation due to strict isolation procedures, feelings of depression and anxiety were common in the general population (56). Several studies predicted that the suicide rates in older adults would increase with the onset of COVID-19 (57–59). These predictions were based on a variety of factors that would increase the risk of suicide attempts in members of the older population. Some of these risk factors included social disconnection (59, 60), thwarted belongingness (59, 61), and perceived burdensomeness (59, 62). These factors increased feelings of loneliness and led to increased levels of social isolation (59, 60), which added to the already pre-existing levels of loneliness they typically experienced. In addition to these factors, their self-worth and value in society were often diminished due to the way the media talked about older adults. Members of the older population would frequently hear how they are less of a priority than younger people (63). Various trends like "#BoomerRemover" would exacerbate the effects of ageism and worsen and undermine their self-worth (64).

As new articles are published, there are contrasting views in terms of the changes in suicide rates after COVID-19 in older adults. Some literature reports that COVID-19 has increased both self-harm (65) and suicide rates in the older population (59, 61, 62, 66). Self-harm is considered an important risk factor for suicide, as there is a 67-fold increase in the chance of dying by suicide for older adults with a history of self-harm (65). Increased periods of social isolation are thought to increase the likelihood of self-harm; however, this relationship is largely understudied and could

benefit from more extensive research (65). The relationship between suicide rates and COVID-19 is complex in nature, but many articles refer to the Interpersonal Theory of Suicide (ITS) to help explain the increased desire and risk for suicide. In the ITS model, the desire for suicide stems from their thwarted belongingness and perceived burdensomeness, which often arise when people experience social isolation, lack of social support, loneliness, and functional impairment (67). The strict and highly enforced isolation procedures during the pandemic increased these factors in many older adults, which subsequently increased their desire and risk for suicide (59, 68).

A few studies have stated the opposite, describing how there were no significant differences in depression (60, 69) and suicidal ideation after COVID-19 (60). These studies describe how older adults have greater resiliency and are better able to adapt to stressors and overcome challenging situations. In addition to resiliency, the isolation procedures lead to older adults communicating more frequently with their family members, which increases their perceived social support (60). This increase in perceived social support is a protective factor, that acts to mitigate some of the risks associated with isolation and depression. Another protective factor for suicide in older adults is religion and spirituality (R/S) (62, 70). It is believed that R/S improves subjective well-being (60) and strengthens religious beliefs about suicide behaviors during times of crisis (70). Even with these protective factors, it is recommended that additional studies are completed to confirm these relationships.

When considering gender differences, Kim et al. (66) describe how suicide rates significantly increased in adolescent males, and adult and older adult females. In women aged 65 and older, suicide rates increased by 12.5% after COVID-19. A factor that could contribute to these elevated rates is the general increase in impulsive suicides, which increased in all age groups after the pandemic (66). Another potential explanation could be how women were more likely to be negatively impacted by COVID-19, resulting in a greater chance of developing emotional distress symptoms (69). Lastly, an important consideration is that older women are less likely to live alone compared to older men (69). These findings would suggest that men would be more likely to experience social isolation and subsequent emotional distress, but these were not the noted findings, indicating the need for further research.

Previous suicide attempts

When discussing old age in adults, the age categories can be further subdivided into young-old and old-old. The young-old age group spans from 65–74, while the old-old age group is those who are 75 or older (71). Within these age groups, the effects of previous suicide attempts have different levels of risk. Previous suicide attempts pose a greater risk of recurrent suicide attempts for the young-old geriatric population. In this age group, not all adults are diagnosed with conditions or diseases that deteriorate their physical well-being and mental health. Suicide attempts are less likely to be fatal on their first attempts, and consequently increase the risk of another suicide attempt (39, 71). For the old-old age group, their physical frailty and vulnerability due to their older age results in most suicide attempts being fatal (72, 73). Moreover, these age groups more carefully plan their attempts (74) and choose methods that are known to be more lethal and fatal at completing suicides (75). As a result, it is unlikely that there will be previous suicide attempts that could increase the risk for subsequent attempts (71, 76). Comparing the older age group (65+) to the younger age group (<65), the older age group is 3 times less likely to have previous suicide attempts when compared to the younger age group. Despite this 3-fold difference, previous suicide attempts still increase the risk for subsequent attempts in older adults (39).

Strategies for mitigating suicidality

Despite the incidence rate of suicide among older adults, the research and implementation of preventative measures are severely neglected (77). Research suggests that suicide in older adults is marked by high intentionality and increased fatality (11). This makes sense given their frailty, tendency to meticulously plan (74), and lower likelihood of interruption which puts them at an increased risk for death from suicide attempts (9). With these factors in mind, implementing protective and preventative measures in society is critical to mitigate the fatal outcomes of suicide in older adults, and subsequently utilize early interventions to prevent attempts from initially occurring. Suicidality in older adults encompasses 20% of all global suicides, with the fatality rate attributable to geriatric suicide being 150,000 per year (78). A key determinant to identifying suicidal individuals is to assess the extent of suicidal ideation they possess, with suicidal ideation manifesting as a range of emotions from passive thoughts of death to premeditated detailed plans on how one wishes to perish (79). Suicidal ideation is often dismissed in older adults and depicted as a typical side effect of aging. Our modern ageist society facilitates the increasing geriatric suicide rates by allowing thoughts of death and depression to be normalized and subsequently undetected, furthering the social isolation that older adults are prone to feeling.

Consequently, suicidality in older adults can be mitigated by implementing preventative measures in four domains (79). The first domain consists of integrating intensive screening protocols in primary care settings, seeing as most suicidal elders see their primary care physician the year before attempting suicide. Depression screening and management in primary care settings particularly in collaborative care had the strongest evidence (80). The second requires modifying society's approach to aging, reducing ageism and combatting the normalization of depression among older adults. The third relies on furthering existing research on older adults' suicide and how symptoms present in this population, mainly so that common warning signs can be made aware to the public and health care workers. Finally, the fourth entails implementing accessible supportive resources for older adults, such that they do not feel isolated and have outlets to discuss their feelings rather than having them dismissed (79). Early screening and intervention are vital to identifying at-risk individuals and providing them with the necessary resources to

cope, rather than resorting to harmful coping mechanisms. Such resources include but are not limited to cognitive behavioural therapies (CBT), interpersonal therapy (IPT), supportive psychotherapy, problem-solving therapy (PST), involving family member/caregiver/environment in therapy (Ecosystem focus therapy), screening mechanisms such as the GDS and DIA-S, pharmacotherapy and antidepressant treatment, community-based outreach programs, counselling in person or via telephone for vulnerable adults, educating primary care physicians on screening protocols and early detection, and the combined effects of exercise and medications on reducing suicidality (80, 81).

Medications and exercise

Researchers often question the use of antidepressants in older adults due to the adverse effects that some people experience, such as hyponatremia, gastrointestinal bleeding, and negative interactions with other drugs (82). Not only that, but the effects of antidepressants on people in the older adult population have differing effects depending on the type of antidepressant administered and the number of antidepressant treatments they are on. Additionally, the effects of antidepressants may also differ due to differences in pharmacokinetics due to aging (83). Hedna et al. describe how older adult individuals on a single antidepressant treatment of mirtazapine or those taking more than one antidepressant at a time had an increased risk of suicidal behaviour compared to those on a single selective serotonin reuptake inhibitor (SSRI) treatment (84). However, it is important to consider that those individuals who were on mirtazapine or taking more than one antidepressant were also more likely to use specialized healthcare systems to treat their depression. Individuals who are taking more than one antidepressant may require specialized services since they may be refractory to treatment or have a severe form of depression that subsequently increases their suicidal risk. Some other antidepressants that were noted to increase suicidal behaviors were fluvoxamine and venlafaxine (84). These effects were attributed to their underlying mechanisms which had subsequent impacts on concomitant drug administration and increased the risk of adverse effects and hospitalizations (85).

The study by Hedna et al. outlined how two-thirds of the older adults who died by suicide were not on antidepressant treatment while the other one-third had filed a prescription within the last three months of their life (2021). This evidence highlights the lower suicide rates of those taking antidepressants compared to those who are not. Of those two-thirds, it is likely that many of them experienced symptoms of major depression but were not diagnosed and were untreated (84). These findings show the importance of screening for older adults' depression as it can help physicians and healthcare professionals mitigate the risk of suicide before it is too late. A recent meta-analysis outlined the effectiveness of some SSRIs and selective norepinephrine reuptake inhibitors in decreasing older adults' depression. Medications such as sertraline, paroxetine, and duloxetine decreased overall depression scores by 50% compared to the typical baseline for depressed older adults (86). This does not necessarily mean that all older adults given antidepressants will have significant reductions in their overall depression scores, as only about 50.7% of older adults respond to antidepressant treatment (83). Collectively, these findings are important and can be incorporated into other strategies to help reduce the risk of depression and suicide in older adults.

Exercise and physical activity have been proven to have beneficial impacts on older adults and their depressive symptoms (87). Older adults who frequently engage in physical activity for 150 minutes or more each week are significantly less likely to suffer from depression when compared to those who do not perform any physical activity (88). Beyond physical activity, regular flexibility exercises could also help reduce depressive symptoms. These positive effects occur due to improvements in both the physical and mental health of depressed older adults resulting in higher psychological well-being which ultimately reduces depression and lowers the risk of suicidal behaviors (89). Physical activity could also improve their physical strength and alter the levels of hormones in the body to ameliorate the effects of their depression (89). Exercise temporarily changes the levels of central norepinephrine, while decreasing the activity of the hypothalamopituitary-adrenocortical axis (88) and increasing the secretion of beta-endorphins (88, 89). These changes reduce feelings of depression in older adults and mitigate the risk of suicidal behaviors.

Depression and the risk for suicide are dependent on a variety of life stressors and are not just caused by one individual factor. Therefore, using several interventions and strategies to try and reduce the symptoms of depression and mitigate suicide risk is quite important. Combining the positive effects of exercise and physical activity with the effects of antidepressants has been shown to have greater improvements in mental health than using antidepressants alone (83). Using sertraline as an example, there were greater cognitive improvements when exercise and sertraline were used together rather than using sertraline alone. Each intervention has its benefits, and combining both leads to synergistic effects that reduce symptoms of depression in older adults (83). The study further suggested including exercise-based interventions in primary health care settings as these are the areas with relatively high concentrations of adults with late-life depression. Despite these findings, additional research is required to further understand the interactions of exercise and antidepressants as there are very few studies exploring these effects in the geriatric population.

Suicide prevention

It is well-established that the general population is aging, placing a great deal of pressure on the provision of geriatric healthcare services, and contributing to the burden of late-life disease (90). Suicide among aging adults continues to receive less attention than it requires, and several factors can be considered when it comes to preventing suicidal thoughts and behaviors from a clinical standpoint.

Firstly, addressing the pervasive issue of ageism should be a universal priority; it is described as the negative attitudes towards aging that are held on both societal and individual levels (91). A 2020 systematic review with over 7 million participants on a global

scale identified the fact that ageist practices and perspectives are related to poorer health outcomes in older adults worldwide, including increased mortality, slower recovery from illness, and mental health issues (92). In the context of individual healthcare settings, factors such as assumptions about poor cognition and functional decline can contribute to the failure to provide high-quality information during treatment, directly or indirectly leading to lower-quality care (92). As mentioned previously, social exclusion is a factor that contributes to suicidality in geriatric patients, and discrimination directed toward the population as a whole only further warrants intervention (93). Studies suggest that directed interventions such as intergenerational contact programs, and structured initiatives that allow for the development of meaningful relationships between individuals of different generations can help combat ageist perspectives and foster respect and admiration for those of advanced age (91). These interventions can be carried out via volunteering endeavours, school-based programming, recreational therapy in long-term care facilities, and community organizations that work with a variety of ages (94). Efforts such as these, in addition to media campaigns focused on positive portrayals of older adults, can help to directly address ageism, and foster mutual respect across the widening generation gaps in society (91).

Older adults as a whole are at risk for concerns that involve cognition, memory, and problem-solving; some of which are pathological, while others may be related to normal aging (95). Collectively, however, these changes are considered to be additional risk factors for the onset of suicidal ideation and behaviors (96). Some studies have demonstrated the efficacy of interventions that address cognition in older adults, such as problem-solving therapy (PST), a cognitive-behavioural technique which helps to minimize the negative impact of stress by helping patients approach and solve problems in a productive manner (97).

Lastly, there are some recommendations that clinicians can make to reduce the risk of harm by helping the patient manipulate their environment. Data from the USA suggests that firearms are involved in up to 70–80% of geriatric suicides, a substantial portion of which are in males (98). While Canada has more restrictions on firearm ownership, firearm-related suicide is still a concern, accounting for roughly 16% of all suicide fatalities in the country (99). Prevention strategies that help to manage the means aspect of suicide attempts include counselling patients on firearm safety like storage practices (such as the use of locking devices that prevent quick access, or community gun storage programs) and exploring the need for firearms through a clinical interviewing lens that may help patients to reconsider their ownership or licensure (98). Open and non-judgmental communication is key when approaching conversations about firearm safety, as gun ownership continues to be a value to some, especially those in rural communities (100).

Screening for mental health disorders

Several different methods can be used to screen for depression in the geriatric population. Each has its advantages and disadvantages, but they are still effective at identifying the presence of depression. Diagnosing or identifying the risk of depression in the geriatric population is important for reducing the risk of suicide, as depression is one of the greatest risk factors for suicide in old age (28). A challenge to identifying depression in old age is the fact that depressed older adults are not as likely to show affective symptoms and are more likely to show somatic/vegetative symptoms and cognitive changes (101). These symptoms may be caused by physiological changes associated with aging, therefore decreasing the likelihood of detecting depression.

Two screening methods that are commonly used to assess depression in the geriatric population are the Geriatric Depression Scale (GDS) and the Depression in Old Age Scale (DIA-S). The GDS comes in various lengths, but the GDS-15 has only 15 questions and is frequently used in geriatric settings. The DIA-S has 10 items that are all answered in a yes or no format (102, 103). Important to both instruments are the positive predictive value (PPV) and the negative predictive value (NPV). Wunner et al. found that the GDS-15 had a greater PPV than the DIA-S, but the DIA-S had a greater NPV (2021). A greater PPV means that a patient with a positive screening value is more likely to have depression. A negative predictive value means that a patient with a negative screening value is more likely to not have depression which can be more accurate. Despite the greater PPV of the GDS-15, it has many questions that are generally considered unsuitable for geriatric patients (102). Some of the questions may lead to the acquisition of false data as they may answer yes on the GDS-15, but the actual reason for their answer is physical impairment or physiological changes associated with aging (102, 103). The DIA-S has questions that are typically more easily understood by patients in the geriatric population, and therefore require less clarification. Despite the differences between these two screening methods, however, there are still contrasting views on which screening method is the most suitable for depression screening. Some suggest that there is no clear preference for one screening instrument over the other (103) while others state that the DIA-S is a good alternative to the GDS-15 (102).

Observing mood and behavioural changes in older adults

Identifying behaviors that signify a geriatric patient is at risk of suicide is crucial for timely intervention and support. Elderly individuals experiencing persistent sadness, hopelessness, a pervasive loss of interest in activities they once enjoyed, or expressing feelings of being a burden to others might be exhibiting warning signs of suicidal thoughts or actions (26).

Suicide risk assessment

The first step when approaching a geriatric patient with concerns of depression or suicide in the clinical setting is to utilize a screening method for suicidal ideation (104).

The Geriatric Suicidal Ideation Scale (GSIS) is a 31-item scale that contains four subscales that assess suicide ideation, death

ideation, loss of personal and social worth, and perceived meaning of life; this assessment scale and its pertinence to the subpopulation of geriatric patients have garnered support in the research community as having strong reliability and validity (105).

The 10-item Brief Geriatric Suicidal Ideation Scale (BGSIS) and the 5-item Geriatric Suicide Ideation Scale – Screen (GSISS) can be employed to identify and measure suicidal ideation in older adults (105). They are both targeted toward the geriatric population, thus helping to be inclusive in their ability to detect risk factors that may be more cohort-specific, including chronic health conditions, loss of loved ones, functional limitations, and loss of independence (104).

The Geriatric Depression Scale (GDS), which has both long and short versions, can also be used to detect elements of suicidality, but not necessarily stratify risk or imminence (106). Other scales that can be used during suicide risk assessment include the:

Columbia Suicide Severity Rating Scale (C-SSRS) can identify cases of actual suicide attempts and determine if there was a previous history of suicide attempts or non-suicidal self-injury (107).

The Suicide Intent Scale (SIS) measures suicide intent and has a total of 15 items (7 of them are subjective and 8 are objective) (108).

The suicide assessment scale (SUAS) measures symptoms known to be related to subsequent suicide irrespective of the diagnosis (109).

Management of older adults who are suicidal

When older adults are at high risk for suicide, several interventions should be swiftly employed to provide support. The first step when presented with a suicidal geriatric patient is to establish an ongoing treatment plan; it is crucial to actively monitor and assess these patients closely, either in an inpatient or outpatient environment (79). While validated scales can be used to assess the severity of the patient's suicidality, it is also encouraged to consider the factors that modify suicide risk. Depending on the content of the suicidal thoughts, there may be safety planning that should take place, and the clinician can routinely assess for access to firearms and other lethal means (110).

Multidisciplinary approaches to care are not only preferred but can be lifesaving in the context of geriatric suicide (110). While this article primarily focuses on the role of a psychiatrist or primary care provider, engaging other healthcare professionals including social workers, nurses, recreation therapists, and community outreach workers where applicable; considering the potential for hospital admission can be performed on an individualized basis (111). When it comes to physicians, studies have demonstrated that interdisciplinary care between geriatricians and psychiatrists with geriatric inpatients helps to reduce adverse outcomes such as polypharmacy (112).

If the patient is not admitted to the hospital, the clinician must provide recommendations for age-appropriate and accessible resources that can be accessed outside of standard business hours (111). This may include facilitating access to emergency departments, suicide hotlines, and first responders (113). Recognizing the influence that loneliness and isolation have on suicidal thinking, it would also be useful for mental health providers to equip themselves with the ability to facilitate interpersonal connections in their patients' community – this can be accomplished through advocacy, liaising with family members, and familiarizing oneself with community programming (114).

The roles of psychotherapy, pharmacology, and electroconvulsive therapy (ECT) can be considered on an as-needed basis. While cognitive-behavioural therapy (CBT) is considered the first-line psychotherapeutic intervention for depression and suicidality in the general population, some special considerations need to be considered when treating older adults (115). Modification of psychotherapeutic techniques may need to be employed to accommodate for issues like cognitive decline, hearing loss, and unfamiliarity with technology (116). The medications that are preferred first-line agents, given their tolerability and efficacy, are duloxetine, mirtazapine, sertraline, venlafaxine, vortioxetine, citalopram, desvenlafaxine, and escitalopram, with an emphasis on frequent follow-up to optimize adherence (117). Failure to respond to first-line therapy warrants specialist referral or guideline-directed medical therapy for combination and/or augmentation strategies (118). Finally, ECT is a safe and effective treatment for depression in older adults, and it has even been shown that older adults who receive ECT have lower rates of mortality compared to alternative antidepressant therapies (119). ECT has evidence in reducing suicide risk (120). When a shorter duration to symptom resolution is prioritized, like in those at risk for suicide, ECT used in combination with venlafaxine can be a rapidly acting and effective treatment in depressed geriatric patients and has evidence in reducing suicide (121). Further research is required to better understand the safety and utility of other factors for treatment-resistant depression and suicidality in older adults, including transcranial magnetic stimulation (TMS) and ketamine (122). Nova Scotia has a new suicide risk assessment tool that incorporates risk and protective factors, documentation of risk levels, communications with other care providers, and management strategies (123).

Suicidal behaviors in older adults

Identifying behaviors that signify a geriatric patient is at risk of suicide is crucial for timely intervention and support. One significant indicator, as previously mentioned, is the manifestation of depressive symptoms, which strongly correlate with suicide risk in older adults (22). Older adults experiencing persistent sadness, hopelessness, a pervasive loss of interest in activities they once enjoyed, or expressing feelings of being a burden to others might be exhibiting warning signs of suicidal thoughts or actions (26).

Changes in behaviour or mood can also be monitored, such as increased irritability, agitation, and anxiety potentially signifying an elevated risk. These alterations might be accompanied by disrupted sleep patterns, changes in appetite, or a decline in personal care (104). Studies have suggested that the presence of these behavioural changes when observed in conjunction with depressive symptoms, could serve as important indicators of potential suicidal tendencies among older adults. Moreover, explicit verbal cues or expressions of suicidal thoughts should not be dismissed; those expressing statements about wanting to die or expressing thoughts of being a

burden to their loved ones, warrant immediate attention and intervention (111). It is important to emphasize the significance of taking such statements seriously and engaging in open conversations about suicidal ideation, ensuring the individual receives appropriate support and professional care (124).

By closely observing and recognizing these behavioural and verbal indicators in geriatric patients, caregivers, healthcare professionals, and family members can play a crucial role in identifying those at risk of suicide, providing timely support, and potentially preventing tragic outcomes.

Discussion

Geriatric suicide remains a significant public health concern, as evidenced by the literature reviewed in this paper. The epidemiology of suicide among older adults reveals concerning trends, with some evident variation in demographic and socio-economic factors. The identification of risk factors for geriatric suicide, including psychiatric disorders, substance use, and social isolation, underscores the complex interplay of biological, psychological, and social determinants contributing to suicidal behaviour in this population. Despite advances in understanding the multifactorial nature of suicide in older adults, several discrepancies among researchers were noted, particularly regarding the role of specific risk factors and their relative importance in predicting suicidal behaviour. For instance, while psychiatric disorders, such as depression and anxiety, are widely recognized as significant contributors to suicidal behaviour among older adults, the extent to which these conditions independently increase the risk of suicide remains a topic of debate. Similarly, the role of substance use, social isolation, and physical health comorbidities in predicting suicidal behaviour in older adults varies across studies, highlighting the need for further research to clarify these discrepancies and establish consensus on the most salient risk factors for geriatric suicide. Future research should aim to clarify these issues to provide more robust evidence for the development of targeted prevention and intervention strategies.

One notable gap in the literature pertains to the impact of the COVID-19 pandemic on geriatric suicide rates and associated risk factors. While preliminary evidence suggests a potential increase in psychological distress and suicidal ideation among older adults during the pandemic, further research is needed to elucidate the long-term consequences and identify effective interventions to mitigate the adverse effects on mental health. Additionally, the role of protective factors against suicide, such as social support, spirituality, and access to mental health services warrants further investigation to inform comprehensive suicide prevention efforts tailored to the unique needs of older adults. A pertinent knowledge gap is the little knowledge about age group differences within the broad group of older adults such as age 60 to 70 versus 80 to 90. The role of medical problems in perpetuating suicide among different age groups remains unclear.

Despite the availability of evidence-based interventions for suicide prevention and management in clinical settings, challenges remain in implementing these strategies effectively. Limited resources, stigma surrounding mental health issues, and barriers to access to care pose significant obstacles to delivering timely and appropriate interventions for older adults at risk of suicide. Addressing these challenges requires a multifaceted approach involving collaboration between healthcare providers, policymakers, and community members to enhance awareness, improve screening and assessment protocols, and expand access to mental health services for older adults. Ultimately, by addressing the gaps in research and practice identified in this review, we can work towards reducing the burden of geriatric suicide and promoting the well-being of older adults worldwide.

Conclusion

Despite the decrease in global suicide mortality rates, the rates of suicide in older adults continue to increase. With the anticipated growth in the size of the geriatric population, these numbers are only expected to continue growing if no further actions are taken. The complex etiology of geriatric suicide and the inability to easily detect suicide risk make it challenging for clinicians to intervene. Depression in older adults is commonly considered a symptom of aging and usually goes undiagnosed in older adults. To improve clinicians' ability to detect and diagnose depression and subsequently lower the risk of suicide, it is important to understand other risk factors that could potentially signify suicidal behaviour. Besides MDD, which is one of the greatest risk factors for suicide, other factors like previous suicide attempts and alcohol consumption should be taken seriously. Additionally, after the COVID-19 pandemic and strict isolation procedures, the literature has revealed contrasting views on the impact of the pandemic and geriatric suicide risk. To further understand this relationship, we suggest that additional research be completed on this topic in the upcoming years. Moreover, we recommend that clinicians develop more evidence-based methods to identify the risk of suicide in geriatric patients to improve early suicide detection and prevention.

Author contributions

JS: Writing – original draft, Writing – review & editing. BD-P: Writing – original draft, Writing – review & editing. LS: Writing – original draft, Writing – review & editing. LM: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 10 May 2024
DOI 10.3389/fpsyt.2024.1389021

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RECEIVED 20 February 2024
ACCEPTED 29 April 2024
PUBLISHED 10 May 2024

CITATION
Ramm M, Jedamzik J, Lenz P, Jürgens L, Heuft G and Conrad R (2024) Older adults coping with critical life events - results of the revised demoralization scale in a representative sample of older adulthood. *Front. Psychiatry* 15:1389021. doi: 10.3389/fpsyt.2024.1389021

Older adults coping with critical life events - results of the revised demoralization scale in a representative sample of older adulthood

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Background: High suicide rates in older adults are a relevant public health concern. Social isolation or widowhood as well as physical decline play a crucial role for suicidality in older adulthood. Previous evidence suggested that demoralization is an important risk factor for suicide. Whether demoralization is a relevant phenomenon in older adulthood which possibly could account for high suicide rates remains unclear.

Methods: Demoralization Scale II (DS-II) scores assessed in a survey of the German general population were investigated with respect to older adults (aged ≥ 65 years). DS-II scores were compared between older (≥ 65 years) and younger (< 65 years) adulthood and between young-old (65–74y), middle-old (75–84y), and old-old (85+y) individuals. We tested the impact of sociodemographic factors on DS-II scores within older adults.

Results: The sample comprised N = 545 adults ≥ 65 years and N = 1922 adults < 65 years. DS-II scores increased in older compared to younger adults ($F_{(1,2465)}$ = 6.1; p = 0.013; d = 0.09) and further from young-old to old-old (M_{diff} = 2.7; 95% CI 0.45, 5.46; p = 0.034). One-fourth of individuals ≥ 65 years and almost half of old-old individuals reported DS-II scores above the cut-off > 5. Living with a partner protected from demoralization in old-old individuals.

Discussion: This study provides first evidence for an increased rate of demoralization in very old adults, in particular women, which is partly related to partnership status. We suggest that demoralization is considered as a crucial entity in older adulthood which can be missed by standard psychological screenings.

KEYWORDS

depression, older adulthood, demoralization, suicidality, cancer, demoralization scale

Introduction

Life expectancy and thus the size of the oldest-old group (80+ years) has increased globally which is partly due to a decline in mortality (1). While suicides generally decreased from the 1980s (2) suicide rates increase with age in most countries, including Germany (3). In the year 2022, 10.119 individuals died by suicide in Germany, corresponding to a rate of 12.1 per 100.000. 75% of those were men and about one-third were at least 70 years (4). Thus, high suicide rates in older adulthood, particularly in older men, remain a major cause of death not only in Germany but worldwide (5) and therefore represent a relevant public health concern (6).

Suicide rates seem to differ among specific age sub-groups (6) so that studies have reported suicide rates in 5 to 10-year age bands throughout the whole life span. The development of suicide rates over the age groups was shown to differ between nations, showing either continuous increases with age, a bimodal pattern with a peak in middle age and oldest old, or an increase with age until middle age and then a decline or stability (3, 6, 7). However, a cross-national finding of 87 countries was that suicide rates in the 75+ years group were consistently higher than in the 65–74 years age group (3). Thus, for studies in the context of suicidality in older adulthood, it seems important to analyze different life stages, i.e. young-old (65–74 years), middle-old (75–84 years), and old-old (85+ years).

In line with the increase of depression with age across countries (8), psychiatric illnesses, in particular depression, have been identified as one of the most relevant risk factors for suicide also in older adulthood (9). However, psychiatric disorders seem to be of greater relevance for suicide in the middle-aged compared to older adults (9, 10), suggesting that a psychiatric disorder might not sufficiently explain the increasing suicide rate in the oldest old.

Several studies have investigated risk factors that are more specific to the age groups > 60 years. While the rate of completed suicides may increase with age, suicidal attempts are even more frequent in adolescents and young adults (11). Suicidal attempts significantly decreased during the life course from 200 per one suicide in teenagers to 10 per one suicide in subjects > 60 years (12) and even within older adults that died by suicide, suicidal attempts decreased from the 65–74 years group to the 75–84 years group (10). In the latter study, this was accompanied by reductions in legal and financial stressors, relationship problems, and frequency of any psychiatric problems, while in contrast, physical conditions and bereavement increased.

In a retrospective analysis of reasons for suicide in a palliative setting, physical illness turned out to be a highly relevant reason to die in older adulthood (13). Conwell et al. identified four domains of risk factors for suicide in later life: psychiatric illness, social connectedness of the older person with his or her family, friends, and community, physical illness and functional capacity (14). Moreover, Sinyor et al. performed cluster analysis in oldest-old suicide victims, showing three clusters: a) married or widowed subjects with depression and more medical health stressors, b) subjects living alone with less depression and medical health stressors and c) subjects with the highest rates of mental disorders (15). In sum, previous evidence suggests that specific sociodemographic such as social isolation, widowhood and bereavement, as well as clinical factors (i.e. dementia, cognitive impairment, and physical illness) seem to play a major role in suicide death in subjects > 65 years (11, 15, 16).

Furthermore, due to an increasing rate of cognitive and physical disabilities within the oldest old, independence and mobility are further reduced (17). Those subjects facing severe physical illnesses such as cancer are not only at higher risk for later suicide (18) but also suffer more frequently from demoralization syndrome (19, 20). Demoralization encompasses feelings of hopelessness and helplessness, a sense of incompetence or failure, and loss of meaning and purpose in life (21), which can be a distinct entity from depression (22, 23). Demoralization has been found to be independently, i.e. beyond depression severity, associated with suicidality (24, 25). In some cases a narcissistic crisis might be a mediator between physical and mental decline and suicidality in older age (26).

Supportive interventions that address demoralization have been developed in the context of patients with chronic diseases such as cancer. For instance, short-term evidence-based meaning-centered Psychotherapy typically includes assessment of the individual sources of meaning that are still present, and finding meaning through courage and commitment (27).

The relationship between demoralization and suicidality was also investigated in the light of the influential Interpersonal Theory of Suicide which posits that perceived burdensomeness and thwarted belongingness interact to foster the desire to die (28). Previous data suggested that "Meaning in life" and demoralization are constructs that mediate the relationship between perceived burdensomeness and thwarted belongingness on the one hand and suicidal ideation on the other hand (29).

An increased risk for suicide in subjects with demoralization syndrome has been confirmed in several populations, including individuals in precarious economic conditions (30), elderly women (31), college students (32), and chronic pain patients (33). However, whether demoralization is a feature of specific age groups of older adulthood remains unclear.

Demoralization is most frequently assessed by the Demoralization Scale, which is available in a refined version, the DS-II (34, 35), that was translated to German (36, 37). Yet, the DS-II has rarely been investigated in samples of the general population (37, 38). In a previous study, we investigated psychometric properties and norm values of the Demoralization Scale II (DS-II) in the German general population, indicating age-dependent DS-II scores (37). In the present manuscript, we investigated DS-II scores in older adulthood (≥ 65 years), specifically comparing the young-old, middle-old, and old-old. We hypothesize that there is not only an increase of DS-II scores with age overall but specifically in individuals ≥ 65 years and between the young-old (65–74 years), middle-old (75–84 years), and old-old (85+ years). Furthermore, as the male gender is a risk for suicide, which even increases with age, we explored gender effects on DS-II scores in the older adult cohort. Last, we explored the relationship between well-known sociodemographic risk factors for suicide (such as partnership status) and demoralization in older adulthood.

Methods

Data sets

Between March and May 2022, a demography consulting company, USUMA (Berlin, Germany) collected data as part of a comprehensive German household survey. A detailed description of the data collection procedure is provided elsewhere (37). In short, the country was divided into 258 regions to proportionately represent all German regions. A multistage random selection process was used to choose 6192 households (6188 valid) across these areas, aiming for a nationally representative sample. The survey involved face-to-face interviews. Of the subjects aged 16 and above, 2522 (41.2%) consented to participate. The final analysis excluded individuals younger than 18 years (44 in total), those who did not identify as male or female (n = 4), and those who were missing two or more items on one of the two subscales (n = 7), resulting in a final sample size of 2467. If there was only one missing item on any subscale, it was filled in using the mean of the valid items.

Demoralization scale Münster

The DS-II is a simplified and shorter version of the original demoralization scale, easier to use with 16 items rated on a 3-point Likert scale (0 = never; 1 = sometimes; 2 = often). Scores vary from 0 to 32, covering two subscales: "Meaning and Purpose" (MaP) and "Distress and Coping Ability" (DaCA). Items of the DS-II and its corresponding subscale are presented elsewhere (37). The scale showed high reliability and good convergent and discriminant validity in a study with 211 palliative care patients (35). Cut-off criteria based on an extreme group design were suggested (37), distinguishing low (<25th percentile; score = 0), moderate (25th – 75th percentile; score = 1–5), high demoralization (> 75th percentile; score > 5) and very high demoralization (> 90th percentile; score > 12). The scale was translated into German using rigorous methods and tested for comprehension without issues in a preliminary study (for details see (37)).

Data analysis

One-way ANOVAs with age-group as between-subject factor (< 65y vs ≥ 65y; 65–74y vs. 75–84y vs. 85+y) were performed to test differences between older adulthood (≥ 65 years) and young to middle adulthood (< 65 years) as well as between different age-groups within older adulthood (65–74y, 75–84y, 85+y). For many analyses, approximation of normal sampling distribution was assumed due to the central limit theorem, and variance homogeneity was not violated. When comparing gender within age groups of older adulthood, sample sizes were unequal and low for the oldest age group, the assumptions of normality and variance homogeneity were not met. Thus, we decided to perform non-parametric analyses (Mann-Whitney-U-Test) to test the effects of gender. Furthermore, robust statistics for *post hoc* tests in terms of bootstrapped (n = 1000 samples, bias-corrected and accelerated) p-values and 95% confidence intervals (CI) were reported for differences between group means.

To analyze the effects of sociodemographic variables on DS-II scores, a linear regression analysis was conducted with age and gender as predictors in the first model, and partnership, income, and education that were stepwise included in the model as additional predictors.

For all analyses, critical p was set at 0.05. Cohen's d was given as an effect size parameter for significant effects of parametric tests. Statistical analysis was carried out with IBM SPSS® Statistics Software (version 28.0, IBM, Armonk, NY).

Results

Research sample

Table 1 presents the sociodemographic profile of the study cohort. The group comprised 50.1% males and 49.9% females, with a mean age of M = 49.8 years (SD = 17.3; range: 18–96 years).

DS-II scores in the aging population

Individuals ≥ 65 years showed significantly increased DS-II scores ($F_{(1,2465)}$ = 6.1; p = 0.013; d = 0.09) and DS-II MaP scores ($F_{(1,2465)}$ = 11.4; p < 0.001; d = 0.14) but not DS-II DaCA scores (p > 0.1); compared to subjects < 65 years (Figure 1).

Within older adulthood (≥ 65 years), age-group (65–74y, 75–84y, 85+y) had a moderate impact on DS-II sum scores ($F_{(2,542)}$ = 3.6; p = 0.027; d = 0.23). This effect was even more pronounced for the DS-II MaP scores ($F_{(2,542)}$ = 4.9; p = 0.008; d = 0.27), while differences between DS-II DaCA scores missed significance in older adulthood (p > 0.1).

As shown in Figure 1, the DS-II sum score was increased in old-old individuals compared to young-old (Mdiff = 2.7; 95% CI 0.45, 5.46; p = 0.034). It did not differ between young-old and middle-old (p = 1), while the difference between middle-old and old-old subjects just missed significance (p = 0.08). For the MaP scale, middle-old subjects showed similar scores as the young old (p = 0.8) whereas the old-old reported higher scores compared to both young-old (Mdiff = 1.6; 95% CI 0.44, 2.86; p = 0.007) and middle-old (Mdiff = 1.3; 95% CI 0.20, 2.50; p = 0.045).

The relative number of individuals scoring below or above the proposed cut-off > 5 is displayed in Figure 2. 20.8% of individuals aged < 65 years showed DS-II sum scores above the cut-off (> 5) whereas in older adults (≥ 65 years) 26.8% reached a DS-II score greater than 5. Within older adulthood, 23.9% of the young-old, 28.3% of the middle-old and 48.5% of the old-old scored above the cut-off (> 5).

9.5% of individuals aged < 65 years showed DS-II sum scores > 12 whereas in older adults (≥ 65 years) 10.5% reached a DS-II score greater than 12. Within older adulthood, 10.6% of the young-old, 8.7% of the middle-old and 18.2% of the old-old scored above the cutoff (> 12).

TABLE 1 Sociodemographic parameters of the sample.

	Total (n = 2471)		Men (n = 1237)		Women (n = 1230)	
Age, M(SD)	49.81 (17.3)		49.66 (17.3)		50.02 (17.3)	
Age groups	N	%	N	%	N	%
< 65 years	1922	77.9	967	78.2	955	77.6
≥ 65 years	545	22.1	270	21.8	275	22.4
65 – 74 years	339	62.2	173	64.1	166	60.3
75 – 84 years	173	31.7	77	28.5	96	34.9
≥ 85 years	33	6.0	20	7.4	13	4.7
Partnership (n = 545)	N	%	N	%	N	%
Living with a partner	273	51.6	175	65.5	98	37.4
Living without a partner	256	48.4	92	34.5	164	62.6
Education (n = 543)	N	%	N	%	N	%
A-level	97	17.9	66	24.5	31	11.3
Below A-level	446	82.1	203	75.5	243	88.7
Household income (n = 535)	N	%	N	%	N	%
<1250€	71	13.3	25	9.5	46	17.0
1250-<2500€	319	59.6	144	54.5	175	64.6
>2500€	145	27.1	95	36.0	50	18.5

M, mean; SD, standard deviation.

Gender effects on demoralization in older adulthood

First, we tested whether DS-II scores differed between younger (< 65 years) and older (≥ 65 years) individuals and further between age groups within older adulthood, for men and women separately (Figure 3).

DS-II sum scores (U-Test = 116468; Z = -2.79; p = 0.005), as well as DS-II MaP scores (U-Test = 110967; Z = -4.08; p < 0.001), were significantly increased in *older men* (≥ 65 years) compared to *younger men* (< 65 years), while the differences for the DS-II DaCA scores were not significant (p = 0.08).

Similarly, DS-II MaP scores were increased in women ≥ 65 years compared to women < 65 years (U-Test = 119838; Z = -2.34; p = 0.019), DS-II sum scores were higher on a trend-level (U-Test = 121564; Z = -1.91; p = 0.056) and DS-II DaCA scores were similar between both (p > 0.2).

Within older adulthood, we found that *old-old women* (85+y) showed significantly increased DS-II sum scores (U-Test = 664; Z = -2.34; p = 0.019) and DS-II MaP scores (U-Test = 568.5; Z = -2.98; p = 0.003), but not significantly different DS-II DaCA scores (p > 0.1) compared to *young-old women* (65–74y). Moreover, *old-old women* (85+y) showed increased DS-II sum scores on a trend-level (U-Test = 420; Z = -1.93; p = 0.054) and DS-II MaP scores (U-Test = 372.5; Z = -2.42; p = 0.016), but similar DS-II DaCA scores (p > 0.2) compared to *middle-old women* (74–85y).

In contrast to the results in older women, DS-II scores (sum, MaP, DaCA) did not significantly differ between old-old and middle-old (all p > 0.24) men as well between old-old and young-old men (all p ≥ 0.07).

In sum, both older men and older women (≥ 65 years) reported greater DS-II scores than younger adults (< 65 years), and further, within older adulthood, DS-II scores particularly increase in the oldest women (85+ years) (Figure 4).

Second, women ≥ 65 years showed increased DS-II DaCA scores compared to men ≥ 65 years (U-Test = 33372.5; Z = -2.12; p = 0.034), while neither DS-II sum score (p > 0.09) nor DS-II MaP scores (p > 0.5) were significantly influenced by gender in older adulthood. DS-II scores (sum, MaP, DaCA) did not significantly differ between women and men for any of the age groups of the older adulthood (all p > 0.09).

Effects of sociodemographic factors on demoralization in the aging population

In a regression analysis within older adulthood population (age ≥ 65 years; n = 518), with age and gender as predictor variables and DS-II sum score as the dependent variable, the variables explained a significant but small part of the DS-II sum variance (R^{2corr} = 0.011; $F_{(2,517)}$ = 3.8; p = 0.023), while only age was a significant predictor (p = 0.043). When sociodemographic variables (partnership, education, income) were stepwise

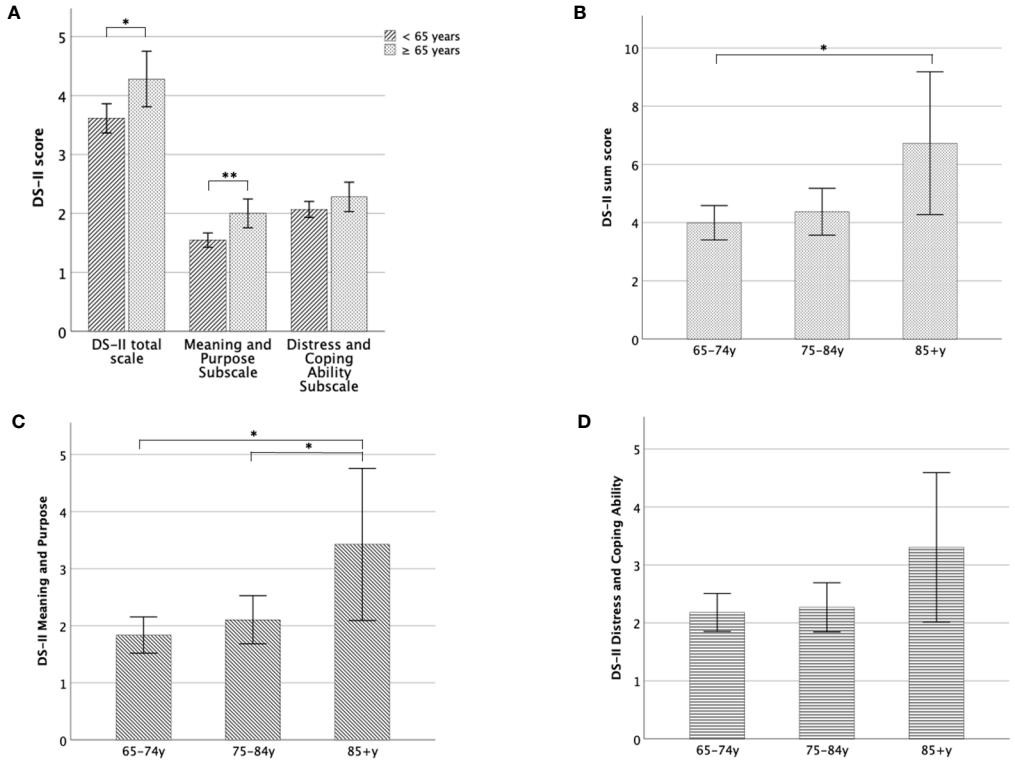

FIGURE 1
DS-II scores in older adulthood. **(A)** Mean DS-II scores of individuals < 65 years compared to those ≥ 65 years, separately for the total scale and both subscales, **(B)** Mean DS-II sum score for different age groups in the older adulthood, **(C)** Mean DS-II Meaning and Purpose subscale score for different age-groups, **(D)** Mean DS-II Distress and Coping Ability Subscale scores for different age-groups. Error bars indicate 95% CI. *significant at the 0.05-level, **significant at the 0.01-level.

included in the regression, the model again significantly improved (R^{2corr} = 0.019; $F_{(2,517)}$ = 4.3; p = 0.005). In the final regression, partnership turned out to be the predictor explaining most of the remaining variance beyond age and gender ($b_{standardized}$ = 0.11; p = 0.021).

Within older adulthood (65+ years), the decrease of DS-II sum scores in those living with a partner was significant ($F_{(1,529)}$ = 11.0; p < 0.001; d = 0.29; Mdiff = -1.6; 95% CI -2.55, -0.65).

Figure 5 shows DS-II scores with respect to whether an individual lives with a partner or not, separately for each age group within older adulthood.

Within the young-old and within the middle-old, those living with a partner did not differ in DS-II sum scores from those not living with a partner (all p > 0.14). In contrast, within old-old, those living with a partner showed DS-II sum scores that were increased on a trend level (U-Test = 63; Z = -1.92; p = 0.055).

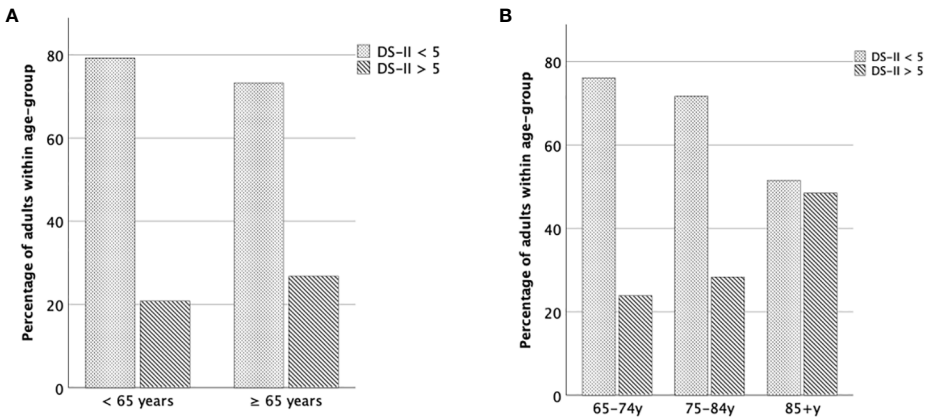

FIGURE 2
Percentage of older adults above the cut-off value. **(A)** Relative number of individuals < 65 years vs. ≥ 65 years scoring above or below cut-off (≤ 5 vs. > 5). **(B)** Relative number of individuals of each age group scoring above or below cut-off (≤ 5 vs. > 5).

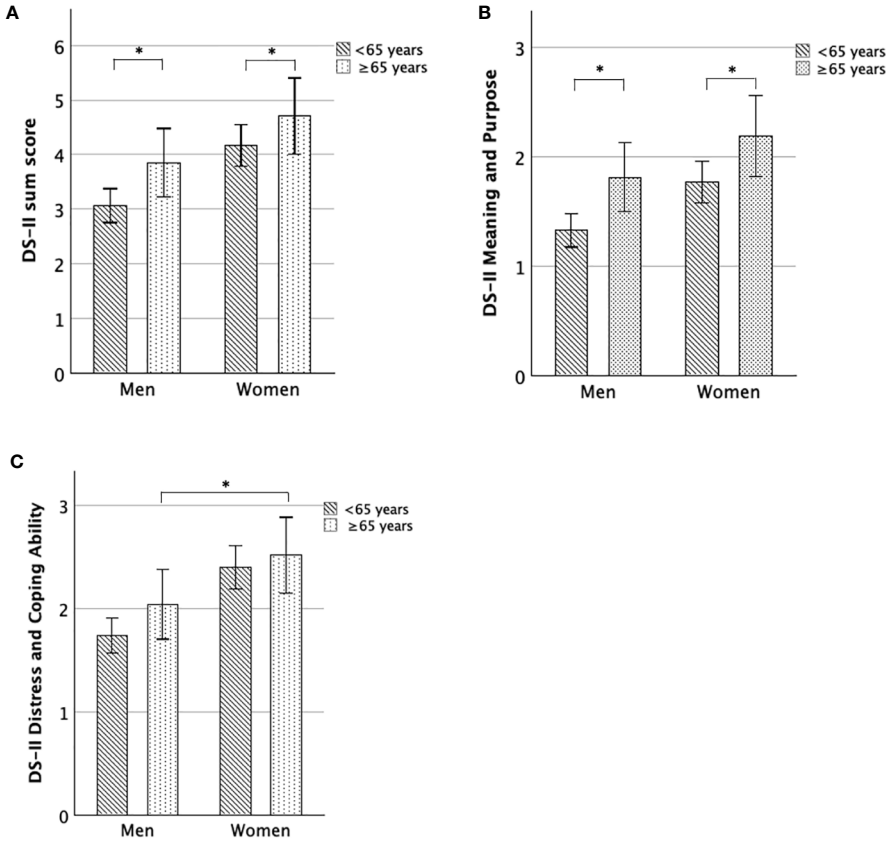

FIGURE 3
DS-II scores for women and men, comparing younger and older adulthood. **(A)** Mean DS-II sum score, **(B)** Mean DS-II Meaning and Purpose score, **(C)** Mean DS-II Distress and Coping Ability score. Error bars indicate 95% CI. *significant at the 0.05-level.

Notably, as far more oldest men lived in a partnership (45%) than oldest women (8%), the higher rate of oldest women living without a partner (e.g. due to widowhood) parallels the increase of DS-II scores in oldest women.

Discussion

In the current study, demoralization, which is a risk factor for suicide, was investigated in older adulthood (age ≥ 65 years) compared to younger adulthood (age < 65 years) using the DS-II in a representative sample of the German population.

This is the first study showing evidence for an increase in demoralization scores, specifically in the MaP subscale, from the younger to older adulthood and further from young-old and middle-old to old-old individuals within the general population. Furthermore, more than one-fourth of older individuals (age ≥ 65 years), and almost half of those aged 85+ years report increased demoralization (DS-II score > 5).

Most of previous empirical evidence regarding demoralization in older adulthood comes from clinical samples, in particular patients with cancer. Here, the findings for an effect of age on demoralization were mixed, showing either no association (39), a positive relationship (40) or a negative correlation (36, 41, 42) between age and demoralization, which might be influenced by treatment status (41). However, a recent meta-analysis including cancer patients with a mean age between about 50 and 68 years, and thus potentially biased by rather older participants, identified age as a risk factor for demoralization (43). This leads to the suggestion that the magnitude and directionality of an age effect on demoralization in cancer likely depend on the included age-groups. This idea is in line with our main study result that individuals ≥65 years suffer from increased demoralization when directly compared to all individuals aged <65 years which is in fact compatible with negative correlations between age and demoralization that might be observed within the range of younger adulthood, as already cautiously indicated by a previous report (37).

Yet, demoralization has rarely been studied in general populations or community-based samples. There is only one study that applied the former version of the DS-II, the DS-I, in a survey of a representative sample of the German general population. Here, in contrast to the results of the present study, subjects > 70 years did not show higher demoralization than younger age-groups (38). The reason for the inconsistency remains unclear as both studies applied similar methods. However, there is some support for the idea that the COVID-19 pandemic during which the survey was performed might account for the increase of demoralization in older adulthood in our study sample. Botto et al. (44) applied the DS-I in a sample of Italian citizens during the Italian quarantine due

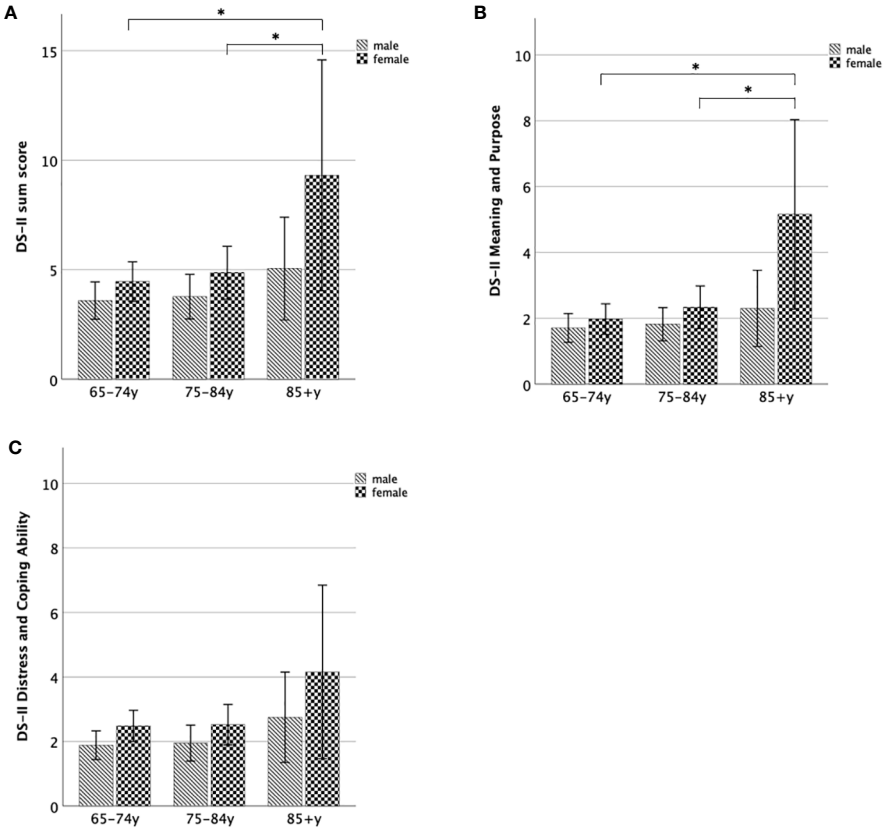

FIGURE 4
DS-II scores for women and men within subgroups of older adulthood. **(A)** Mean DS-II sum score, **(B)** Mean DS-II Meaning and Purpose score, **(C)** Mean DS-II Distress and Coping Ability score. Error bars indicate 95% CI. *significant at the 0.05-level.

to COVID-19 pandemic. Indeed, they found partially high DS-I subscores, and older and female individuals, among others, had an increased risk of heightened demoralization. However, here, the literature is inconsistent. Several studies investigated psychological distress during COVID-19 pandemic, showing that older adults experienced less stress and resilient coping (45) while other studies indicated that high psychological distress also occurred in the elderly (46).

Moreover, few studies reported demoralization scores in older adulthood (including clinical samples of older adulthood), showing mean scores that were still within normal range (47, 48). However these studies did not directly compare older to younger individuals with respect to mean demoralization scores (47, 48), limiting these results' impact on our research question.

Furthermore, we specifically found an increased MaP score in older adulthood, suggesting that older adults experience greater

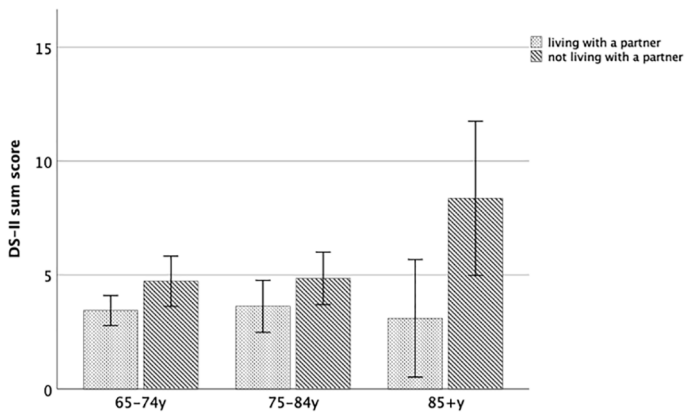

FIGURE 5
DS-II sum score with respect to partnership status within older adulthood. Error bars indicate 95% CI.

hopelessness, helplessness, a feeling of incompetence and a loss of purpose in life. This is in line with empirical evidence on demoralization-related constructs such as "meaning in life", showing a small age-associated decline in purpose in life which aggravates in older adulthood (49). On the other hand, the DaCA score remained stable until older adulthood, indicating that older adults are less affected by feelings of distress and irritability and a perceived inability to cope with life. This result is in line with a wealth of literature postulating that older adults are good in transforming perspectives and goals, avoid negative stimuli, cope with stressors, thereby invest in social relationships (50–52).

The result that old-old individuals showed significantly greater DS-II sum scores than young-old, and greater DS-II MaP scores than both young-old and middle-old, is a novel finding. It supports the notion that within older adulthood, demoralization increases, reaching a peak in the old-old.

Within older adulthood, old-old women reported significantly greater DS-II scores (sum score, MaP score) than young-old and middle-old women, while this was not observed in older men. This adds to the existing literature by showing that women not only generally show higher demoralization scores than men (37, 38) but the increase of demoralization seems to occur predominantly in older women but not older men. In contrast, there is one study that investigated demoralization scores based on the DS-I specifically in a community sample of elderly women (31). They compared old women with a history of suicidality (N = 31; age 61–84 years) with old women without a history of suicidality (control group; n = 31; age 54–84 years) that were matched according to sociodemographic factors. The study found substantially increased demoralization scores in the suicidality group but a mean score within normal limits in the control group. These results however cannot directly be compared to our findings. First, our sample of the older adults was much larger (n = 545) and representative compared to the control group in that study. Second, specifically the old-old women showed the highest demoralization scores in our study, and this age group was not included in the study from Lau et al. (31).

What sociodemographic factors drive demoralization in older adulthood and particularly in older women? In the present study, we investigated whether sociodemographic factors such as income, education, or partnership had an impact on DS-II scores. Indeed, within older adulthood, partnership was the only factor beyond age and gender that remained in the final regression model, explaining about 2% of the total DS-II variance. Importantly, specifically in the oldest old (85+y), living with a partner protected from demoralization and most old-old women were not living with a partner, suggesting that the loss of partnership might explain a large part of old women's increase of demoralization. This result is well in line with the higher life expectancy of women leading to a greater proportion of women living alone compared to men.

An increase of demoralization in older adulthood parallels findings of higher prevalence of major depression (53, 54), subclinical depression (55, 56) and completed suicides (3) in older adults. Importantly, existing literature in patients with chronic diseases indicate that demoralization can be partly distinct from depression and that demoralization is further known to be a major risk factor for suicidality independent of depression (24, 25). Notably, several studies found that the frequency of depression as the reason for suicide declines in older adulthood, suggesting that depression cannot sufficiently explain increasing suicide rates in older adulthood. Such findings in the context of increasing demoralization scores in older adulthood led us to the suggestion that demoralization could play a role. Indeed, several studies have found an association between demoralization and risk for suicide in specific populations (30–33). And widowhood has been acknowledged as a major risk factor for suicide in older adulthood (11, 15, 16) while not having a partner was also a crucial factor for demoralization in older adults in our present study. Furthermore, particularly the old-old individuals more frequently suffer from physical illnesses or just struggle with age-related normal physical changes (57) which is related to demoralization (58). Future studies should directly test whether experiencing age-related physical (and cognitive) decline might predispose to a demoralized state and whether this can explain part of the heightened risk for suicide in older adulthood.

While almost 20% of the old-old adults report demoralization syndrome (DS-II score > 12), only 0.9% of individuals 70–79 years and 0.0% of those aged 90+ years compared to 13.2% of young adults (18–29 years) receive psychotherapeutic treatment (59). Yet, evidence for the effectiveness of meaning-centered interventions in reducing demoralization is limited to patients with cancer (60, 62) but its effects on the broader target group of older adults remains unclear. As techniques of meaning-centered interventions may be implemented within few sessions and have positive effects on distress, anxiety and depression in patients with a terminal illness (27, 61) we suggest that therapists treating older adults should strongly consider incorporating such interventions into their psychotherapeutic programs. However, whether offering meaning-centered interventions to older adults can be generally recommended should be tested in future clinical trials broadly applying such techniques to older adults.

The present study has several limitations. First, while we analyzed a large sample size of older adults (N = 545), the number of included individuals aged ≥ 85 years was small (N = 33), which might limit the generalizability. Future studies could include a wider range of elderly subgroups so that effects of several psychosocial factors can be explored. A strength is that the study sample was recruited through a multistage random selection process aimed to ensure a representative sample of the German population. Second, in the present study, important related aspects such as depression, suicide ideation or behavior, and social support were not assessed so we cannot draw conclusions on the direct relationship with DS-II scores. These factors should be investigated in future studies. Third, the cross-sectional design precludes the determination of causality; future studies could adopt longitudinal designs for a better understanding of the directionality of these relationships.

In conclusion, the results of the present study indicate that demoralization is a major concern in older adults which is related to socio-environmental factors (widowhood, social isolation) and further might represent a consequence of dealing with (normal) physical changes, which is a crucial developmental task in the age-group ≥ 65 years.

Our data suggest that professionals working with older adults should consider demoralization as a complicating comorbidity more frequently occurring in the old-old. Screening for demoralization using self-report scales and adequate psychotherapeutic interventions should then be offered.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics committee University Leipzig, 04103 Leipzig. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MR: Conceptualization, Formal analysis, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. JJ: Writing – review & editing. PL: Writing – original draft, Writing – review & editing. LJ: Writing – review & editing, Supervision. GH: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Writing – original draft, Writing – review & editing. RC: Formal analysis, Methodology, Validation, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Psychiatry

TYPE Brief Research Report
PUBLISHED 17 June 2024
DOI 10.3389/fpsyt.2024.1425371

OPEN ACCESS

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RECEIVED 29 April 2024
ACCEPTED 03 June 2024
PUBLISHED 17 June 2024

CITATION
Chan EC, Conlon K and Gagnon L (2024) Risk factors and methods in suicides of elderly patients connected to mental health services from 1999–2024.
Front. Psychiatry 15:1425371.
doi: 10.3389/fpsyt.2024.1425371

Risk factors and methods in suicides of elderly patients connected to mental health services from 1999–2024

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Introduction: Suicide prevention is an important aspect of psychiatric care, with older men being a population identified at especially high suicide risk and a recent increase in suicides among older women.

Methods: Using data collected by the region's quality assurance team, we examined all suicide deaths occurring between March 1999 and February 2024 in patients aged 60 years or older who were connected to the region's Addiction and Mental Health Program at the time of death. Data were analyzed to describe which factors were most commonly identified in suicides in older adults receiving mental healthcare. We also compared male and female cases to determine whether certain factors were more commonly observed in one gender.

Results: We identified 48 cases of suicide occurring in patients aged 60 or over. 60% of suicides occurred in males. Overdose and hanging were the most common suicide methods used, and all suicides occurring on inpatient units occurred via hanging. Depression was the most common diagnosis, and was diagnosed more frequently in suicides of female older adults. A greater proportion of suicides in older women were associated with previous history of suicide attempts.

Discussion: Our findings support many current best practices for suicide prevention in psychiatric care, including minimizing ligatures and anchor points on inpatient settings, assessing for and limiting access to means in individuals at-risk, and assessing suicide risk in hospitalized patients prior to passes and discharge. Recognition and treatment of depression remain important aspects in the treatment of older adults to prevent suicide.

KEYWORDS

suicide, depression, elderly, psychiatric services, suicide risk factors, suicide methods, psychiatric hospitalization

1 Introduction

Suicide prevention is an important aspect of the psychiatric care of the elderly, with older men in particular being a group often identified as at especially high risk. In 2019, males aged 85 to 89 years were the sex and age group with the highest rate of suicide at 27.7 per 100,000 population and males aged 90 years and older had the highest rate in 2020 at 20.3 per 100,000 (1). Furthermore, among women in the U.S., the only significant increase in suicides between 2020 and 2021 occurred in the population aged 75 and over (2).

Psychiatric disorders, non-psychiatric medical illnesses, social isolation, substance use, and recent loss/adverse events have been identified as risk factors of suicide in the general older age population (3, 4). Depression is the most common psychiatric diagnosis occurring in older adults who died from suicide, being especially common in women receiving mental healthcare at the time of death (5). The presence of non-psychiatric medical illness is also common in suicides occurring in older adults, in particular among older men (4, 6).

While many older adult suicides occur in individuals with no psychiatric diagnosis or contact with mental health services, involvement with mental health services is still common, occurring in more than 30% of suicides in older women and more than 20% of suicides in older men (4, 5). Of note, the presence of non-psychiatric medical illness is more common in older adult suicides without known mental illness (4). Likewise, the use of firearms is less common in cases without depression or known mental illness (4, 5). Contact with mental health services is an important opportunity to take steps to assess for and address factors contributing to suicide risk. Consequently, an understanding of the unique factors associated with suicide in older adults in the mental healthcare system is important in improving suicide prevention efforts.

To describe the factors associated with suicide in older adults receiving mental healthcare services, we analyzed data collected by the quality assurance team in Calgary, Canada on suicides occurring in older adult patients connected due the region's Addiction and Mental Health Program at the time of death. Our aim is to identify which factors are most common, to inform our understanding of interventions that can be developed within the mental healthcare system, and to identify differences that may exist between genders in this setting.

2 Methods

This study examines suicide deaths occurring in elderly patients receiving psychiatric care between March 1999 (when the quality assurance team began collecting these data) and February 2024. We examined all deaths from suicide occurring in patients aged 60 years or older who were receiving care from services within the municipal region's Addiction and Mental Health Program at the time of death. Cases include patients who died from suicide:

- While followed by an outpatient addiction and mental health program.
- While on a waitlist for an outpatient addiction and mental health program.
- Seen by a psychiatric emergency services team in the emergency department in the 72 hours prior to death.
- While admitted to a psychiatric unit.
- In the month following a psychiatric admission.
- After being seen by the psychiatric consultation liaison team while admitted to another medical service within the 30 days prior to death.

The quality assurance team was alerted to possible suicides by clinical services involved in the patient's care (both psychiatric and non-psychiatric services such as intensive care), family members of the individual, and/or the medical examiner's office.

Data on the date of death, clinical service most recently involved in the patient's care, gender, age, ethnicity, marital status, employment status, psychiatric diagnosis, history of substance use, history of suicide attempts and self-harm, presence of social isolation, and events preceding death from suicide were collected by the quality assurance team. These factors were chosen given their previous association with suicide risk in various studies, including studies of suicide in older adults (3, 4). These data were obtained through various sources, including review of discharge summaries, psychiatric assessments, progress notes, and notes obtained from collateral sources by the treatment team that had been managing the patient's care. The primary diagnosis and all other diagnoses were identified from the most recent comprehensive psychiatric assessment or discharge summary. Information on suicide method was obtained through the medical examiner's report or information provided to the quality assurance team by the individual's loved one.

Data was analyzed using IBM SPSS version 29.0.0.0 (241) to describe the demographic characteristics of cases identified, as well as the most recent care setting, suicide method used and presence/absence of adverse life events identified in the period preceding death. To determine whether an association existed between gender and marital status, employment status, suicide method, presence of adverse events in the preceding 6 months, psychiatric diagnosis, history of substance use disorder and history of self-harm/suicide attempt, Fisher's exact test. This test was selected as it can be used for small sample sizes such as the sample used in this study.

3 Results

In total, we identified 48 cases of suicide occurring in patients aged 60 or over. No statistically significant association between gender and variables listed above was identified when performing Fisher's Exact Test, however the small sample size limits our ability to interpret this. Some patterns were observed in which there was a greater than 10% difference in proportion within each gender with certain characteristics and these are reported to inform future studies. Detailed results can be found in Supplementary Appendix 1.

3.1 Demographic characteristics

Demographic characteristics of suicide deaths are described in Table 1. 29/48 (60%) of suicide deaths occurred in males. The

TABLE 1 Demographic factors.

	n (%)
Total	48
Gender	
Female	19 (40%)
Male	29 (60%)
Age at time of death (years)	
60 - 69	34 (71%)
70 – 79	9 (19%)
80 – 89	3 (6%)
90 +	2 (4%)
Ethnicity	
Caucasian	44 (91.7%)
Hispanic	1 (2.1%)
Southeast Asian	1 (2.1%)
East Asian	1 (2.1%)
Jewish	1 (2.1%)
Marital status	
Married	22 (46%)
Single	7 (15%)
Divorced	10 (21%)
Separated	3 (6%)
Widowed	6 (13%)
Employment status	
Unemployed	13 (27%)
Unemployed with disability income	4 (8%)
Partially employed with disability income	1 (2%)
Employed	3 (6%)
Retired	24 (50%)
Unknown	3 (6%)

TABLE 2 Treatment setting and suicide method.

	n (%)
Total	48
Most recent treatment setting	
Outpatient psychiatric management	27 (56%)
On waitlist for outpatient treatment	1 (2%)
Psychiatric inpatient	
Discharged by treatment team	2 (4%)
Discharged against medical advice	1 (2%)
On psychiatric unit	2 (4%)
Off-unit while admitted	1 (2%)
On weekend/overnight pass	6 (13%)
during admission	1 (2%)
Seen by consultation liaison team	2 (4%)
Assessed and discharged from ED	1 (2%)
Continuing care facility	4 (8%)
Addiction program	
Method	
Unknown	7 (15%)
Laceration	1 (2%)
Drowning	4 (8%)
Overdose	15 (31%)
Firearm	2 (4%)
Hanging	15 (31%)
Carbon Monoxide	1 (2%)
Fall from Height	2 (4%)
Asphyxiation	1 (2%)

majority (34/48; 71%) of suicide deaths occurred in patients aged 60 – 69. Notably, all five suicides occurring in patients 80 or older were male. Likewise, almost all (44/48; 91%) of patients were Caucasian, with four additional cases identified as Hispanic, Southeast Asian, East Asian, or Jewish.

Slightly less than half (22/48; 46%) of elderly patients that died from suicide were married, and roughly one quarter (13/48; 27%) were divorced or separated at the time of death. A greater proportion of females were married at time of death compared to males (Male: 38%; Female 58%). Half (24/48; 50%) of elderly patients that died from suicide were retired, and many were unemployed (13/48; 27%), unemployed with disability income (4/48; 8%) or partially employed with disability income (1/48; 2%) at the time of death.

3.2 Most recent treatment setting and suicide method

Data on the most recent treatment setting and suicide method are detailed in Table 2. Suicide deaths occurred in all treatment settings examined, with more than half (27/48; 56%) of suicide deaths occurring in patients receiving care in an outpatient psychiatric setting. Half of all suicide deaths associated with an inpatient psychiatric admission (admitted patient or recently discharged) occurred while the patient was on a weekend or overnight pass while admitted (6/12; 50%) and another quarter occurred in patients recently discharged.

Overdose and hanging were the most common suicide methods used in identified cases, with each method used in 15/48 (31%) of deaths. In 7/48 (15%) of cases, the suicide method was not identified in the quality assurance team record. Of note, hanging was the suicide method in both deaths that occurred on an inpatient psychiatric unit and in the suicide death occurring in a continuing care facility. While hanging and overdose were the two most common suicide methods for both genders, a greater proportion of males died from hanging (Male: 35%; Female: 26%) and a greater proportion of females died from overdose (Male: 24%; Female: 42%).

3.3 Adverse life events prior to death

45 cases had data recorded on whether adverse life events occurred in the 6 months preceding death, with details described in Table 3. Of the 45 cases with recorded data, 32 (71%) had adverse life events identified in the 6 months preceding death. Many patients had more than one adverse life event in the 6 months prior to death, with a newly identified medical issue (10/45; 22%) being the most common adverse event identified. Loss of an important social support was also frequently identified, and this may have occurred through severe illness or death of a loved one (6/45; 13%) or for other reasons (5/45; 11%) (ex. adult children travelling or moving away, physical impairments preventing

TABLE 3 Adverse life events in 6 months preceding death.

	n (%)
Total	45
Type of adverse life event in preceding 6 months	
Any adverse life event in preceding 6 months	32 (71%)
New medical issue	10 (22%)
Illness or death in loved one	6 (13%)
Loss of important social support for other reasons	5 (11%)
Loss of housing	6 (13%)
Financial stress	3 (7%)
Social conflict	1 (2%)

patient from participating in previous social activities, decreased contact with friends). While financial stress was only identified in 3 out of 45 cases (7%), loss of housing was identified as a stressor for 6 out of the 45 cases (13%). These data are summarized in Table 3.

When examining whether social isolation or medical illness were present regardless of the time of onset, social isolation was identified in 30 out of 46 cases (65%) and any history of medical illness was identified in 34 out of 48 cases (71%). The proportion of cases with adverse life events in the preceding six months were similar between men and women. A slightly higher proportion of males had a history of medical illness (Male: 76%; Female: 63%).

3.4 Psychiatric history

Table 4 summarizes the frequencies of diagnosis in elderly patients that died from suicide. Each record had a single primary diagnosis but may have had multiple additional diagnoses listed. The number of cases with a history of substance use disorder or previous self-harm/suicide attempt is also included in Table 4.

Overall, a wide range of diagnoses were represented in cases of suicide in elderly patients, with depression being the most common primary diagnosis (23/48; 48%) and most common diagnosis overall (29/48; 60%). A history of substance use disorder (including alcohol use disorder) was identified in 14/48 (29%) of cases, including two cases in whom the most recent substance use occurred more than 3 months prior to death and four in which the most time of recent use was unknown. Nearly half (23/48; 48%) of cases had a history of suicide attempt or self-harm, with twelve of those cases having self-harm or a suicide attempt in the 3 months prior to death.

A greater proportion of males had a history of substance use (Male: 36%; Female: 21%) and had no history of previous self-harm or suicide attempts (Male: 50%; Female 39%). A higher proportion of females had a diagnosis of depression (Male: 52%; Female 74%), whereas a higher proportion of males had a diagnosis of adjustment disorder (Male: 21%; Female 0%) or grief/bereavement (Male: 10%; Female: 0%). A similar trend was observed for primary diagnoses, in which a much greater proportion of females had a primary diagnosis of depression than males (Male: 38%; Female: 63%). A greater proportion of females had a history of suicide attempts (Male: 46%; Female: 61%), especially in the preceding 3 months (Male: 23%; Female: 33%).

TABLE 4 Psychiatric history.

	n (%)
Total	48
Primary diagnosis	
Depression	23 (48%)
Bipolar disorder	3 (6%)
Adjustment disorder	3 (6%)
Schizophrenia or other psychotic disorder	4 (9%)
Anxiety	5 (11%)
Substance-related disorder	5 (11%)
Grief	2 (4%)
Cluster B personality disorder	1 (2%)
Dementia	1 (2%)
Somatoform disorder	1 (2%)
All diagnoses	
Depression	29 (60%)
Bipolar disorder	5 (10%)
Adjustment disorder	6 (13%)
Schizophrenia or other psychotic disorder	5 (10%)
Anxiety	9 (19%)
Substance-related disorder	8 (17%)
Grief	3 (6%)
Cluster B personality disorder	8 (17%)
Cluster C personality disorder	3 (6%)
Unspecified personality disorder	2 (4%)
Post-traumatic stress disorder	1 (2%)
Dementia	1 (2%)
Somatoform disorder	1 (2%)
Substance Use Disorder	
No	32 (67%)
Yes	14 (29%)
Unknown	2 (4%)
Previous Self-harm or Suicide Attempt	
No	21 (44%)
Within 3 months prior to death	12 (25%)
More than 3 months prior to death	9 (19%)
Yes, timeline unknown	2 (4%)
Unknown	4 (8%)

4 Discussion

Our findings are generally consistent with previous data on suicide in the elderly and suicide in patients receiving mental health services. In particular, we observe similar patterns in gender, ethnicity, recently identified medical illness, and diagnosis, with some differences in suicide method.

Similar to previous studies, males accounted for a greater proportion of suicides compared to females, though in our study a smaller proportion of cases were male (60% male) when compared to previous studies of suicide in older adults that reported proportions of 77% (7), 83.% (4), and 73% (6). This may be due to the decreased likelihood of men to seek help for mental health difficulties (8), leading to a lower proportion of men dying from suicide having previous contact with mental health services. These findings also suggest that a greater proportion of suicides in older women occur in the context of contact with mental health services, which is consistent with previous general population data in the U.S (5). Consequently, efforts to improve suicide prevention for older

women in the mental healthcare system may be especially effective in reducing suicide in this group.

Cases of suicide identified were predominantly Caucasian, which is similar to U.S. data on suicide in older adults from the National Violent Death Reporting System (4). Of note, while Indigenous populations are a group at particularly elevated risk of suicide in Canada (9), no cases in this study were identified as Indigenous. This may be due in part to mental health services' colonial roots, which negatively impact the willingness of Indigenous populations to engage with the system (9). It is also possible that patients may have been reluctant to identify as Indigenous, due to potential concerns on how this may impact the way they are treated. This in turn would lead to underrepresentation of Indigenous populations in data on suicide within mental health services.

Similar to other studies of suicide in older adults (4, 6), hanging was identified as one of the most common suicide methods. In this study, overdose was tied with hanging as the most common suicide method, which is similar to U.S. data (4) but differs from findings in a study in Italy (6). Both of the aforementioned studies identified firearms as a common suicide method overall, and more commonly used by men. In contrast, we only identified two cases of suicide in which firearms were used, though both cases occurred in men. This difference may be due to the difference in culture around firearms, especially in the U.S. where firearms were the most commonly used method (4). Furthermore, suicide risk assessment within mental healthcare settings typically involves asking about access to means. If a patient receiving mental health services is identified as at risk of suicide and has access to a firearm, steps may have been taken to limit this access at least in the interim period of elevated risk. This hypothesis is supported by a comparison of our findings to general population data from Statistics Canada, in which firearms were the third most commonly used method (16%) (10). The relatively smaller proportion of suicides arising from firearms in mental healthcare settings supports the importance of assessing for and limiting access to suicide means, especially firearms.

Our findings on suicide methods are similar to Statistics Canada data for all age groups, with hanging being the most common method in men and overdose being the most common method in women (10). Furthermore, we note that all suicides occurring in inpatient settings in our study occurred via hanging. As hanging has been identified as the most common method of suicide in inpatient settings in other studies (11, 12), our findings further demonstrate the importance of limiting access to potential ligatures and fixture points in inpatient settings. As three-quarters of suicide deaths among admitted/recently discharged patients occurred while the patient was on pass or recently discharged, our findings also indicate the importance of assessing suicide risk prior to patients leaving on passes and prior to discharge.

The presence of a non-psychiatric medical issue was identified in more than two-thirds of cases, with newly identified medical issues being the most common preceding adverse event. This is consistent with data on suicides in older adults in the community (4, 6), though we note that in our data newly identified medical illness was still only present in 22% of all cases, suggesting that, while it may often be a factor contributing to overall suicide risk, it is the major precipitant in only about one quarter of suicides. Previous data on suicides noted non-psychiatric health concerns as being more predominant in older men and mental health concerns as being more predominant in older women, and this was also suggested by our data, underscoring the importance of addressing mental health in older adults, especially men.

Depression was the most commonly identified diagnosis among all suicides, though older women were much more likely to have a diagnosis of depression than older men (both among all diagnoses and as primary diagnosis). Conversely, no older women had a diagnosis of adjustment disorder or grief/bereavement, though both diagnoses were present in cases of suicide in older men. Similar to men's lower engagement with mental health services noted above, it is possible that this reflects a difference in the manner that men and women engage with the mental healthcare system and/or the manner in which the mental healthcare system engages with male and female patients. It's possible that men are more likely to minimize the breadth, impact, or chronicity of mental health symptoms and/or that providers are more likely to underestimate the severity of symptoms that older men experience. Notably, a history of suicide attempts was much more common in suicides in older women compared to older men, with one-third having a suicide attempt in the preceding three months. This finding underlines the importance of assessing and accounting for recent suicide attempts especially in older women with depression. Previous studies examining suicide in older women suggest that physical activity and behavioral activation or other psychotherapeutic interventions may have been more effective than pharmacotherapy in reducing suicidality in this population (5), suggesting that it is essential that these treatments are readily available to this population in mental healthcare settings.

5 Conclusion

Our findings identify factors in cases of suicide in older adults receiving mental health services that are similar to those described in suicides in older adults in the general population and in patients with psychiatric hospitalizations. We identified a greater number of suicides in older males compared to older females, with the majority of cases being Caucasian. Hanging and overdose were the most common suicide methods used. Suicide involving firearms was less common when compared to general population data, potentially due to the routine assessment and restriction of access to means that occurs in mental healthcare treatment. The presence of non-psychiatric medical illness is common in cases of suicide in older adults and newly diagnosed medical illness is the most common adverse event occurring prior to suicide in this population. Depression was diagnosed less frequently in cases of suicide in older men when compared to suicide in older women, with more diagnoses of adjustment disorder or bereavement in cases of suicide in older men. A previous suicide attempt was more common in suicides in older women than in older men.

Our data supports many current best practices in suicide prevention, including minimizing ligatures and anchor points in inpatient psychiatric settings, assessing for and restricting access to means in at-risk patients receiving psychiatric assessment, and assessing suicide risk in hospitalized patients prior to passes and discharge.

Data availability statement

The datasets presented in this article are not readily available because they include data (such as age at time of death) that could be used to identify specific individuals, as well as details around individual circumstances of death. Requests to access the datasets should be directed to eric.chan1@ucalgary.ca.

Ethics statement

The studies involving humans were approved by Conjoint Health Research Ethics Board, University of Calgary (REB23-1089). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

EC: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal Analysis, Conceptualization. KC: Writing – review & editing, Investigation, Data curation. LG: Writing – review & editing, Supervision, Investigation.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This project was supported through start-up funding provided by the Department of Psychiatry at the University of Alberta and Alberta Health Services.

Acknowledgments

We would like to thank Alberta Health Services for their support of the Psychiatry Quality Assurance Team, who collected the data used in this study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1425371/full#supplementary-material

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frontiers | Frontiers in Psychiatry

TYPE Brief Research Report
PUBLISHED 25 July 2024
DOI 10.3389/fpsyt.2024.1354030

OPEN ACCESS

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RECEIVED 11 December 2023
ACCEPTED 11 July 2024
PUBLISHED 25 July 2024

CITATION
Corrêa Matias Pereira C, Najafi Moghaddam Gilani V and Nazif-Munoz JI (2024) A brief research report of suicide rates in the Brazilian elderly over a 12-year period: the lack of association of the "*Setembro Amarelo*" campaign for suicide prevention. *Front. Psychiatry* 15:1354030. doi: 10.3389/fpsyt.2024.1354030

A brief research report of suicide rates in the Brazilian elderly over a 12-year period: the lack of association of the "*Setembro Amarelo*" campaign for suicide prevention

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Objectives: Aiming to disseminate information related to suicide prevention in Brazil, the "*Setembro Amarelo*" campaign has been conducted since 2015. The objective of this study is to assess the association between this campaign and elderly suicide rates over a 12-year period.

Methods: Data were gathered from the Mortality Information System and the Notifiable Diseases Information System, established by public institutions in Brazil. An interrupted time-series framework was applied to assess the association between the "*Setembro Amarelo*" campaign and suicide mortality rates in the elderly population (60 et plus) in the southeastern region of Brazil. We consider three monthly outcomes: all suicides, suicides in males and suicide in females. We operationalize the campaign assuming three effects: short-term, declining and sustained. The period of analysis was from 2011-2022.

Results: The suicide-mortality rate over time has remained stable; the average rate in the pre-campaign period was 0.028 and increased slightly to 0.035. Regardless of the campaign's operationalization and the outcome used, results show no significant associations between the campaign and elderly suicide rates. The campaign was associated with non-significant decreased effects of 15% (P=0.532) in the short term, and 16% (P=0.446) assuming the campaign was sustained.

Conclusions: There is a lack of association between the campaign and suicide rates, among the elderly in Brazil's southeastern region. As suicide is complex and multifactorial, more research is needed. The campaign, while raising awareness and reducing stigma, may not reduce suicides. To reduce the suicide rate in the elderly requires addressing social, economic and cultural factors, multisectoral interventions, and upholding basic human rights.

KEYWORDS

suicide, suicide prevention, public health, aged, health campaign, public policy, mortality

1 Introduction

The World Health Organization (WHO) underscores the alarming worldwide impact of suicide, with more than 700,000 deaths annually. Suicide prevention prominently features on the WHO's agenda and is integrated as an indicator in the United Nations' Sustainable Development Goals (1). Effective suicide prevention strategies require understanding of risk and protective factors across different life stages (2). Elderly individuals face the highest global suicide risk, with elevated lethality (3–6). Unique risk factors for this group include among others social isolation, bereavement, loss of social roles, debilitating illnesses, depression, loneliness, and access to lethal means (items that can be used in a suicide, such as firearms and certain drugs or toxic substances) (3–10). In general elderly individuals exhibit a heightened suicide rate, attributed to more lethal attempts (11, 12).To address prevention, there is an urgent need for comprehensive suicide prevention programs (SPP) involving diverse sectors such as health, education, social welfare, media and case notification, aiming to optimize tailored initiatives across contexts (2, 13, 14).

The rapid aging of the population underscores a pressing issue regarding the deteriorating epidemiological circumstances for older adults, as the provision of care, aid, and backing for this demographic fails to advance adequately in terms of speed, urgency, or scope. Among the specific challenges encountered by this demographic, especially in low and middle-income countries, is the prevalence of suicide (15–18). While the World Health Organization (WHO) marks the onset of old age at 65, as this may be indicative of potential retirement and eligibility for certain benefits, this age threshold may drop to 60 in areas with shorter life expectancies (19, 20). In Brazil, its Federal Law No. 8.842/1994, classifies individuals as elderly if they are 60 years of age or older (21). The suicide death rates of elderly in Brazil from 1996 to 2018 have increased by 162.2% (age group 60-69), 141.4% (70–79), and 189.3% (80 years and above) respectively (11). Overall, all Brazilian regions have experienced an increase of suicide rates in older adulthood from 1996 to 2018, with notable percentages in the North (81.1%), Northeast (126.5%), Southeast (26.6%), Central-West (28.5%) and South (17.8%) (11).

Studies conducted in Brazil have identified that the most frequent social reasons triggering suicide among the elderly include financial problems, unemployment, employment instability (e.g., farming, mining), relationship difficulties, family conflicts, social isolation, and loneliness (22–26). In general, the prevalence of male suicides is higher, associated with the fact that men are more competitive, impulsive, and have easier access to lethal means (27). Additionally, societal expectations within the Brazilian patriarchal culture, which cast men in the role of the primary provider for the family, further contribute to this phenomenon (27). Also, retirement, social exclusion and deprivation of social support, very common in the reality of the elderly, are linked to preliminary depression diagnoses and demoralization, important risk factors for suicide (28–30). In Brazil, there are scientific publications addressing aging and suicide in general; however, few focus on elderly suicide mortality, underscoring the need for further research on these topics within the country (4, 31–33).

In Brazil, in 2015, an initiative led by the Center for Valorization of Life (CVV- Brazilian helpline), the Federal Medical Council, and the Brazilian Psychiatric Association created a campaign called "*Setembro Amarelo*," (Yellow September), aimed at suicide prevention and raising awareness. While the campaign runs throughout the year, its concentrated events occur in September. Throughout this month, the campaign endeavors to raise societal awareness and disseminate information related to suicide prevention in the country. This includes organizing events to discuss mental health and suicide prevention, reducing stigma, sharing data on suicide rates, promoting help channels, distributing educational materials, providing specific training, and lighting national landmarks in yellow (34–36). A limited number of studies from Brazil (37–40) have endeavored to evaluate changes following the campaign's implementation. The impact of this campaign on suicide mortality rates, in this specific age-group, remains unexamined. The present study investigated Brazilian elderly suicide rates over a 12-year period, considering the launch and implementation of the "*Setembro Amarelo*" campaign.

2 Methods

2.1 Study design

We applied a quasi-experimental design by using an interrupted time-series (ITS) framework (41) spanning twelve years (2011 to 2022). We specifically assess the association between the "*Setembro Amarelo*" campaign and suicide mortality rates in the elderly population. We selected three outcomes: i) all suicides, ii) suicides in males and iii) suicide in females.

2.2 Data

We utilized publicly available and official information derived from the Brazilian Government. Data were extracted from the Mortality Information System (SIM) and the Notifiable Diseases Information System (SINAN), both established by the Brazilian Ministry of Health and accessible via the DATASUS online platform. This system functions through the systematic compilation of data concerning vital statistics, encompassing mortality and survival rates, as well as epidemiological and morbidity insights. We restricted our analysis to monthly suicide mortality rates for the southeastern region of Brazil, which encompasses São Paulo, Rio de Janeiro, Minas Gerais, and Espírito Santo. This dataset covers the years from 2011 to 2022. The database (case registration) for the SIM and SINAN was more complete in the southeast region, therefore, this region was chosen for the analyzed years. Additionally, we included data on

unemployment rates obtained from the International Labour Organization (ILO) for the same period, 2011 to 2022.

2.3 Study variables

2.3.1 Dependent variables

Counts of suicide mortality rates in the elderly population (Yij) and counts of suicides for male (YMij) and female (YWij) respectively, were derived from the total number of fatal self-inflicted injuries of individuals of 60 years and over, information gathered from the Brazilian Ministry of Health. We have included the classification according to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) (42), including ICD codes (X60 to X84), corresponding to Intentional self-harm. The rate was obtained by dividing the total number of individuals aged 60 and more, population numbers were gathered from the Brazilian census data.

2.3.2 Policy time-varying covariates

We operationalized "*Setembro Amarelo*" campaign, in three forms: i) *Short-term effect*: 0 for the years 2011 to 2014, 0 for January to August and for October to December for the years 2015 to 2022, and 1 for September for the years 2015 to 2022. We assumed this campaign was effective only during September since 2015; ii) *Declining effect*: 0 for the years 2011 to 2014, 0 for January to August and for December for the years 2015 to 2022, and since 2015 1, for Sep, 0.5 for October, and 0.25 for November. We assume this campaign was effective from September to November however its effect may have declined at the third month of implementation; iii) *Sustained effect*: 0 for the years 2011 to 2014, 0 for January to August and for December for the years 2015 to 2022, and since 2015 1 for the months of September, October, and November.

2.3.3 Control variables

In our study, we addressed the potential impact of seasonal variations by incorporating Fourier terms, using pairs of sine and cosine functions to model these patterns. Additionally, unemployment rates were included as a control variable. Specifically, these rates pertain to adults aged 60 years and older.

2.4 Statistical analysis

An extension of generalized linear models was employed, incorporating both the Poisson and Negative Binomial models. These models are well suited for the analysis of count data, such as number of suicides. The Poisson model is a reliable choice for modeling count data when events occur at a consistent rate over time. On the other hand, the Negative Binomial model offers flexibility and accounts for data over-dispersion, which is common when dealing with rare events like suicides. The use of the Poisson and Negative Binomial models within the ITS analysis ensures a thorough exploration of temporal patterns and trends, providing more nuanced insights into the connection between the campaign and suicide rates.

3 Results

Table 1 provides an overview of summary statistics regarding suicide mortality rates across all gender categories. Figures 1–3 present monthly time-series plots for the suicide mortality rates: all individuals, males, and females aged above 60 years old, respectively. Tables 2, 3 provide the results Poisson and the Negative Binomial models.

In Table 1, we observe that suicide mortality rates over time are relatively stable. Whereas the mean in the pre campaign period is 0.028 at the end of studied period the rate is slightly higher with 0.035. This trend is also observed in men and women respectively. Nevertheless, we observe differences across men and women rates. In the per period campaign men's rates were 0.038 and women's 0.020, and at the end of the analyzed period these rates were 0.048 and 0.024 respectively. Based on the results of Tables 2, 3, we fail to observe significant associations between the campaign and suicide mortality rates regardless of the campaign's operationalization and the outcome used. The decision to collapse the data for the declining and sustained effects was made due to their similar statistical outcomes in preliminary analyses, simplifying the presentation and focusing on the most significant findings. Results were robust after we included unemployment rates as well.

Our analysis of the association between unemployment rates and suicide rates showed variability by the model and demographic group. In the Poisson model, unemployment rates were not significantly associated with changes in suicide rates. However, the Negative Binomial model indicated a significant impact for all individuals and females, but not for males, suggesting differing economic effects across demographic groups. Statistical tests for stationarity confirmed the reliability of these findings. The Augmented Dickey-Fuller (ADF) tests showed that the series are stationary, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests indicated a presence of a stochastic trend at zero lags. These tests are detailed in the newly added Table 4, enhancing our understanding of the data's characteristics and the robustness of our analysis.

4 Discussion

In this quasi-experimental study, we observe no significant differences between three different operationalizations of the "*Setembro Amarelo*" campaign and suicide mortality rates in the elderly population in four Brazilian States: São Paulo, Rio de Janeiro, Minas Gerais, and Espírito Santo. This lack of association is observed regardless of the operationalization of the campaign and statistical method applied. Our analyses also indicate that the campaign was not necessarily effective when targeting men nor women specifically. While the World Health Organization recommends conducting awareness and prevention campaigns utilizing mass media to promote mental health, raise awareness, reduce mental health stigma, and disseminate information about support resources, these efforts should be accompanied with specific prevention interventions

10.3389/fpsyt.2024.1354030

TABLE 1 Monthly suicide rates per 100 000 population before, during and after three operationalizations of the "*Setembro Amarelo*" Campaign.

Period	Suicide rate (All)			Suicide rate (Male)			Suicide rate (Female)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Short-term effect									
Pre-Intervention	0.028	0.000	0.068	0.038	0.000	0.122	0.020	0.000	0.068
Intervention 1: Sep 2015	0.034	0.034	0.034	0.059	0.059	0.059	0.015	0.015	0.015
Post Intervention Year 1	0.029	0.008	0.051	0.040	0.019	0.078	0.020	0.000	0.045
Intervention 2: Sep 2016	0.008	0.008	0.008	0.000	0.000	0.000	0.014	0.014	0.014
Post Intervention Year 2	0.022	0.000	0.039	0.028	0.000	0.072	0.017	0.000	0.042
Intervention 3: Sep 2017	0.031	0.031	0.031	0.054	0.054	0.054	0.014	0.014	0.014
Post Intervention Year 3	0.027	0.000	0.055	0.040	0.000	0.069	0.017	0.000	0.056
Intervention 4: Sep 2018	0.015	0.015	0.015	0.000	0.000	0.000	0.027	0.027	0.027
Post Intervention Year 4	0.027	0.007	0.065	0.031	0.000	0.083	0.024	0.000	0.051
Intervention 5: Sep 2019	0.029	0.029	0.029	0.017	0.017	0.017	0.039	0.039	0.039
Post Intervention Year 5	0.020	0.000	0.044	0.026	0.000	0.064	0.015	0.000	0.039
Intervention 6: Sep 2020	0.021	0.021	0.021	0.016	0.016	0.016	0.025	0.025	0.025
Post Intervention Year 6	0.019	0.000	0.042	0.023	0.000	0.064	0.018	0.000	0.039
Intervention 7: Sep 2021	0.013	0.013	0.013	0.000	0.000	0.000	0.024	0.024	0.024
Post Intervention year7	0.034	0.006	0.067	0.047	0.000	0.104	0.024	0.000	0.060
Declining effect or Sustained effect									
Pre-Intervention	0.028	0.000	0.068	0.038	0.000	0.122	0.020	0.000	0.068
Intervention 1: Sep, Oct, Nov 2015	0.040	0.034	0.051	0.052	0.020	0.078	0.030	0.015	0.045
Post Intervention Year 1	0.026	0.008	0.041	0.038	0.019	0.078	0.016	0.000	0.043
Intervention 2: Sep, Oct, Nov 2016	0.014	0.000	0.033	0.019	0.000	0.056	0.010	0.000	0.014
Post Intervention Year 2	0.023	0.000	0.039	0.028	0.000	0.072	0.019	0.000	0.042
Intervention 3: Sep, Oct, Nov 2017	0.034	0.016	0.055	0.048	0.036	0.054	0.023	0.000	0.056
Post Intervention Year 3	0.025	0.000	0.053	0.025	0.000	0.053	0.015	0.000	0.040
Intervention 4: Sep, Oct, Nov 2018	0.018	0.008	0.030	0.017	0.000	0.035	0.017	0.000	0.035
Post Intervention Year 4	0.028	0.007	0.065	0.032	0.000	0.083	0.026	0.013	0.051
Intervention 5: Sep, Oct, Nov 2019	0.012	0.000	0.029	0.006	0.000	0.017	0.017	0.000	0.039
Post Intervention Year 5	0.023	0.007	0.044	0.032	0.016	0.064	0.017	0.000	0.039
Intervention 6: Sep, Oct, Nov 2020	0.026	0.014	0.042	0.032	0.016	0.064	0.021	0.012	0.025
Post Intervention Year 6	0.017	0.000	0.034	0.019	0.000	0.032	0.015	0.000	0.036
Intervention 7: Sep, Oct, Nov 2021	0.025	0.013	0.040	0.026	0.000	0.046	0.024	0.012	0.036
Post Intervention Year 7	0.035	0.006	0.067	0.048	0.000	0.104	0.025	0.000	0.060

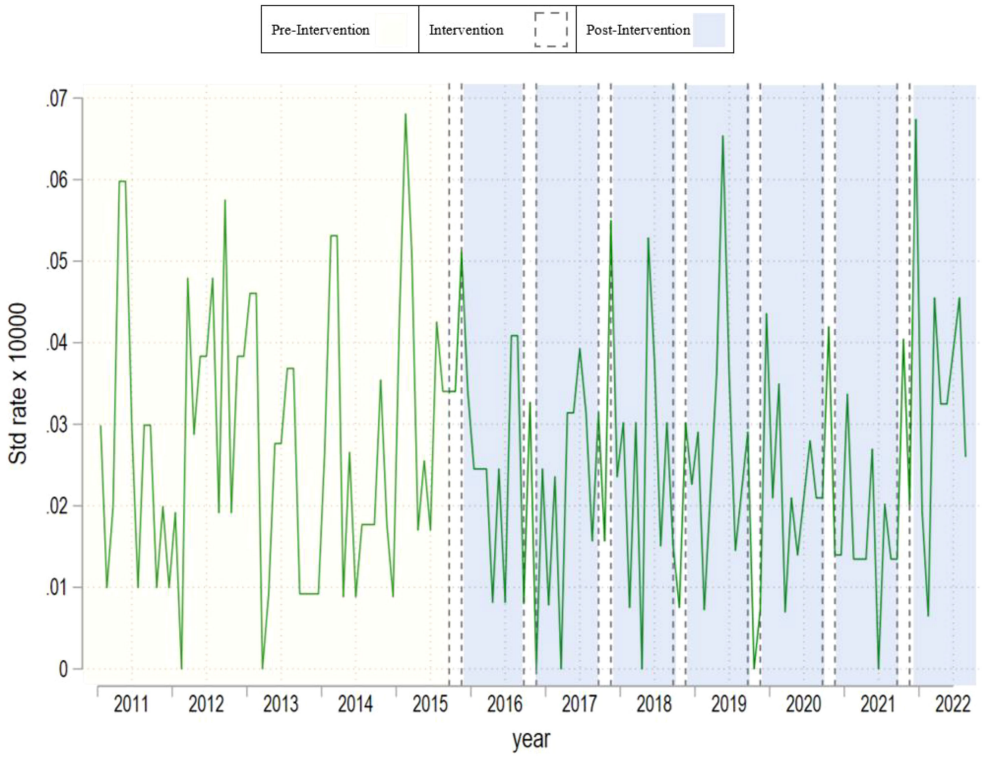

FIGURE 1
Monthly time–series plot for suicide rate of all individuals aged above 60 years old.

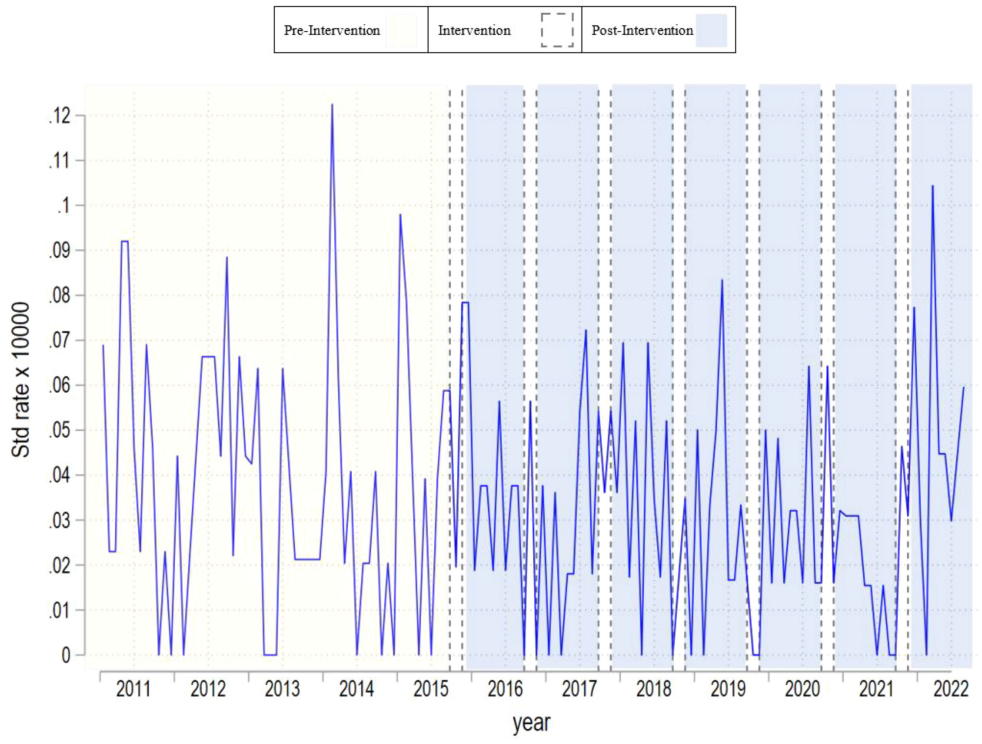

FIGURE 2
Monthly time–series plot for suicide rate of males aged above 60 years old.

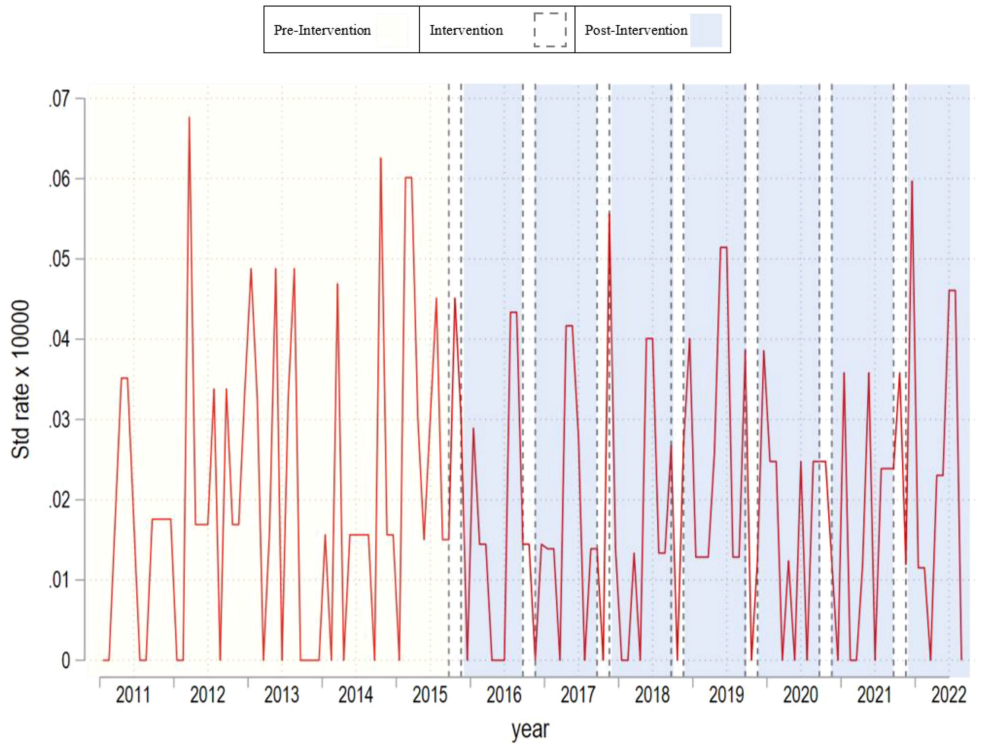

FIGURE 3
Monthly time–series plot for suicide rate of females aged above 60 years old.

(6, 43). Indeed, sparsely evaluated outcomes of suicide prevention campaigns have demonstrated contradictory and inconsistent results (43, 44), with positive effects on awareness and help-seeking (43–45), or the need for caution when developing strategies because of prejudice, misinformation and questioning how to reach vulnerable populations not considered in more consistent prevention efforts (44, 46).

Our study partially aligns with at least three studies developed in Brazil. First, a time-series study analyzed the temporal pattern of suicide mortality in the state of Ceará between 2009 and 2019. The study observed that the population aged 60 to 79 experienced a stabilization in suicide rates, raising questions about the campaign's potential impact in this age group within this state (38). A second study conducted to identify changes following the implementation of "*Setembro Amarelo*", in the Brazilian population, revealed that suicide-related incidence rates showed an upward trend after the program's implementation. The suicide rate increased by 66.6% (37). Third, an interrupted time series study analyzed the evolution of elderly suicide rates in Brazil between 2011 and 2019 (30), observing a 14.3% increase in suicide rates after the campaign was implemented. These results raised considerable questions as to whether this increment was due to an adverse effect of the campaign's implementation or a result of more effective case reporting (37).

The following elements are necessary to interpret our results. First, while there are guidelines issued by the Brazilian Psychiatric Association (47), based on international guidelines, on how to safely communicate or address suicidal behavior, many recommendations may not be followed. More specifically, the campaign may lack multi-sectoral actions, establishing an assistance network, implementing longitudinal strategies for monitoring at-risk groups (i.e. men, or elderly), as well as offering training and professional development opportunities (39). Relatedly, in September, the Brazilian campaign may lead many to discuss the topic of suicide, however, taking preventive actions and ensuring secure communication about suicide requires a more nuanced approach to avoid the risk of contagion (38, 48).

Second, suicide is generally underreported more than other causes of death, a trend that intensifies when concerning the elderly (2, 49–51). Death certificate data may be underreported due to various factors, including differing professional perspectives and training regarding their completion. Suspected suicide cases may be recorded as accidental poisonings or other external causes of mortality. Numerous taboos (for religious, cultural, or other reasons) and bureaucratic challenges, such as idealized post-mortem perceptions, life insurance implications, and the need for accurate cause of death, contribute to this context. Overcoming underreporting is crucial to enable reliable epidemiological analyses and, consequently, to inform effective care strategies (4, 52, 53). Two Brazilian studies analyzing suicide notifications after the campaign found no changes regarding self-harm case notifications; it may have even triggered the opposite effect as increases in cases in October compared to August were observed (37, 40).

Third, public campaigns aimed at preventing suicide among the elderly effectively should include widespread societal efforts on mental health and suicide awareness, information about help seeking, investing in access policies to mental health professionals

TABLE 2 Poisson model results for suicide rate of all types of gender groups.

Period	Suicide rate (All)			Suicide rate (Male)			Suicide rate (Female)		
	IRR	95%CI	P-Value	IRR	95%CI	P-Value	IRR	95%CI	P-Value
Short-term effect	0.85	0.53 1.38	0.532	0.62	0.29 1.30	0.212	1.18	0.64 2.16	0.588
Unemployment rate	0.85	0.72 1.02	0.091	0.94	0.78 1.12	0.522	0.80	0.62 1.02	0.075
Time	1.00	0.99 1.00	0.315	0.99	0.99 1.00	0.770	1.00	0.99 1.01	0.103
Seasonal Trend (cos)	0.94	0.82 1.08	0.420	0.98	0.82 1.17	0.892	0.88	0.72 1.09	0.264
Seasonal Trend (sin)	1.02	0.88 1.19	0.729	1.05	0.86 1.27	0.606	0.98	0.77 1.25	0.907
MLE	-282.83			-234.99			-210.40		
AIC	4.09			3.41			3.06		
BIC	-501.84			-502.44			-499.93		
Declining effect	1.02	0.92 1.14	0.606	0.82	0.56 1.20	0.318	1.00	0.67 1.49	0.996
Unemployment rate	1.30	1.28 1.32	0.000	0.93	0.77 1.11	0.432	0.80	0.63 1.02	0.077
Time	0.99	0.99 0.99	0.000	0.99	0.99 1.00	0.894	1.00	0.99 1.01	0.103
Seasonal Trend (cos)	0.93	0.81 1.09	0.396	0.98	0.81 1.19	0.878	.87	0.69 1.09	0.245
Seasonal Trend (sin)	1.04	0.87 1.26	0.607	1.09	0.87 1.37	0.440	.97	0.73 1.29	0.874
MLE		-213.18		-235.64			-210.55		
AIC		3.10		3.42			3.06		
BIC		-641.13		-501.13			-499.63		
Sustained effect	0.84	0.54 1.30	0.446	0.67	0.36 1.23	0.197	1.07	0.60 1.92	0.808
Unemployment rate	0.85	0.71 1.02	0.082	0.93	0.78 1.11	0.467	0.80	0.63 1.02	0.078
Time	1.00	0.99 1.00	0.281	0.99	0.99 1.00	0.868	1.00	0.99 1.01	0.107
Seasonal Trend (cos)	0.94	0.81 1.08	0.420	0.99	0.83 1.19	0.981	0.87	0.71 1.07	0.212
Seasonal Trend (sin)	1.03	0.87 1.23	0.682	1.05	0.85 1.31	0.623	1.01	0.76 1.31	0.992
MLE		-282.72			-235.23		-210.52		
AIC		4.09			3.41		3.06		
BIC		-502.06			-501.96		-499.69		

and therapists, proactive engagement with psychiatric patients following discharge or a suicidal crisis, integration with primary health care services, fiscal support from professionals, social cohesion via social media, targeted online discussion forums for the elderly, telephone helplines, community integration interventions to combat loneliness, and public health messages emphasizing the importance of social involvement for all older individuals (4, 54–57). Particular attention to reducing stigma in the elderly should be considered in these campaigns. Indeed, the elderly often do not recognize or seek help for mental illness due to stigma, seeing it as a weakness and fearing the loss of independence. Tackling stigma needs focused efforts through professional training, public education, media collaboration, and inclusion in health and social care programs to encourage help-seeking and community integration (58, 59). Much of these elements have not been considered in the "*Setembro Amarelo*" campaigns and therefore next versions of this campaign should discern some of these strategies to target elderly more properly (47, 48).

Fourth, in addition to the need for interventions tailored to different life stages, it is also crucial to develop gender-specific interventions. Studies indicate that women are more likely to seek healthcare services, exhibit better coping with stigma, prejudice, and taboos compared to men, resulting in increased access to mental health services for this population (60, 61). Furthermore, social roles, such as being mothers and grandmothers, are often viewed differently for men. Men, traditionally seen as providers, tend to lose this role as they age. The loss of this social role represents a significant risk factor for suicide in the elderly, that is why socioeconomic issues, including economic crises, unemployment, and reductions in personal income, are significant risk factors, especially among men (33, 60, 61). Studies conducted in Brazil corroborate the international literature, as it is believed that men exhibit more competitive and impulsive behaviors than women, along with higher substance abuse rates, including alcohol and drug consumption (4, 62).

Last, suicide, in Brazil as a social phenomenon, must account for religious practices (63). In this country, most individuals claim a religious affiliation and consider religion a significant aspect of their

10.3389/fpsyt.2024.1354030

TABLE 3 Negative binomial model results for suicide rate of all types of gender groups.

Period	Suicide rate (All)			Suicide rate (Male)			Suicide rate (Female)		
	IRR	95%CI	P-Value	IRR	95%CI	P-Value	IRR	95%CI	P-Value
Short-term effect	1.03	0.51 1.56	0.901	0.59	0.00 1.37	0.309	1.59	0.72 2.11	0.248
Unemployment rate	0.82	0.64 1.00	0.040	0.92	0.74 1.10	0.423	0.76	0.52 0.99	0.045
Time	1.00	0.99 1.00	0.206	0.99	0.99 1.00	0.863	1.00	0.99 1.01	0.079
Seasonal Trend (cos)	0.92	0.79 1.05	0.223	0.98	0.81 1.15	0.797	0.84	0.65 1.04	0.135
Seasonal Trend (sin)	1.06	0.92 1.22	0.381	0.93	0.88 1.25	0.495	1.03	0.81 1.26	0.767
MLE	-280.76			-234.26			-207.53		
χ^2	0.37			0.50			0.23		
Declining effect	1.12	0.71 1.53	0.562	1.03	0.49 1.57	0.906	1.16	0.57 1.77	0.582
Unemployment rate	0.81	0.63 0.99	0.034	0.91	0.74 1.09	0.346	0.76	0.52 1.00	0.050
Time	1.00	0.99 1.00	0.220	0.99	0.99 1.00	0.875	1.00	0.99 1.00	0.093
Seasonal Trend (cos)	0.89	0.74 1.04	0.179	0.97	0.77 1.16	0.748	0.83	0.61 1.04	0.116
Seasonal Trend (sin)	1.09	0.82 1.27	0.290	1.11	0.88 1.25	0.335	1.03	0.77 1.30	0.811
MLE	-280.60			-234.81			-208.01		
χ^2	0.34			0.63			0.31		
Sustained effect	1.12	0.57 1.68	0.660	0.81	0.06 1.57	0.636	1.39	0.62 2.18	0.321
Unemployment rate	0.81	0.63 0.99	0.036	0.92	0.74 1.10	0.389	0.75	0.51 0.99	0.045
Time	1.00	0.99 1.00	0.205	0.99	0.99 1.00	0.898	1.00	0.99 1.00	0.089
Seasonal Trend (cos)	0.91	0.77 1.04	0.198	0.98	0.81 1.16	0.862	0.83	0.63 1.03	0.096
Seasonal Trend (sin)	1.08	0.91 1.25	0.326	1.07	0.89 1.25	0.496	1.05	0.79 1.31	0.658
MLE		-280.68		-234.70			-207.68		
χ^2		0.35		0.61			0.25		

existence (64, 65). The relationship between religion and suicidal behavior is complex and it needs more research in different cultures and religious backgrounds, as it can offer both protective factors, (e.g. coping mechanism and support system) and risk elements (e.g. assigning all life responsibility to God, blaming spiritual beliefs for failures when feeling forsaken, and interpreting stressors as either divine retribution or the influence of "evil forces.") (66–70). For the elderly, spirituality and religiosity have been linked to improved quality of life and mental health promotion promising valuable contributions to geriatric psychiatry effective interventions and campaigns (71, 72). The extent to which "*Setembro Amarelo*" should consider religious aspects in its messages is something that should be studied further.

Our study should consider the following limitations to better temper the implication of its results. First, a large range of suicide risk factors and regional inequalities play significant roles in Brazil (33). Indeed, this country is characterized by multiple cultures and deep social inequalities, emphasizing that our findings cannot be generalized to the entire nation. It may be the case that in other regions, the campaign was effective not only in the elderly population but in others too. Our results suggest thus the identification of region-specific public policies to properly assess the extent to which this campaign may have not been effective (33). Secondly, to analyze suicide mortality rates and the "*Setembro Amarelo*" campaign, it is essential to consider case notification challenges, a prevalent issue in several countries, including Brazil, where underreporting in official

TABLE 4 Results of Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Tests.

Suicide rate	Augmented Dickey-Fuller (ADF)				Lag order of Kwiatkowski-Phillips-Schmidt-Shin (KPSS)				
	Test Statistic	1%	5%	10%	0	1	2	3	4
Male	-7.620	-3.497	-2.887	-2.557	0.0437	0.0400	0.0383	0.0397	0.0411
Female	-7.620	-3.497	-2.887	-2.557	0.0488	0.0469	0.0443	0.0432	0.0425
Total	-7.620	-3.497	-2.887	-2.557	0.0367	0.0360	0.0394	0.0431	0.0448

records maybe prevalent (4, 38). Suicide statistics result from a complex process involving various stages, including reports from family members, witnesses, physicians, law enforcement, coroners, and statisticians. Due to these procedural intricacies, data may be distorted throughout, particularly in regions where social, economic, cultural, and religious factors contribute to the stigma surrounding suicidal behavior (38, 52). Third, while we used different operationalizations to understand the potential impact of the campaign, our application considered the overall post period after the campaign was implemented. So, we did not study if there were specific years in which the campaign could have been more effective. Last, while suicide is a multifactorial phenomenon, our study only covered specific results in terms of sex, and some models also included the variable unemployment—which was robust to our main results. As this is the first study in the elderly population, and no significant associations were found in this region, one potential explanation could be a more consistent network of social support and better access to health services for the elderly. However, this should be tested with other variables, such as family composition, state programs, and health services designed to support this population. Nevertheless, other factors such as socioeconomic status or marital status, which have been consistently associated with suicide outcomes were not considered and therefore other analyses are necessary to better understand the potential impact of this campaign in other subgroups of the elderly population in Brazil.

5 Conclusion

To our knowledge, this is the first study to assess the impact of the "*Setembro Amarelo*" campaign on suicide rates among the elderly population in Brazil's Southeast region. Regardless of the campaign's operationalization and the outcome used, no significant variation was observed. It is important to emphasize that suicide is a complex and multifactorial phenomenon. Therefore, the campaign alone, which aims to raise awareness and reduce stigma related to mental health promotion and suicide prevention, requires other actions to effectively tackle suicides at the population level.

We emphasize the importance of developing more scientific research and public policies for suicide prevention in Brazil, based on scientific knowledge, culturally adapted, focused on different stages of the life cycle, as well as sex and gender-specific interventions. Public policies, regardless of their format, need to be evaluated and planned to achieve continuous interventions, not limited to specific campaign months, as suicide is a public health issue that occurs daily in Brazil and around the world.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/fruf.def Official morbimortality data in Brazil are made available by DATASUS - Information Technology Department of the Brazilian Public Health Care System (SUS).

Author contributions

CC: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing, Data curation, Visualization. VN: Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. JN: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This research was supported by the Fonds de recherche du Québec -Santé (JN-M, Grant 330642), Charles Le Moyne scholarship of CC.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Psychiatry

TYPE Review
PUBLISHED 02 September 2024
DOI 10.3389/fpsyt.2024.1449526

OPEN ACCESS

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RECEIVED 15 June 2024
ACCEPTED 12 August 2024
PUBLISHED 02 September 2024

CITATION
Sessa F, Polito R, Li Rosi G, Salerno M, Esposito M, Pisanelli D, Ministeri F, Messina A, Carotenuto M, Chieffi S, Messina G and Monda M (2024) Neurobiology and medico-legal aspects of suicides among older adults: a narrative review.
Front. Psychiatry 15:1449526.
doi: 10.3389/fpsyt.2024.1449526

Neurobiology and medico-legal aspects of suicides among older adults: a narrative review

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The task of preventing suicide in older adults is an important social burden as older adults aged above 65 are exposed to singular psychological aspects that increase suicide risks. Moreover, when an older adult corpse is found, the medico-legal inspection represents a fundamental tool to identify the exact cause of death, classifying or excluding it as suicide. In this scenario, this review aims to explore the neurobiological factors that could be related to suicidal behavior in older adults. A further goal of this review is the exploration of the medico-legal aspects surrounding older adult suicides, clarifying the importance of forensic investigation. Particularly, this review examines issues such as neurotransmitter imbalances, cognitive impairment, neuroinflammation, psychosocial factors related to geriatric suicide, and neurodegenerative diseases. Additionally, medico-legal aspects such as policy considerations, legal frameworks, mental health assessments, ethical implications and forensic investigation were explored. Considering the importance of this phenomenon, especially in western countries, a need has emerged for focused screening tools on suicidal behavior among older adults, in order to contain it. Therefore, this review makes an exhaustive appraisal of the literature giving insights into the delicate interplay between neurobiology as well as mental health in relation to older adult suicide within a medico-legal context. The comprehension of different aspects about this complex phenomenon is fundamental to propose new and more effective interventions, supporting tailored initiatives such as family support and improving healthcare, specifically towards vulnerable ageing societies to reduce older adult suicide risks.

KEYWORDS

aging, neurobiology, medico-legal aspects, suicides, older adult, populations

1 Introduction

Aging encompasses two interchangeable definitions: age-related decline in biological functions and age-related increase in mortality. Suicide among older adults is a critical public health concern. Individuals aged above 65 face unique mental health challenges, including increased suicidal behavior risks (1). Globally, according to the World Health Organization (WHO), one person dies from suicide every 40 seconds, with the highest rates observed among those over 65 years (2). Persistent concerns involve social isolation, loneliness, and addiction as significant risk factors for suicide (3).

Epidemiologically, older adults, particularly those over 65, exhibit higher rates of completed suicide compared to other age groups (4, 5). Suicide rates among the older adults progressively increase with age, especially among men. In 2017, rates were 16.17 per 100,000 for ages 50–69 and 27.45 per 100,000 for ages 70 and older (1, 6). Men in this demographic group have notably higher completion rates, whereas women tend to attempt suicide more frequently (4, 5). Physical health challenges, chronic illnesses, social isolation, and experiences of bereavement contribute significantly to their vulnerability (7).

In developed countries, people aged 65–74 generally maintain good health and social inclusion, though by 2050, two-thirds of the global older adult population will reside in low- and middle-income countries (8). The COVID-19 pandemic raised concerns about its impact on geriatric suicides, potentially exacerbating anxiety, depression, and post-traumatic stress symptoms (9–11). Understanding neurobiological factors in geriatric suicide is crucial, including neurotransmitter imbalances such as serotonin and dopamine (DA) dysregulation linked to depressive states and suicidal ideation (12). Chronic neuroinflammation, exacerbated by systemic illnesses and aging, contributes to cognitive decline and emotional instability (13). These factors underscore the need for targeted interventions to mitigate older adult suicide risk.

When an older adult corpse is discovered, a medico-legal inspection becomes an essential tool in the investigation process. This thorough examination is vital for accurately determining the cause of death and plays a crucial role in classifying or excluding the possibility of suicide (14). The importance of such inspections cannot be overstated, as they provide a comprehensive understanding of the circumstances surrounding the death, ensuring that justice is served, and families receive accurate information. The presence of pre-existing medical conditions, medications, and age-related changes must be carefully considered to avoid misclassification of the cause of death (5). Furthermore, medico-legal inspections contribute to the broader understanding of patterns and trends in older adult deaths. By accurately classifying deaths as suicides or otherwise, forensic data can be used to inform public health strategies and preventive measures. This information is crucial for developing targeted interventions aimed at reducing suicide rates among older adults, a demographic often vulnerable to mental health issues and social isolation (15, 16).

The complexity of understanding suicide ideation and behavior in this population involves aging-related factors, neurobiology, and legal considerations. This review explores neurobiological contributors to geriatric suicide, focusing on neurotransmitter imbalances, neuroinflammation, cognitive impairment, and neurodegenerative diseases, alongside psychosocial factors. It also examines medico-legal aspects, including forensic investigations, legal frameworks, policy considerations, ethical implications, and mental health assessments.

2 Materials and methods

A comprehensive search was conducted across the electronic databases PubMed/MEDLINE, PsycINFO, Scopus, and Google Scholar. Key search terms included “geriatric suicide”, “neurobiological factors”, “neurotransmitter imbalance”, “neuroinflammation”, “cognitive impairment”, “neurodegenerative diseases”, “psychosocial factors”, “medico-legal aspects”, “forensic investigation”, “legal framework”, “policy considerations”, “ethical implications”, and “mental health assessments”. Articles and reviews published in English between 2000 and 2024 were included. Emphasis was placed on studies focusing on neurobiological mechanisms of suicidal behavior in older adults and medico-legal aspects of geriatric suicide.

2.1 Study selection

Titles and abstracts of retrieved articles were screened for relevance to the topic. Full texts of potentially relevant articles were then assessed for eligibility. Studies and reviews that provided substantial insights into neurobiological factors contributing to suicidal behavior in older adults, as well as those discussing medico-legal considerations, were included. Studies focusing on pediatric populations, non-human subjects, or lacking relevance to the review’s scope were excluded. This methodology facilitated a comprehensive exploration of neurobiological mechanisms and medico-legal considerations surrounding geriatric suicide, contributing to the understanding of factors influencing suicidal behavior in older adults.

3 Neurobiological factors contributing to suicidal behavior in older adults

Suicidality, encompassing suicidal thoughts, behaviors, and completed suicide, is a severe public health concern and a leading cause of death worldwide. As reported in Figure 1, neurobiological factors play a pivotal role in suicidal behavior, particularly in older adults. Understanding the underlying mechanisms of suicidality is crucial for developing effective prevention and intervention strategies. Mental disorders, including major depressive disorder (MDD), bipolar disorder (BD), schizophrenia, and anxiety disorders, are significantly associated with increased risk of suicide. These disorders are characterized by complex neurobiological alterations that contribute to the emergence and progression of suicidal behavior (17–19). Research has identified

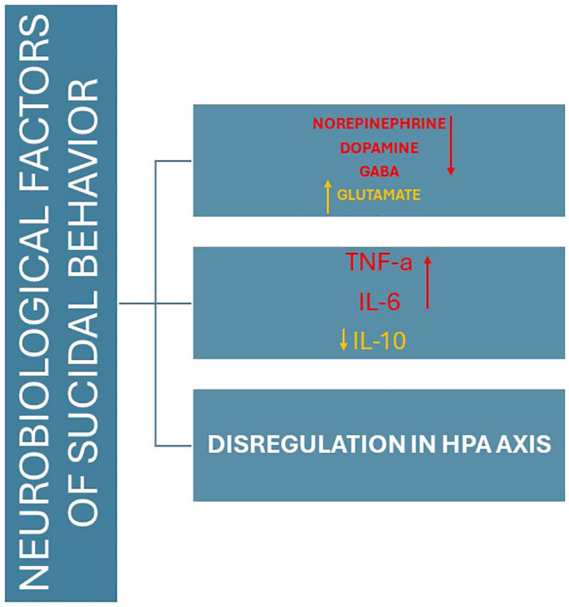

FIGURE 1
The main neurobiological factors involved in older adult suicides.

several key neurobiological factors implicated in suicidality across various mental disorders. These include dysregulation of neurotransmitter systems, structural brain abnormalities, hypothalamic-pituitary-adrenal (HPA) axis dysfunction, genetic predispositions, and neuroinflammation. For instance, imbalances in serotonin, norepinephrine (NE), and DA levels have been consistently linked to mood disturbances and impulsivity, which are common precursors to suicidal acts. Additionally, structural changes in brain regions involved in emotion regulation and decision-making, such as the prefrontal cortex, amygdala, and hippocampus, have been observed in individuals with a history of suicide attempts (20, 21). The HPA axis, a central component of the body's stress response system, is often dysregulated in those at risk for suicide, leading to abnormal cortisol levels and heightened stress reactivity. Genetic studies have also revealed specific polymorphisms that may predispose individuals to suicidality by affecting neurotransmitter function and inflammatory pathways (20). Moreover, chronic neuroinflammation, marked by elevated pro-inflammatory cytokines and microglial activation, has emerged as a significant factor contributing to the pathophysiology of suicidality (22).

By elucidating these complex mechanisms, we can better understand the etiology of suicidal behavior and pave the way for innovative treatment and prevention strategies tailored to the neurobiological profiles of at-risk individuals (20).

3.1 Neurotransmitter imbalance

Neurotransmitter imbalances play a critical role in suicidal behavior among older adults. These imbalances affect mood regulation, cognitive function, and stress responses, which are crucial in understanding the pathophysiology of suicidal behavior. In this context, drug assumption may negatively influence mood regulation systems (23–25). Alterations in neurotransmitter systems, particularly serotonin and NE, play a significant role in the pathophysiology of suicidal behavior (26). In the older adult population, age-related changes in these neurotransmitter systems may contribute to an increased vulnerability to suicidal ideation and actions: - serotonin (5-HT) is integral to mood regulation, anxiety, and impulse control (27). Platelet serotonin levels are commonly used as a peripheral marker of serotonergic function. Studies have shown reduced platelet serotonin levels in suicidal individuals compared to non-suicidal controls (28, 29). Lower levels of 5-HIAA (5-hydroxyindoleacetic acid), a primary serotonin metabolite, in the blood are also associated with increased suicidality. Reduced serotonergic activity is consistently linked to increased suicidal behavior. Studies have found lower levels of serotonin and its primary metabolite, 5-hydroxyindoleacetic acid (5-HIAA), in the cerebrospinal fluid of individuals who have attempted or completed suicide. Furthermore, low serotonin levels can impair impulse control and increase aggression, contributing to the risk of suicidal actions (24, 30). Moreover, several older adults could be homozygous for the "s" allele in the serotonin transporter promoter polymorphism (5HTTLPR): The 5HTTLPR gene, which is involved in serotonin transport, has been extensively studied in relation to how it may influence an individual's response to life stressors. Variations in the 5HTTLPR gene affect serotonin reuptake, thereby influencing serotonin availability in the brain. Research suggests that individuals with certain variants of the 5HTTLPR gene may have different responses to stress compared to those with other variants. Specifically, the short allele (S allele) of the 5HTTLPR gene has been associated with increased susceptibility to stress-related disorders. Individuals carrying the S allele may exhibit heightened emotional reactivity and vulnerability to developing depression and anxiety disorders in response to stressful life events. On the other hand, carriers of the long allele (L allele) tend to show more resilience and adaptive responses to stressors (31).

The interplay between genetic variants of 5HTTLPR and environmental factors, such as life stressors, underscores the complex nature of how genes and environment interact to influence mental health outcomes, this polymorphism may negatively influence life stressors, predicting adverse mental health outcomes such as depressive symptoms (32, 33). In addition, cerebrospinal fluid (CSF) levels of 5-HIAA (5-hydroxy indole acetic acid) have been extensively studied, revealing lower concentrations in suicidal individuals. It was found that low CSF 5-HIAA levels were significantly associated with violent suicidal behavior, suggesting a central serotonergic deficit (32, 33). DA is another important neurotransmitter involved in reward processing, motivation, and pleasure (34). Dysregulation in the dopaminergic system can lead to anhedonia (loss of pleasure), decreased motivation, and depressive symptoms, which are prominent risk factors for suicide. Altered dopamine transmission can disrupt reward circuits, leading to feelings of hopelessness and reduced life satisfaction (35). Peripheral measures of DA activity, including plasma levels of homovanillic acid (HVA), a major DA metabolite, provide indirect insights into central dopaminergic function.

Reduced plasma HVA levels have been associated with suicidal behavior in depressed patients (36). CSF studies have shown decreased levels of CSF HVA in suicidal individuals, particularly in those with major depressive disorder and schizophrenia. These findings suggest a deficit in central dopaminergic activity (35). NE is crucial for stress response, arousal, and mood regulation. Abnormal noradrenergic function is associated with mood disorders and suicidal behavior (37). Elevated or dysregulated NE levels can exacerbate anxiety and stress. Imbalances in NE can lead to hyperarousal, irritability, and heightened stress responses, increasing suicidal ideation (38). Altered levels of NE and its metabolites such as 3-methoxy-4-hydroxyphenylglycol (MHPG) in plasma have been reported in suicidal individuals. Other authors observed elevated plasma MHPG levels in suicidal patients with major depression, indicating heightened noradrenergic activity. CSF MHPG levels have also been studied as a marker of central noradrenergic function (39). Elevated CSF MHPG levels have been found in individuals with a history of suicide attempts suggesting dysregulation in NE turnover (38).

Glutamate is the primary excitatory neurotransmitter in the brain, involved in synaptic plasticity and cognitive function. Abnormal glutamatergic signaling has been linked to depression and suicidal behavior. Elevated glutamate levels can cause neurotoxicity and neuronal damage. Excessive glutamate activity can lead to excitotoxicity, impairing brain function and contributing to mood disturbances and cognitive deficits (38). Gamma-aminobutyric acid (GABA) is the main inhibitory neurotransmitter, crucial for reducing neuronal excitability and maintaining balance in brain activity. Reduced GABAergic activity has been associated with depression and anxiety, which are risk factors for suicide (40, 41). Low GABA levels can lead to increased neural excitability, anxiety, and stress, exacerbating suicidal tendencies (38).

Neurotransmitter imbalances play a critical role in the pathophysiology of suicidality. Studies of neurotransmitter metabolites in body fluids such as blood and CSF provide essential insights into central neurotransmitter function. Continued research in this area is crucial for developing effective strategies to identify, treat, and prevent suicidal behavior. The study of biomarkers in individuals with suicidal tendencies involves examining various body fluids and tissues to identify neurobiological alterations associated with suicidality.

3.2 Neuroinflammation

Chronic neuroinflammation has been linked to various neuropsychiatric disorders, including depression and anxiety, which are significant risk factors for suicide. In older adults, the presence of neuroinflammatory processes may exacerbate psychiatric symptoms, thereby increasing the risk of suicidal behavior (42, 43). Neuroinflammation plays a significant role in the pathophysiology of suicidal behavior, particularly in older adults. Chronic inflammation can influence brain function and mood regulation, leading to increased vulnerability to depression and suicidal tendencies (44, 45). Cytokine dysregulation plays an important role in neuroinflammation establishment (42). Elevated levels of pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and interleukin-1 beta (IL-1β) are commonly observed in individuals with major depressive disorders and suicidal behavior (46, 47). These cytokines can cross the blood-brain barrier and affect brain regions involved in mood regulation, such as the prefrontal cortex and hippocampus, leading to altered neurotransmission and neuronal function (48). Neuroinflammation has been increasingly recognized as a significant factor in the pathophysiology of suicidality. Inflammatory markers in body fluids such as blood and CSF can provide valuable insights into the neurobiological mechanisms underlying suicidal behavior. Blood studies are commonly used to measure systemic inflammation and provide indirect insights into central nervous system (CNS) inflammation. Elevated levels of cytokines such as IL-6, IL-1β, and TNF-α have been found in the blood of suicidal individuals. Lindqvist et al. found significantly higher plasma levels of IL-6 and TNF-α in suicide attempters compared to non-suicidal depressed individuals and healthy controls (49). Janelidze et al. reported increased IL-1β and IL-6 levels in the blood of suicide attempters, suggesting a strong association between systemic inflammation and suicidality (50). Moreover, C-reactive protein (CRP) is a general marker of inflammation and has been associated with suicidality. Elder et al. found elevated CRP levels in individuals with suicidal ideation, indicating an association between systemic inflammation and suicidal thoughts (51). In addition, CSF studies provide direct insights into CNS inflammation and are critical for understanding the central mechanisms of suicidality. Increased levels of pro-inflammatory cytokines in CSF reflect neuroinflammation directly within the CNS. Lindqvist et al. reported elevated CSF levels of IL-6 in suicide attempters, indicating central inflammation (52). Moreover, Pandey et al. found increased levels of IL-1β and TNF-α in the CSF of suicide victims, further supporting the role of central neuroinflammation in suicidality (53). Neuroinflammation markers in body fluids, particularly elevated levels of pro-inflammatory cytokines and microglial activation markers, play a crucial role in the pathophysiology of suicidality. Studies of these markers in blood and CSF provide valuable insights into the systemic and central inflammatory processes associated with suicidal behavior (54).

Furthermore, microglial activation contributed to neuroinflammation. Microglia are the brain's resident immune cells. In response to chronic stress or systemic inflammation, microglia can become overactivated, releasing pro-inflammatory cytokines and neurotoxic substances (55, 56). Persistent microglial activation can result in neuroinflammation, synaptic dysfunction, and neuronal damage, contributing to mood disturbances and cognitive impairments associated with suicidal behavior (48). In addition, chronic stress activates the hypothalamic-pituitary-adrenal (HPA) axis, leading to prolonged cortisol release. Elevated cortisol levels can exacerbate inflammatory responses. Dysregulation of the HPA axis and chronic inflammation can synergistically impair brain function and increase the risk of depression and suicidal behavior (57). There is evidence linking neuroinflammation and suicidal behavior, in fact, in postmortem

analyses of individuals who died by suicide often reveal increased levels of pro-inflammatory cytokines and signs of microglial activation in brain tissues. These findings support the role of neuroinflammation in the pathophysiology of suicidal behavior (57).

Furthermore, neuroimaging studies using positron emission tomography (PET) scans have shown increased markers of neuroinflammation in the brains of individuals with suicidal ideation and behavior. These studies provide *in vivo* evidence of the link between neuroinflammation and suicidal tendencies (58–60). Regarding clinical studies, elevated inflammatory markers in blood samples such as C-reactive protein and IL-6 are often found in patients with depression and those with a history of suicide attempts (59). Systemic inflammation may reflect neuroinflammatory processes contributing to suicidal behavior. There are some important aspects such as age-related changes, in particular, aging is associated with increased systemic inflammation (often referred to as "inflammaging"), which can exacerbate neuroinflammatory processes (61, 62). In addition, older adults often have comorbid conditions such as cardiovascular diseases, diabetes, and neurodegenerative disorders, which can contribute to increased systemic and neuroinflammation (63). The combined effects of aging, comorbidities, and neuroinflammation can increase the vulnerability of older adults to depression and suicidal behavior. In this scenario, potential interventions are anti-inflammatory treatments such as non-steroidal anti-inflammatory drugs and cytokine inhibitors to reduce systemic and neuroinflammation (64). Moreover, lifestyle modifications promoting physical activity, a balanced diet, and stress management techniques are recommended to attenuate inflammation (65). Furthermore, some antidepressants have anti-inflammatory properties and can help reduce cytokine levels and neuroinflammation. Omega-3 fatty acids have been shown to have anti-inflammatory effects and can improve mood symptoms (66). Cognitive-behavioral therapy (CBT) and other psychotherapeutic interventions can help manage stress and reduce inflammatory responses (65). Over the last years the development of online and personal computer-based CBT programs may have been helpful in reducing suicides (67).

In summary, neuroinflammation is a critical factor in the development of suicidal behavior in older adults. Understanding the mechanisms and impacts of neuroinflammation can guide the development of targeted interventions to reduce the risk of suicide in this vulnerable population. Comprehensive approaches that combine pharmacological treatments, lifestyle modifications, and psychotherapeutic interventions are essential for effectively addressing neuroinflammation and its contribution to suicidal behavior (65, 68).

3.3 Cognitive impairment and neurodegenerative diseases

Older adults with dementia face unique challenges that may predispose them to suicidal tendencies. Cognitive impairment and neurodegenerative diseases significantly contribute to suicidal behavior in this age group (69). Particularly, cognitive decline, loss of autonomy, and the emotional burden on caregivers can increase the risks of suicidal ideation (70).

Structural changes in the brain associated with neurodegenerative diseases, such as Alzheimer's disease (AD), have been implicated in the emergence of psychiatric symptoms and suicidal behavior in older adults (71, 72). These conditions affect cognitive function, emotional regulation, and overall quality of life, increasing the risk of depression and, as a consequence, suicidal ideation.

There are various forms of cognitive impairment. Mild cognitive impairment (MCI) represents a transitional stage between normal aging and dementia. It is characterized by noticeable cognitive decline that does not markedly interfere with daily functioning (73, 74). Dementia, on the other hand, entails severe cognitive decline affecting memory, thinking, and behavior to the extent that it disrupts daily activities (75).

In the early stages of cognitive decline, individuals are often aware of their diminishing cognitive abilities, leading to feelings of frustration, hopelessness, and depression, which can increase suicidal ideation. As cognitive impairment progresses, the ability to plan and execute complex actions, including suicide, may diminish. However, the distress and burden of living with cognitive decline can still contribute to suicidal thoughts (69, 76). In this context, AD represents the most common form of dementia, characterized by progressive memory loss, cognitive dysfunction, and behavioral changes (77, 78). Individuals with early-stage Alzheimer's may experience depressive symptoms and suicidal ideation due to the awareness of their cognitive decline. Behavioral changes and reduced impulse control in later stages can also contribute to suicidal behavior. Moreover, Parkinson's disease is a neurodegenerative disorder affecting motor function, often accompanied by cognitive impairment and mood disorders (79). Depression is common in Parkinson's disease and significantly increases the risk of suicidal behavior. Cognitive impairment and reduced quality of life also contribute to this risk (80, 81). Frontotemporal dementia (FTD) involves the degeneration of the frontal and temporal lobes, leading to changes in personality, behavior, and language. Early onset and rapid progression of FTD can lead to severe emotional distress and impulsive behaviors, increasing the risk of suicidal actions (82). Lewy body dementia is characterized by the presence of Lewy bodies in the brain, leading to cognitive decline, visual hallucinations, and motor symptoms. The combination of cognitive impairment, hallucinations, and depression in Lewy body dementia can significantly increase the risk of suicidal behavior (83–85).

The perception of being a burden on caregivers can exacerbate feelings of worthlessness and hopelessness, contributing to suicidal ideation (86).

Neurodegeneration and dementia are complex conditions that often intersect with psychiatric disorders, including suicidality. Several studies demonstrated that patients diagnosed with dementia faced a higher risk of suicide within the first year compared to those without dementia (87, 88). For this reason, the identification of biomarkers in suicidal individuals with neurodegenerative diseases can provide insights into the underlying mechanisms and potentially guide interventions. Amyloid Beta (Aβ) Peptides are crucial in the

pathology of AD and have been studied in relation to suicidality in neurodegenerative conditions. Reduced levels of Aβ42 in CSF are indicative of AD. Some studies suggest a correlation between low CSF Aβ42 and increased risk of suicidality. Other authors found that decreased CSF Aβ42 levels were associated with depressive symptoms and suicidal ideation in AD patients (89, 90). In addition, plasma levels of Aβ peptides are less reliable but may still provide useful information in conjunction with other biomarkers. Cai et al. showed that altered plasma Aβ levels, along with other markers, could predict cognitive decline and suicidal thoughts in older adults (91). Furthermore, Tau proteins, particularly total tau (t-tau) and phosphorylated tau (p-tau), are important markers for neurodegenerative diseases such as AD and FTD. Elevated CSF levels of t-tau and p-tau are associated with neuronal damage and have been linked to suicidality in dementia patients. Aamodt et al. reported higher CSF tau levels in patients with AD and FTD who exhibited suicidal behavior compared to those who did not (92). Advances in assay techniques have allowed for the detection of tau in plasma, providing a less invasive method to monitor neurodegeneration. Indeed, Mattsson et al. demonstrated that elevated plasma t-tau levels were correlated with increased risk of suicidal ideation in AD patients (93). Neurofilament Light Chain (NfL) is a marker of axonal damage and has been studied in various neurodegenerative conditions. Elevated CSF NfL levels are found in several neurodegenerative diseases and have been linked to the severity of neurodegeneration and suicidality. Soylu-Kucharz et al. found that increased CSF NfL levels were associated with both disease progression and suicidal tendencies in patients with neurodegenerative diseases (94). Blood levels of NfL are also elevated in neurodegenerative conditions and correlate with CSF levels, offering a non-invasive biomarker. Ashton et al. showed that plasma NfL levels could distinguish between suicidal and non-suicidal patients with neurodegenerative diseases (95).

Furthermore, synaptic dysfunction is a hallmark of neurodegeneration. Synaptic proteins serve as biomarkers for synaptic integrity and function. Proteins such as neurogranin and SNAP-25 are elevated in the CSF of patients with AD and other dementias and have been linked to suicidality. Kvartsberg et al. reported that increased CSF neurogranin levels were associated with cognitive decline and suicidal behavior in AD patients (96). Synaptic protein levels in blood are less commonly studied but may provide insights into synaptic health. Moreover, Ferrer-Cairols et al. found correlations between plasma neurogranin levels and suicidal ideation in dementia patients (97). In addition, as previously reported, neuroinflammation is significant in the progression of neurodegenerative diseases and has been linked to suicidality.

Biomarkers for neurodegeneration and dementia, detected in body fluids such as CSF and blood, provide critical insights into the interplay between neurodegenerative processes and suicidality. Key biomarkers include Aβ peptides, tau proteins, NfL, synaptic proteins, and inflammatory markers. Understanding these biomarkers' roles can aid in diagnosing, monitoring, and potentially intervening in neurodegenerative diseases associated with suicidality.

3.4 Psychosocial factors

Older adults often face detachment from society and feel alone. These aspects are dangerous to the extent of bringing about depression as well as loneliness. In such cases, if an individual does not have any social networks, he or she may be overwhelmed by hopelessness and become so desperate that it can lead to suicidal thoughts and actions (98, 99).

Moreover, the mental health of older adults can be severely affected by chronic diseases, physical disabilities, and physical sicknesses, which, in turn, may raise the chances of suicidal behaviors (100). There are many psychosocial factors involved in this risk, which include a variety of social, psychological, and environmental influences that can impact mental health status and general well-being. Among older adults, feeling isolated and alone is a significant determinant of depression as well as being suicidal. The loss of a partner, friend, or family member can negatively influence their mental health status by causing a sense of extreme isolation or loneliness (100), increasing stress levels, decreasing mental health status, and deteriorating mental well-being. Different experiences, such as losing a loved one, especially a partner, are stressful events that often lead to the emergence of depressive disorders and suicidal thoughts. Sadness and loss make people feel that they are unfulfilled, unhappy, and have no reason to live, which hurts their psychological well-being. Chronic physical illness and the experience of persistent pain are well-documented and prevalent in older adults, who are highly vulnerable to depression and suicide (101). Such situations result in physical disability, substance abuse, and chronic pain, which eventually cause hopelessness and perceived burden. All these situations could be socially humiliating, making older adults unable to care for themselves: in this way, subjects increase their vulnerability, increasing depression and suicidal thoughts (102, 103). Financial stress and insecurity, often stemming from retirement, medical expenses, or loss of income, significantly impact mental health in older adults, generating anxiety, stress, and feelings of being a burden, increasing the risk of suicidal behavior (104). Depression, anxiety or previous suicide attempts are some of the mental health disorders that predict future suicidal behavior because mental health problems make other stress factors worse and decrease the ability to cope with change. Older adults could combine the consumption of alcohol and prescription medication, and this substance abuse increases the risk of suicide because it worsens depressive symptoms, affects judgment, and impulsive behavior (105, 106). The quality of relationships with family members and caregivers also influences mental health. Positive support can be protective, while conflict or perceived burden can increase suicide risk. Strained relationships and feelings of being a burden can led to worthlessness and hopelessness (107).

Daily living changes are challenging, and major life changes such as retirement, moving to a new place, or moving to a care home can be stressful and confusing. These transitions frequently lead to identity crises, role changes, and social isolation, which, in

turn, give rise to depression and suicidal thoughts. Mental illness remains a taboo subject in many cultures, and there is still some shame involved in seeking help for a mental health issue (108, 109). Stigmatization by society will make such individuals develop feelings of shame and isolation, which will, in the long run, deny them any chance for help and thus increase their tendency towards suicide. In this case an effective approach to support and prevent is to promote the involvement in social activities and community programs to minimize isolation and loneliness (100). It should also be noted that the creation of opportunities for communication between individuals will also contribute to the significant improvement of the quality of life of older adults, including their sense of belonging and purpose. In addition, it should be made possible to get counseling and psychotherapy for grief, depression, and anxiety issues. Screening for depression and suicidal thinking should be carried out at regular intervals; early intervention is the best way to prevent dire consequences (110). It is also fundamental to ensure adequate medical treatment and pain management for chronic illnesses and offer physical therapy and rehabilitation services to improve functionality and quality of life. Managing physical health conditions effectively can reduce mental health strain (111, 112). Moreover, it would be helpful to provide guidance on financial matters to overcome challenges such as retirement, medical bills and financial pressure, as well as offering legal aid services to older adults who may be encountering issues with their finances or housing. Mental health problems can be eased by dealing with some financial problems to reduce the stressors associated with them.

As summarized in Figure 2, the factors that lead to suicidal behavior in older adults are multifaceted and therefore the approach to dealing with such patients would also be complex. Education, improving social support, offering mental health care, and addressing financial concerns are critical aspects. Thus, learning these factors will help in coming up with a more fitting solution to the problem of suicide and enhance the quality of life of older adults.

4 Medico-legal aspects surrounding suicides in older adults

The medico-legal issues of suicides in older adults is a particular field of interest. A recent Italian retrospective study demonstrated that a great number of suicides occurs in men, with a higher rate after 80 y.o (113). Suicidal ideation and behavior can sometimes be difficult to identify and appropriately intervene due to the presence of co-morbid conditions, cognitive changes, and communication difficulties in older adults (7, 114). Additionally, assessing the capacity of older adults to make decisions regarding their care and treatment, including the decision to end their lives, raises intricate ethical and legal considerations (115, 116). Another crucial aspect concerns forensic investigations in cases of death at home of older adults: In the light of post-mortem events, this occurrence, from a forensic perspective, might be a characteristically challenging event. Furthermore, the concern for end-of-life considerations such as promoting palliative and hospice care, advanced directives, and ethical dilemmas concerning suicides and older adults further overlap with the medico-legal imbalance of the focus on older adult suicide cases, which requires a highly sensitive and systematic approach to address such concerns.

4.1 Forensic investigations

Forensic investigations in cases of suicide among older adults involve meticulous procedures to establish the cause of death accurately, differentiate between natural, accidental, and intentional causes, and rule out foul play (117, 118). These procedures

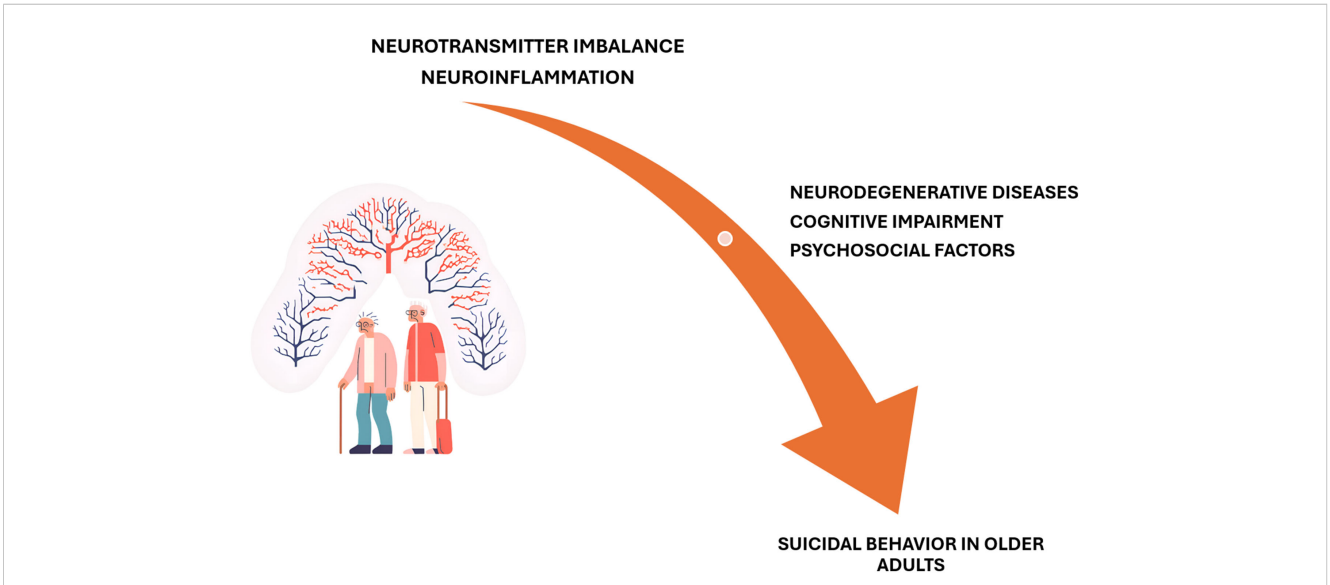

FIGURE 2
The neurotransmitter imbalance and neuroinflammation represent a substrate for suicidal behavior in older adults.

encompass several key aspects: crime scene investigation, determination of postmortem interval (PMI), identification of the cause of death, autopsy challenges, toxicological examination, and histological tests (119). In similar cases, the victim lived alone, and their body was found with a long PMI present significant challenge due to severe post-mortem modifications (120). These cases often involve advanced decomposition, which complicates the determination of the cause and manner of death: given the long PMI and in relation of the external factor, such as the seasonality, the body may be in an advanced state of decomposition, mummification, or skeletonization (121). Investigators look for contextual evidence such as suicide notes, medications, and the arrangement of the living space to gather clues about the victim's intentions and mental state. Environmental factors such as temperature and humidity, which affect the decomposition rate, are also recorded. Moreover, in such cases, because of climate change, post-mortem modifications could be accelerated (122). In similar cases, a multidisciplinary approach is essential, combining detailed crime scene analysis, entomology, pathology, and toxicology to establish the cause and manner of death.

A crucial aspect is the so-called psychological autopsy that involves reconstructing the psychological state of the deceased through interviews with family members, caregivers, and healthcare professionals (123). In geriatric suicides, the psychological autopsy plays a crucial role in elucidating the individual's mental health history, recent life events, and behavioral changes that may have preceded the suicide (124). All these pieces of information could be very important not only in order to define the cause of death, but also to adopt preventive strategies and interventions. Identifying the precise cause of death in older adult suicides involves distinguishing between lethal injuries and underlying natural diseases. Common methods of suicide in older adults include overdosing on medications, hanging, precipitation, and firearm use: each method presents different challenges (125, 126). For instance, distinguishing a medication overdose from natural death due to disease requires thorough toxicological analysis. In cases involving hanging or firearms, the forensic pathologist must differentiate between suicidal injuries and potential post-mortem artifacts or pre-existing conditions.

The initial phase of any forensic investigation begins at the crime scene. In cases of older adult suicide, investigators must proceed with sensitivity and precision: in this way the use of modern tools, such as the laser scanner technology, could be very useful (127, 128). The scene should be carefully documented through photographs, notes, and sketches to capture every detail. Investigators look for evidence such as suicide notes, medications, and the position of the body, which may provide clues about the method of suicide. The environment is examined for signs of a struggle or forced entry to rule out foul play (14). As represented in the case reported in Figure 3, the CSI investigation is fundamental in order to define the cause of death (Figure 3A). Moreover, the external examination of the corpse is very useful in describing the lesions, such as in the case of death through precipitation, where the lesions should be compatible with the dynamics of the fall (Figures 3B-D).

The inspection with a forensic light could be very useful to collect biological evidence: in this context, it is crucial to remember that collecting 'touch DNA' can be useful for placing a subject at a crime scene. However, this type of evidence should be handled with caution to accurately assess its significance in the context (129, 130). In older adult cases, special attention is given to potential contributory factors such as chronic illnesses, mobility aids, and living conditions, which might influence both the method and the likelihood of suicide (131).

Estimating the postmortem interval (PMI), or the time elapsed since death, is crucial in forensic investigations. This determination can be particularly challenging in older adults because of the presence of age-related physiological changes and potential comorbidities. Standard methods to estimate PMI include assessing body

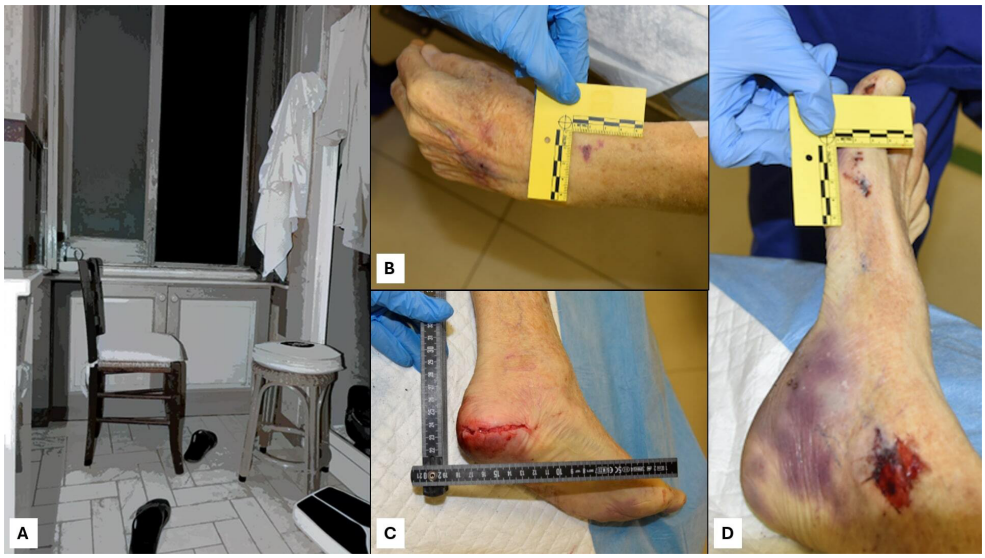

FIGURE 3
Crime scene examination in the case of suicide through precipitation **(A)**. At the external examination, each lesion should be carefully described and photographed **(B, C, D)**.

temperature, rigor mortis, and livor mortis. However, these methods can be influenced by the individual's age and health condition. For instance, an older adult with decreased muscle mass may exhibit rigor mortis differently. Moreover, the use of new reliable methods to estimate the PMI, for example using the biochemistry of the vitreous humor, could be very useful (132). In the same manner, forensic entomology, which involves studying insect activity on the body, can also provide PMI estimates, however, it has to be interpreted carefully, considering the deceased's environment and health (133). Furthermore, the application of histological and immunohistochemical investigations combined with standard methods could be fundamental in the correct estimation of the PMI and trauma dating (134, 135).

Conducting autopsies on older adults poses unique difficulties. Age-related diseases such as osteoporosis, arteriosclerosis, and organ atrophy can complicate the interpretation of findings. An autopsy must be meticulous, considering the delicate condition of older adult tissues. Pathologists must distinguish between injuries caused by suicide and those resulting from natural aging processes or pre-existing diseases. In addition, determining the impact of chronic illnesses on the cause of death is essential, as these conditions might mask or mimic trauma (136, 137).

During the autopsy, the forensic pathologist examines the body for evidence of self-inflicted injuries, such as ligature marks, gunshot wounds, or drug overdose (138, 139). Determining the presence and nature of these injuries is critical for confirming the cause of death and differentiating suicides from accidental deaths or homicides. It is important to acquire the medical conditions of the involved subject, including chronic illnesses, cognitive impairments, and physical frailty, which can complicate the forensic investigation of suicides (140, 141). The presence of comorbidities and the use of multiple medications require careful consideration during autopsy and toxicological analysis to ascertain the role of these factors in the individual's mental state and decision-making processes. Toxicological analysis is critical in cases where drug overdose is suspected. Indeed, the analysis of biological samples, such as blood and urine, is essential for identifying the presence of drugs, alcohol, or other substances that may have influenced the individual's behavior (142, 143). In geriatric suicides, the interaction between prescribed medications and their potential contribution to suicidal behavior necessitates a comprehensive toxicological assessment (144). Given the high prevalence of prescription medication use among older adults, toxicologists must identify and quantify multiple substances. Interpreting toxicology results can be complex because of polypharmacy (the use of multiple medications), which is common in this age group (145, 146). The presence of therapeutic, subtherapeutic, or toxic levels of medications must be carefully analyzed to ascertain whether the overdose was intentional. Additionally, interactions between medications, as well as the genetic substrate, can complicate the determination of toxicity levels (147).

Histological examinations involve microscopic analysis of tissues and are vital for identifying pathological changes at the cellular level. In older adults, histological tests help distinguish between age-related tissue changes and pathological findings relevant to the cause of death (148, 149). Moreover, the use of these techniques is fundamental to investigate vitality markers (150). For instance, chronic inflammation, fibrosis, or neoplastic changes must be evaluated in the context of potential trauma or poisoning. Histology can also reveal subtle signs of disease processes such as myocardial infarction or cerebral hemorrhage, which may contribute to the overall understanding of the cause of death (151). Moreover, as recently described in a thematic review, the post-mortem investigation on brain tissue could be very useful to better define the role of neurotrophin factors in suicide. In the same review, a pivotal role seems to be played by brain-derived neurotrophic factor (BDNF), while less evidence supports the hypothesis of glial cell line derived neurotrophic factor (GDNF) involvement (152). Furthermore, studies have shown that decreased gray matter volume in the hippocampus is associated with impaired memory and emotional dysregulation, which are factors in suicidal behavior. Integrity of white matter tracts, crucial for communication between brain regions, can be assessed using diffusion tensor imaging (DTI). Changes in white matter integrity may indicate disruptions in neural connectivity associated with mental disorders (153).

4.2 Legal framework and policy considerations in older adult suicide

The phenomenon of suicide among older adults poses significant ethical, legal, and policy challenges (154). As society grapples with the complexities of an aging population, it is crucial to develop and implement a robust legal framework and comprehensive policy measures to address this sensitive issue. These frameworks mustrespect individual autonomy while protecting vulnerable populations, ensuring access to mental health care, and promoting preventive strategies (155).

Considering the legal framework, one of the most contentious legal issues related to older adult suicide is the question of older adult abuse and neglect, which can be contributing factors to suicidal ideation among older adults (6, 156). The types of older adult abuse could be:

- physical abuse: inflicting physical pain or injury through actions such as hitting, pushing, or inappropriate use of restraints;
- emotional abuse: causing emotional pain or distress through verbal assaults, threats, humiliation, or harassment;
- sexual abuse: non-consensual sexual contact of any kind with an older adult;
- financial abuse: illegal or unauthorized use of an older adult's funds, property, or assets;
- neglect: failure to provide the necessary care, including food, shelter, healthcare, and protection.

Several factors contribute to older adult abuse, including caregiver stress, societal attitudes that devalue the older adult, and their isolation or dependence on others for care. Cognitive impairments such as dementia also increase vulnerability (157, 158). Prevention strategies

may be the improvement of caregiver and healthcare professional education, particularly in the identification of signs of older adult abuse and the importance of reporting them. As recently reported, home care might positively impact on preventing suicidal behavior in individuals with dementia, however, further investigation is needed (159). Moreover, it is essential to provide resources and support for caregivers to reduce stress and prevent burnout (160). Furthermore, public health campaigns could be useful to identify the signs of depression and suicidal ideation in older adults, helping family members, caregivers, and healthcare providers to intervene early (161). Another crucial aspect concerns social isolation, which represents a significant risk factor for suicide, and initiatives to promote social engagement and community involvement can mitigate this phenomenon (99). Programs that encourage intergenerational activities, volunteerism, and community-based services can help older adults stay connected and reduce feelings of loneliness and worthlessness. Finally, the legal validity of advanced directives and the determination of decision-making capacity in the context of suicidal behavior pose important medico-legal challenges that require careful consideration within the legal and healthcare systems: strengthening laws and regulations, as well as establishing community programs, may protect individuals and reduce risks (162).

4.3 Ethical considerations in older adult suicide

It is therefore very clear that because of the complex nature of legal and ethical issues, the prevention and combating of older adult abuse and neglect involves a delicate mix of legal and ethical approaches (163). Legal systems give the necessary means to safeguard older adults by means of the reporting requirements, use of protective services, criminal sanctions, and guardianship provisions (164). However, these measures have to be carried out following a firm ethical framework that recognizes self-determination, privacy, and the worth of older adults (165). Through enforcing appropriate and strong legal frameworks and combining them with ethical issues concerning older adults, society will be in a good position to protect older adults by giving them the dignity they deserve.

One of the hardest questions in ethical decision-making in the case of older adult abuse is the conflict of respect for the autonomy of older adults and the need to protect them. Older adults have the same rights as everybody else, including the right to self-determination – that means the right to stay alone or reject some forms of treatment (166). However, when there is a threat to their lives, it becomes necessary to intervene and take them away from such situations. As much as people must be allowed to decide about their own body, especially in the case of patients with mental disorders, it becomes a Herculean task for healthcare and legal practitioners. That is why ethical practice entails making sure that the particular intervention is the least intrusive and as much as possible, in accordance with the patient's wishes and their rights as a person (167).

The major principles of beneficence, the principle of doing good, and nonmaleficence, the principle of doing no harm, apply to elder care. This means that caregivers and professionals have a duty of implementing the best interest of older adults and make sure the action taken will not be detrimental to their welfare (168). This includes meeting the needs of older adults through caregiving, fighting for their rights, and ensuring that they are shielded from abuse or mistreatment.

It implies that all older adults should be treated right and accorded equal rights and privileges irrespective of their economic status, color or origin (169). Ethical practice demands that all older adults have to be provided with protection and care, and for this to be made possible, resources, support, and interventions should be distributed (115).

Furthermore, issues related to end-of-life care, decision making and the controversy regarding the permissibility of palliative and hospice care for older adult suicides are also included in the medico-legal domain (116). The challenge of intervening in the lives of older adults who may be vulnerable to self-neglect is a contentious one, thus there is a fine line between honoring their right to independence and doing what is best for them. Undoubtedly, each case should be treated as unique, it is necessary to assess each aspect in order to identify the nature of the event.

4.4 Mental health assessments in post-mortem samples in older adult suicide cases

Psychological evaluations of the brain in the post-mortem specimens are important for identifying the antecedent causes and precipitating factors in older adult suicides (170). These assessments entail evaluating aspects of biology, psychology, and the social environment that may have prompted the individual to suicide (171). Forensic samples taken after death can help identify any mental health issues and stress factors that the older adult was suffering from, which can further enhance the understanding and may even suggest measures to avoid such incidents in the future (172).

The above discussion shows that one of the primary objectives of post-mortem mental health assessment is a neurochemical examination. This includes analyzing mood regulating neurotransmitters such as serotonin, DA, and NE among others that are related to mental health conditions. Low levels of certain neurotransmitters, such as serotonin, have been linked to depression and suicidal tendencies (173). When these neurochemical levels are measured in brain tissue samples, it may be possible to determine the mental state of the person.

The correlations between chronic stress and mental health disorders are associated with changes in stress biomarkers such as cortisol (174). Cortisol is a hormone that is released during stress and since stressed people have high cortisol levels, it is possible to get this hormone even from hair of a dead body. These biomarkers can work to substantiate a history of chronic stress or anxiety, both of which are suicide risk factors (175). New data suggest that oxidative stress may be implicated in suicidality, but only one study has examined the sources of reactive oxygen species (ROS) in subjects demonstrating suicidal behavior. It has been demonstrated that oxidative stress by nicotinamide adenine dinucleotide phosphate (NADPH) oxidase (NOX2) is involved in the changes in the animal model of psychosis. According to these studies, the raised NOX2 mediated oxidative stress in the brain

might participate in the neuropathological alterations responsible for suicidal behavior (176, 177).

In addition, histological analysis of brain samples can show the histopathological abnormalities that are related to mental illnesses. For example, the volume of the hippocampus was shown to be decreased in patients with major depressive disorder. By analyzing samples of brain tissue, pathologists can discover such morphological alterations that may have given rise to the psychological state of the patient (178).

Molecular and genetic analyses can help to determine the presence of genetic and epigenetic factors that may affect the individual's psychological state. In human samples, we can study the depressed or activated genes in the brain to determine whether they are linked to depression, anxiety, or other mental disorders (179, 180). As recently demonstrated, major depressive disorder could be related to miRNA dysregulation both in peripherical blood and in post-mortem brain samples (181, 182). It can also assist in understanding the various biological factors that could have contributed to an older adult's suicide. In addition, as highlighted in the previous section, the toxicological data play an important role in post-mortem evaluation of mental health issues, especially in older adult suicide. In direct post-mortem assessment, there is the concentration of the biological and chemical results, but there is the consideration of the medical and personal background of the deceased. Data from medical records such as patient's history of mental illnesses, previous suicide attempts, and prescribed medications can provide crucial background information (183).

Therefore, it is imperative that an extensive psychiatric evaluation is conducted to properly assess the risk of suicide in older adults. Capacity assessment is not easy for forensic investigators to handle because of the numerous aspects of an older adult's suicide they must work within.

Furthermore, histological analysis of the brain tissues also depicts some structural alterations that are related to mental health disorders. For instance, it was revealed that the hippocampal volume is reduced in major depressive disorder. The pathologists can then tell such things from the brain tissue samples that might have caused such structural changes that probably caused the individual's psychological problems.

5 Discussion

Older adults often suffer from neurological disorders such as Alzheimer's, Parkinson's, and vascular dementia, leading to significant mental health changes, impaired performance, and decision-making, which can result in suicidal tendencies (184, 185). Neuropsychological assessments are crucial for detecting cognitive changes and potential confounding factors, helping clinicians understand the link between brain function, mental health, and suicide risk (186).

Neurochemical markers, such as neurotransmitters and their metabolites, can provide insights into the biochemical environment of the brain before death. These markers are often studied post-mortem and can indicate abnormalities or dysregulations that may have contributed to the individual's mental state and behavior. Neurotransmitters, such as serotonin, DA, and NE, play crucial roles in regulating mood, cognition, and behavior. Post-mortem studies examine levels of these neurotransmitters and their metabolites in brain tissues (35, 187). In the same way, inflammatory markers, including cytokines and microglial activation, are increasingly recognized for their role in neuropsychiatric disorders (21, 47). Moreover, structural changes in the brain, observed through neuroimaging or post-mortem analysis, provide anatomical insights into how these changes may correlate with mental health conditions and behaviors exhibited during life. Reduction in gray matter volume, particularly in regions associated with mood regulation such as the prefrontal cortex and hippocampus, are common in various mental disorders (153). Combining neurochemical analyses with structural brain changes provides a more comprehensive understanding of the neurobiology underlying mental states before death. In addition, identifying specific neurochemical markers or structural brain changes associated with suicidal behavior can inform diagnostic criteria, treatment strategies, and preventive measures. Neurochemical markers in tissues and structural brain changes observed post-mortem offer valuable insights into the pre-mortal mental state. These markers can illuminate underlying neurobiological mechanisms that contribute to mental disorders and suicidal behavior, paving the way for targeted interventions and improved patient care strategies.

Forensic evaluation in older adults is very useful to gather information for the formulation of preventive measures to tackle the risks and weaknesses in this vulnerable group of the population. By comparing the identified precipitating factors and patterns, the forensic findings can be useful in providing the necessary guidance for the provision of specific interventions, mental health support services and social policies that would help prevent suicide in older adults (4, 188). Furthermore, because formalin-fixed, paraffin-embedded tissue analysis makes it feasible, post-mortem samples obtained for other uses—such as histological examination to determine organ damage—may be used. Thus, forensic research facilities serve as a priceless "magic box" for obtaining samples, underscoring the significance of upholding moral principles such as the Declaration of Helsinki.

Patients who are older adults and present with suicidal thoughts in the emergency department need to be assessed differently. Practical considerations, such as living in the countryside, availability of mental health care, and legal issues (forcible admission, for instance) should also be considered. Psychiatric and psychological interventions are also ideal for older adults and should be offered in a comprehensive manner. This includes management of mental health disorders (for instance depression, bipolar disorder, anxiety) which are associated with a high suicide rate among this group of people (189, 190).

These are comprehensive in the sense that they involve medical, psychological, and social interventions in dealing with suicidal behaviors among older adults (7). One of these is to improve mental health care for older adults, such as increasing the number of geriatric psychiatrists, counselors, and support group meetings (102). Raising awareness on potential suicidal indicators in older adult patients and encouraging healthcare practitioners, caregivers, and family members to discuss mental health and end-

of-life preferences are crucial for timely identification and prevention (102). Additionally, practices of screening for depression, anxiety and the relative genetic predisposition investigation, cognitive changes during routine health check-ups can also assist in early detection of these patients and early management. Social disconnectedness and loneliness are critical predictors of geriatric suicides; therefore, social, community-based organizations, senior citizen centers, and support groups are crucial in reducing feelings of isolation amongst seniors (191). Further, older adults who experience financial difficulties, who require help with basic physical needs, and those who cannot afford medical or mental healthcare services are vulnerable to suicidal thoughts. Through these proactive measures, society can establish the necessary framework that could protect the mental health of older adults and decrease the rate of geriatric suicides.

Based on these considerations, community intervention programs offer important assistance and recommendations for older adults who are prone to suicide (192, 193). Such programs may be a joint effort of the health care centers, social welfare offices, and other community-based organizations wherein they provide different services such as screening to detect cases of mental illnesses, counseling to individuals and families, and setting up seminars and/or lectures on the topic of suicide prevention. Furthermore, they could help to arrange social activities, volunteering, and peer-support groups, which are important to prevent social isolation and loneliness that are risk factors for geriatric suicide. In addition, community outreach programs can also help in building relationships between older adults and younger people, where older adults can volunteer to mentor younger people or take up community service, thus giving them a sense of direction and usefulness. Therefore, community outreach programs remain an effective means of fostering optimal health, as well as reducing geriatric suicide risk, by increasing social acceptance and belonging for older adults (194).

6 Conclusion

Older adult suicide represents a significant and complex challenge, intricately linked to neurotransmitter imbalances and underscored by crucial medico-legal considerations. Neurotransmitters are known to influence mood regulation and can significantly contribute to suicidal ideation in older adults. Given that mental health disorders such as depression are prevalent among older adults, addressing these imbalances is critical for developing targeted interventions. A thorough understanding of the complex interactions between neurotransmitter imbalances and mental health is essential for accurate medico-legal evaluations of suicide. Such evaluations must consider not only the biological but also the psychological and social dimensions of older adult suicides. This interdisciplinary approach can lead to identifying strategies for the identification, prevention, and ethical management of suicidal behavior in older adults. The need for specialized measures to screen for suicidal ideation in this age group is evident, as conventional assessment tools may not fully capture the unique neurobiological and psychosocial factors affecting older adults. Specialized instruments designed for older adults should incorporate factors such as age-related cognitive decline, chronic illness, and social isolation, which are often overlooked in non-specific measures. Ongoing research must promote closer collaboration among neurobiologists, clinical practitioners, and legal professionals to deepen our understanding of the neurobiological mechanisms behind suicidal behavior and develop more effective prevention strategies.

Author contributions

FS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. RP: Conceptualization, Data curation, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. GL: Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing. MS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. ME: Conceptualization, Data curation, Investigation, Software, Writing – review & editing. DP: Formal analysis, Methodology, Software, Validation, Writing – review & editing. FM: Data curation, Investigation, Writing – review & editing. AM: Conceptualization, Data curation, Methodology, Writing – review & editing. MC: Data curation, Investigation, Methodology, Writing – review & editing. SC: Data curation, Methodology, Software, Writing – review & editing. GM: Supervision, Validation, Visualization, Writing – review & editing. MM: Software, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The authors thank the Scientific Bureau of the University of Catania for language support.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 03 September 2024
DOI 10.3389/fpsyt.2024.1450683

OPEN ACCESS

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RECEIVED 18 June 2024
ACCEPTED 12 August 2024
PUBLISHED 03 September 2024

CITATION
Hed S, Berg AI, Wiktorsson S, Strand J, Canetto SS and Waern M (2024) Older adults make sense of their suicidal behavior: a Swedish interview study. *Front. Psychiatry* 15:1450683. doi: 10.3389/fpsyt.2024.1450683

Older adults make sense of their suicidal behavior: a Swedish interview study

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Introduction: The aim of this study was to explore how individuals aged 70 or older living in Sweden understood a recent suicidal act, and what changed in them and around them in the aftermath.

Method: Four women and five men (age range 71-91 years) receiving care at a geriatric psychiatric outpatient clinic in a large Swedish city took part in two interviews about their most recent suicidal act. Most of the women and none of the men had engaged in prior suicidal acts. Interpretative phenomenological analysis was employed.

Results: The suicidal act was explained as a response to losses (in physical and cognitive functions, social roles and relationships) that rendered previous coping strategies unviable. The participants reported being dependent on a healthcare system that they experienced as indifferent and even dismissive of their suffering. The suicidal act was described as an unplanned act of despair. Positive changes followed for participants who reported having had suicidal ideation prior to the suicidal act and had insights into its triggers. Some gained access to needed medical care; others developed greater awareness of their psychological needs and became more effective at coping. Individuals who said that they had not had suicidal thoughts prior to the suicidal act and could not explain it reported no positive change in the aftermath. The respondents' narratives indicated gendered themes.

Discussion: Participants' age-related losses were in many cases exacerbated by negative interactions with health care providers, indicating that continued attention needs to be given to implicit ageism in medical professionals. The suicidal acts were described as impulsive, which was unexpected because a dominant belief is that older adult suicidal behavior is planned. One reason for the discrepancy may be that this study focused on nonfatal acts, and planned acts may be more likely to be fatal. Another reason could be shame due to suicide

stigma. Alternatively, these acts were truly unplanned. The older adult suicide planning question should be addressed in larger studies across geographical and cultural settings. Future studies should also include questions about gender norms of suicidality and separately examine women's and men's data.

KEYWORDS

older adults, nonfatal suicidal behavior, despair, interview study, interpretative phenomenological analysis, geriatric psychiatry

Introduction

Around the world nonfatal suicidal behavior is the most prevalent form of suicidality (1). Globally, the combined prevalence of nonfatal and fatal suicidal behavior among older adults is high (1). A paradox of suicidality, including among older adults, is that women are less likely to die of suicide than men, but women are more likely to be diagnosed with depression and have higher or similar rates of nonfatal suicidal behavior, relative to men (2). While the number of suicidal acts per suicide death is lower among older adults than among other age groups (3), a previous suicidal act is a strong predictor of death by suicide in older adults (4). Yet older adults are underrepresented in research on nonfatal suicidal behavior (5).

Quantitative studies, primarily conducted in high-income countries, have identified factors associated with nonfatal suicidal behavior. Among these are mental illness, including both major and minor depression and problematic alcohol use, previous suicidal behavior, physical illness and disability, loss of autonomy, low level of education, relationship problems and social disconnectedness, financial difficulties, and personality (e.g., 6–12). In recent years there has been increasing research on the link between mild cognitive impairment (MCI) and both suicidal ideation (13) and behavior (14).

There seems to be a discrepancy between the risk factors reported in quantitative studies and the older adults' own narratives of their suicidal behavior. The authors of a qualitative study conducted in England (15); concluded that the risk factors identified in the suicide literature were often absent or viewed by older adults who survived a suicidal act as irrelevant to their suicidal act. Including the study by Crocker and colleagues, we could identify only four qualitative studies involving interviews with older adults following an act of suicidal behavior (15–18). The findings of these studies were reviewed in two studies (19, 11). Themes summarized in these reviews included loss of control, loneliness and isolation, impaired decision-making, accumulated suffering and pain, threats to identity, lacking reasons to live, ageing-related challenges in daily life, and feeling like a burden. Only two of the reviewed studies involved interviews with older adults in psychiatric care (16, 18). Both of these studies focused primarily on the events and states of mind preceding the suicidal act. Questions not addressed are how older adults integrate their suicidal behavior in their personal story and how they anticipate managing a future suicidal crisis, if they were to face one. Increased understanding of these phenomena could inform the development of clinical interventions that target suicidal older adults.

Building on and extending prior interview research with older adults who survived a suicidal act, this study explored how individuals aged 70 or older living in Sweden understood a recent suicidal act, and what changed in them and around them in the aftermath.

Materials and methods

Participants and procedure

Individuals living in a large Swedish city and receiving outpatient care at a geriatric psychiatric outpatient clinic following a suicidal act were invited to participate in the study. Inclusion criteria were age 70 years or older (corresponding to the minimum age for referral to the clinic); a suicidal act within the past 3-36 months; being capable of giving written informed consent and participation approval from their psychiatrist. Exclusion criteria were a clinical diagnosis of dementia or a Montreal Cognitive Assessment (MoCA) score of less than -2 standard deviations from Swedish normative score for age and education level (20); a personality disorder, active psychosis, delirium, or aphasia diagnosis; and insufficient knowledge of the Swedish language. Persons deemed by their psychiatrist as being at high risk of suicide were also excluded. Both women and men were included in the current study as rates of nonfatal suicidal behavior are rather similar in women (46/100 000) and men (52/100 000) aged 65+ living in Sweden (21). Since women live longer than men, the actual numbers of nonfatal acts are nearly identical in women and men (21).

Twenty-two individuals were identified by the clinic's staff as meeting the study's criteria. These individuals were asked if they would like to receive information about the study. Thirteen declined to receive information and to participate in the study. Reasons included a desire to move past the suicidal episode; life circumstances; lack of energy; or limited time primarily due to somatic illnesses and frequent medical visits. The individuals who accepted the invitation (n=9) received oral and written information

about the study, including information about the interview (i.e., that the interview would focus on their most recent suicidal act and its aftermath), and were given the opportunity to ask questions about the study before giving a written consent. Each participant was interviewed twice. Prior to the interviews, a research psychologist (SW) carried out a psychiatric assessment, including a cognitive screening, to ensure that all participants met study criteria. All participants completed the study protocol which involved a psychiatric assessment and two interviews. Recruitment started August 2021 and ended December 2022.

The study sample included four women and five men (age range 71-91 years, median 76 years) (See Table 1 for participants' demographic profile, mental health and suicidality history). The time between the interview and the suicidal act ranged from 4 to 27 months. Eight of the participants were born in Sweden and one had immigrated from central Europe in early adulthood. MoCa scores ranged from 23-29 (mean 25.6); two of the participants met criteria for Mild Cognitive Impairment (MCI). The participants' Montgomery-Åsberg Depression Rating Scale (MADRS: 22) scores ranged from 0-33, median 12. The female and male participants differed in terms of demographic characteristics, mental health and suicidality history. The women were either divorced or widowed, and living alone. All men but one were married. Half of the women were elementary school-educated; half were college-educated. One man had a college degree, the other men were high school educated. Most of the women and none of the men had engaged in prior suicidal acts.

As documented in Table 1, none of the participants was receiving psychiatric care at the time of the suicidal act although several had been in contact with psychiatric services in the past. Two men had received a short period of psychotherapy before their non-fatal suicidal act, but this contact was no longer ongoing at the time of the act. All participants had been prescribed antidepressants by their general practitioner prior to the suicidal act; one had discontinued taking the antidepressant due to side effects. Information about psychoactive prescription medication before and after the suicidal act and at the time of the research interview is shown in Supplementary Table 1. After the suicidal act and ensuing hospital medical care, seven individuals were referred to the geriatric psychiatric inpatient ward. The other two were referred to geriatric psychiatric outpatient services.

Interviews

Each participant took part in two interviews with a geriatric psychologist (SH, this article's first author) one to two weeks apart. This procedure was chosen because of the age of the participants and also because of the time required by the interview and the sensitive information to be covered. Our previous experiences interviewing older adults after a nonfatal suicidal act suggested that having some structure in the interview is important when discussing sensitive topics in this age group (18). A semi-structured interview guide was developed based on previous research on suicidal behavior in older adults. This approach provided a certain degree of structure while allowing each participant's personal story to unfold and lead the course of the interview (23). The opening question "Can you tell me how you reached the point of attempting suicide?" was followed by questions such as "What triggered and intensified your plans and actions?"

Both interviews focused on the most recent suicidal act. The first interview included questions about interactions with relatives and care professionals before and after the suicidal act. In the second interview emphasis was placed on events related to the suicidal act and how the individual was coping. The two-interview method enabled the researchers to plan for the second interview based on the first interview.

Five participants chose to meet the interviewer at the geriatric psychiatry outpatient clinic, and four were interviewed in their own homes. The interviews (n=18) were conducted in Swedish and lasted between 45 and 90 minutes. The interviews were audio recorded and transcribed.

Analysis

The Interpretative-Phenomenological-Analysis method (IPA: 24) was used to develop the interview and to analyze the interviews. IPA was chosen because it is designed to understand how people make sense of an experience. IPA's epistemological positions are phenomenology and hermeneutics (24). The phenomenological approach is embedded in the research and interview questions, reflecting our intention to capture subjective sense-making processes of the suicidal act. The hermeneutic stance was mainly present during the analysis as the intention was to understand the participants' making sense of their own experiences, thus creating a double hermeneutic. The ontological position adhered to was critical realism, which acknowledges that people's understanding is always subjective and influenced by context.

In line with the IPA steps described by Smith and colleagues (2022), each interview was ideographically analyzed. Two of the authors (SH and AIB) read each interview transcript and made separate descriptive (phenomenological) coding. Thereafter, SH and AIB reread the interview transcripts and separately made interpretative (hermeneutic) notes. Emergent themes in each transcript were identified and connections between themes were documented. SH and AIB then compared their coding and discussed links between themes. Thereafter, each case was discussed with authors SH, AIB, SW, and MW, all of whom had read the transcripts and taken notes. This discussion focused on how participants narrated their suicidal act in their individual context. Similarities and differences among cases were explored. During the analytic process the authors iteratively returned to the transcripts to check on themes and to ensure that the themes were consistent with the participants' narratives. Finally, a thematic structure consisting of four superordinate themes with subthemes was developed and agreed on by all authors. The analyses continued through the writing process. During the entire analysis, the intention was to integrate the participants' and the researchers' interpretations of the suicidal act and its aftermath.

TABLE 1 Demographic characteristics, mental health and suicidal behavior history of older adults who engaged in a nonfatal suicidal act.

Participant pseudonyms	Age	Sex	History of psychiatric care	Previous suicidal acts (SA)[a]	Age at first SA	Health care provider at the time of index SA	AD[b] at index SA	Preparatory acts at index SA (C-SSRS)[c]	Method[e] at index SA, Level of lethality (C-SSRS)[f]	Clinical diagnosis after index SA	Months between index SA and interview	Depression[g] at the time of the research interview
Anna	74	F	None	Yes	20	Primary care	Yes	No	Self-poisoning 4. Severe physical damage	Mixed anxiety and depressive disorder, Alcohol dependence	7	No symptoms
Jane	76	F	Recurrent contact since her 20s, no ongoing contact	Yes	61	Primary care	Yes	No	Self-poisoning 2. Moderate physical damage	Bipolar disorder, depressive phase Alcohol dependence	4	Mild depression
Emma	80	F	Recurrent contact since her 30s but no ongoing contact	Yes	35	Primary care	Yes	No	Jumping from height Aborted SA 0. No physical damage	Bipolar disorder, manic phase	27	Moderate depression
Cecilia	91	F	Brief contact in her 20s	No	91	Primary care	Yes	Yes[d] (Note with a single word)	Self-poisoning 3. Moderately severe physical damage	Major depressive disorder, recurrent. Sleep disorder	6	No symptoms
Ben	71	M	Brief contact in his 40s	No	70	Primary care	Yes	No	Self-poisoning 1. Minor physical damage	Bipolar disorder, depressive phase	14	No symptoms
Tom	75	M	None	No	73	Primary care	Yes	No	Hanging 1. Minor physical damage	Major depressive disorder, recurrent	16	Moderate depression
Otto	75	M	Sporadic contact in later life but not ongoing	No	75	Primary care	No	Yes (Brief phone text to spouse)	Self-poisoning 3. Moderately severe physical damage	Major depressive disorder, single episode	5	Moderate depression
Sam	76	M	None	No	76	Primary care	Yes	No	Self-poisoning 3. Moderately severe	Major depressive disorder, single episode.	4	Moderate depression

(Continued)

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TABLE 1 Continued

Participant pseudonyms	Age	Sex	History of psychiatric care	Previous suicidal acts (SA)[a]	Age at first SA	Health care provider at the time of index SA	AD[b] at index SA	Preparatory acts at index SA (C-SSRS)[c]	Method[e] at index SA, Level of lethality (C-SSRS)[f]	Clinical diagnosis after index SA	Months between index SA and interview	Depression[g] at the time of the research interview
									physical damage	Hypochondrical disorder		
Johan	81	M	None	No	80	Primary care	Yes	No	Self-poisoning 3. Moderately severe physical damage	Major depressive disorder, single episode	12	No symptoms

[a]SA, Suicidal act; [b]AD, Antidepressant; [c]C-SSRS, Columbia Suicide Severity Rating Scale, Item: Preparatory acts or behavior = Acts or preparation toward imminently making a suicide attempt. This can include anything beyond a verbalization or thought, such as assembling a specific method (e.g., buying pills, purchasing a gun) or preparing for one's death by suicide (e.g., giving things away, writing a suicide note). [d]The medical record reports a note (a single word) not reported in the interview. [e] All self-poisoning involved own prescribed psychotropic medication. A few acts combined prescribed psychotropics with over-the-counter pain medication or drugs prescribed for their medical conditions. [f]C-SSRS item: Actual lethality/medical damage = 0. No physical damage or very minor physical damage (e.g., surface scratches). 1. Minor physical damage (e.g., lethargic speech; first-degree burns; mild bleeding; sprains). 2. Moderate physical damage: medical attention needed (e.g., conscious but sleepy, somewhat responsive; second-degree burns; bleeding of major vessel). 3. Moderately severe physical damage: medical hospitalization and likely intensive care required (e.g., comatose with reflexes intact; third-degree burns less than 20% of body; extensive blood loss but can recover; major fractures). 4. Severe physical damage: medical hospitalization with intensive care required (e.g., comatose without reflexes; third-degree burns over 20% of body; extensive blood loss with unstable vital signs; major damage to a vital area). 5. Death. g Level of depression based on MADRS score (Montgomery-Åsberg Depression Rating Scale).

Ethics and reflexivity

The study was approved by the Gothenburg Regional Ethics Committee (2020-00321). During the project, the Swedish team worked closely with the clinical staff of the institutions where the sample was recruited. All participants had regular mental health care at the geriatric psychiatry clinic, whom they could turn to before, during, or after participation in the study. The participants were assured that they could withdraw from the study at any point and that the findings would be made available to them upon the study's completion. SH, the interviewer, was employed at the geriatric psychiatric clinic where the data were collected and has experience working with depressed and suicidal older adults. SH's clinical experience was helpful in handling the sensitive nature of the topics discussed in the interview, as some participants experienced mental fatigue and a temporary increase in anxiety during the interview. The interview's pace was flexible. Participants were offered breaks and the option to continue the interview at another time. The study's protocol stipulated that the participant's psychiatrist would be notified immediately if suicidal feelings were to be triggered during the study. This was, however, not necessary because no participant reported suicidal ideation during or after the interviews. Several participants spontaneously said the interviews had been a positive experience. The participants' well-being was always a priority during the interview and as a result, the length and content of the interviews varied. Pseudonyms were used to protect the identities of the respondents.

The research team was dominated by professionals with clinical interests and experiences. There was a concern that the interviewer's clinical interests and experiences would influence the participants' narratives. To counteract this, open-ended interview questions were used and follow-up questions were always based on the participants' responses. The authors' clinical pre-understanding was also in focus during the analyses. The transcripts were re-read several times to make sure that codes, notes, and themes were grounded in data, consistent with the qualitative research practice of investigator triangulation. The different professional and personal profile (e.g., discipline, seniority, cultural) of the co-authors broadened the analyses' lenses within and between cases. In a final step, the research team's cultural and gender expert (SSC) provided extensive cultural and gender feedback about the results and contributed to expanding the cultural and gender framework of the method and discussion.

Results

Themes generated by our analyses are organized in a temporal structure, from the events preceding the suicidal act to thoughts and situations experienced after the suicidal act (Figure 1). The superordinate themes are: 1) Contextual drivers of suicidality: Loss of self, 2) Constricted coping: Previous strategies no longer viable, 3) The suicidal act: A time of inner chaos, 4) After the suicidal act: Coping (or not) in the aftermath. Each superordinate theme has 2 to 4 subthemes (see Figure 1).

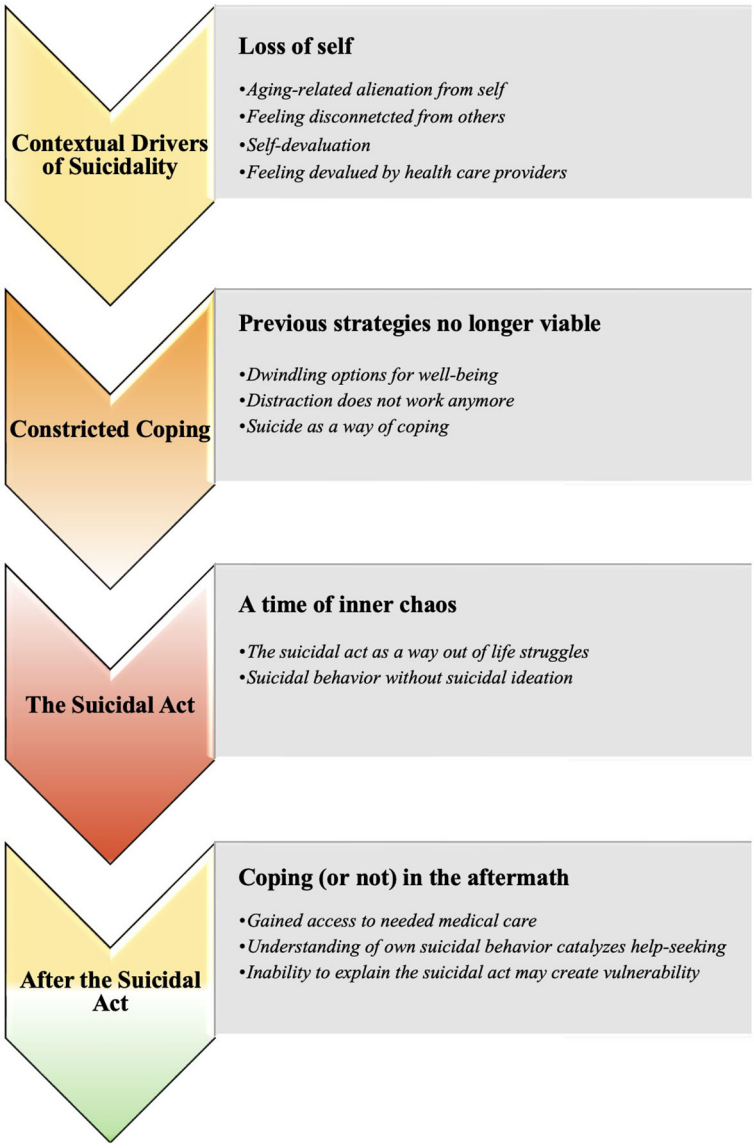

FIGURE 1
How older adults made sense of their own suicidal behavior: Superordinate and subordinate themes.

Contextual drivers of suicidality: loss of self

Participants described age-related losses (e.g., losses in physical capabilities, social engagements and independence) that they were unprepared for and found distressing. Some said that they had tried to ignore aging-related limitations. A sense of isolation was described by many. Some participants reported that prior to their suicidal act they lacked knowledge about mental illness and about mental-health care options. In one way or another, all participants said that they had lost valued aspects of their identity.

Aging-related alienation from self

Alienation from oneself was described as a suicide driver. Several participants said that losses in relationships, health, and physical or cognitive decline triggered a loss of identity. The participants said that they did not recognize themselves and struggled to cope with the physical limitations they experienced and the challenges of accepting and adapting to changed conditions. An inability to contribute to others and society triggered a sense of loss in purpose and meaning.

Throughout her adult life, Cecilia had been in charge of herself. She had abundant energy and had dedicated herself to caring for others. In her early nineties Cecilia experienced episodes of confusion that impacted on her ability to carry out daily tasks. This led to feelings of inadequacy followed by rumination. Cecilia said that she felt that she was failing her loved ones. The loss of the ability to care for others represented for her an existential crisis.

> …the thought, that I had made a huge mistake, it embedded itself deep within my mind, and I just couldn't handle it. I don't

> understand (…) it was as if I had lost connection with myself entirely. (Cecilia, 91 years)

Cecilia's account suggests an experience of helplessness that brought on feelings of shame and a subjective loss of value as a person. She did not view her feelings of worthlessness as a mental health issue. The thought of seeking mental health care did not occur to her prior to the suicidal act.

Being assertive and getting things done had been a salient part of Otto's identity. He had felt valued and appreciated for those qualities. Otto talked about how age-related losses had stifled his drive to have a public impact, and what that meant for him as a man.

> A man perhaps needs to assert himself more, or has a need to create something, whether it is to build a house, plant a tree or write a book. Men have that drive to manifest their presence in the world. (…) I've felt some kind of pride, … sometimes when I've written something that I think is good. It is something that I've created that didn't exist in the world before and that … that means something to me (…). I think that men have more of a need to find some kind of … justification for … their right to live. (Otto, 75 years)

The loss of opportunities to assert himself and to accomplish things he would be admired for was experienced as an existential threat by Otto.

Feeling disconnected from others

Many participants said that feeling disconnected from others had preceded the suicidal act. Feeling disconnected was described as a sense of standing alone in the face of challenging circumstances and as a sense of abandonment. Some talked about a feeling of not belonging. For some participants the loneliness followed the loss of a loved one. Others described profound loneliness despite having relationships.

Jane had always seen herself as a loner. Still, after the death of her husband, she felt a new sense of loneliness, and coping with life's challenges became increasingly difficult.

> The loss that fell over me when I didn't have all this practical stuff to deal with, when it started to calm down (after the funeral). Then I actually started to realize … I don't have my husband anymore. (…) I can't live on my own. Alone." (Jane, 76 years)

Johan recounted how loneliness had become overwhelming. Advancing in age, he experienced the loss of close relationships, including the passing of his partner. Intensified by the pandemic, this loneliness meant an abundance of time for rumination. His inner monologue became fraught with negative existential questions.

> It is the loneliness that is the worst for me. I go into myself somehow. And then the (suicidal) thoughts come. What am I doing here? (Johan, 81 years)

Self-devaluation

Several participants said that they ruminated over failures. All who reported ruminating exhibited moderate depression symptoms at the time of the interviews.

Emma believed that her recurrent depressions made it difficult for others to be with her. She said that she had always been self-critical. Over time, she felt that she had become even more self-critical and that she came to believe that she did not deserve to live.

> I think I have finished living. I'm tired of this. I don't think highly of myself (…) and really, I'm quite a failure if you look at the whole life span. (Emma, 80 years)

Otto described how age-related losses led to changes in his thoughts. Things that had previously brought him pride became an occasion for negative rumination.

> Some of those thoughts are very much self-accusations and a kind of anger and questioning of the choices I had actually made. (Otto, 75 years)

Feeling devalued by health care providers

All participants discussed how their age-related physical losses increased their dependence on the health care system, and all described having had negative interactions with care providers. They expressed that their psychological distress and life-weariness were met with a lack of response from both primary care doctors and specialists alike, which made it difficult to seek help. Some reported that their interactions with the healthcare system had heightened their hopelessness and left them to believe no help was available. For some participants these experiences triggered suicidal ideation.

Anna suffered from a severely disabling condition, the consequence of an obstetric complication that worsened with age. This condition made her feel embarrassed so she started to withdraw from social life. The operation that would have resolved her condition was not treated as urgent by her medical providers, and then postponed because of the pandemic. Anna lost confidence in the health care system. She felt dismissed and unworthy of living.

> My doctor said it would take three years. (…) and I said, in three years I won't be alive. That's how it felt then. (…) I mean, you can wait three months. But three years. You know, I'm old, so three years is a very long time for me. (Anna, 74 years)

Johan, a man with frequent medical care contacts due to multimorbidity, said that the way health care providers related to him was crucial to his suicidal act. He said that he had never thought of taking his own life until he was discharged from the hospital with very short notice. He believed that the discharge decision was inappropriate and based on an incorrect assessment of his condition.

> The thought of killing myself, it came just then, when the doctor let me down. Then there was nothing more, it was enough. So, then I did it. (Johan, 81 years)

Constricted coping: previous strategies no longer viable

All participants described how their well-being had diminished. They also said that their coping options had become more limited and that coping strategies they had used when they were younger were no longer viable. For some, thoughts of death then started to provide comfort.

Dwindling options for well-being

Participants expressed that as older adults they had fewer paths to well-being as previous coping outlets were reduced. They felt lost when difficulties arose, as they discovered that their previous means of coping no longer worked.

Cecilia had always used baking to feel good about herself and to care for the ones she loved. At the age of 91, she continued to make cakes and cookies and she wanted to be there for everyone, as she had been in the past. Yet baking now made her feel exhausted.

Sam described a challenging upbringing but was determined to leave it behind and live a full life. He described himself as a lifelong hypochondriac. As he aged, his somatic concerns became more frequent and harder to treat, making it increasingly difficult to find relief. He felt guilty about contacting his health care providers so often. Shortly before he self-poisoned he read the doctor's notes and felt rejected by the negative tone of the notes.

> I constantly visit the primary care center (…), I've been there often, unfortunately. But then they wrote about this (his excessive consultations and hypochondria) in my medical record online. I didn't know that they always write (their notes) on the internet. (…) I was so saddened by what I read. (Sam, 76 years)

Otto reported that age-related losses in physical capacities reduced his autonomy and sense of freedom, ultimately resulting in depression. He said that when he was younger, he tackled challenges by actively altering the course of his life when things were not as he desired. He explained that age-related losses in physical vitality deprived him of an important way to deal with anxiety and mental pain.

> Throughout life, I have always felt a power to be able to take hold of things when things come to a standstill. A feeling that I could grab it. If I had been younger, I could have started over like that. I have no real opportunity to do that anymore. (Otto, 75 years)

Otto vividly remembered what it was like to feel physically and mentally strong, to make changes, and to accomplish things. He was painfully aware that his vigorous days were over.

Distraction does not work anymore

All participants said that in the past they had used distraction to deal with difficult circumstances but that distraction was no longer effective. They also said that the loss of distraction as a coping mechanism contributed to their suicidal act.

Otto could no longer engage in things that mattered to him. He described his unsuccessful attempts to distract himself from anxiety by reading or listening the radio.

> So, the anxiety lies quite close under the surface. And one way to deal with that anxiety is to just flip through a newspaper, start a book, listen to the radio. Sometimes I find myself doing it all at the same time, I turn on the radio and I open a book, and … in that pattern I see a desperation. (Otto, 75 years)

Anna used alcohol as a distraction and a way to cope while waiting for needed surgery. Over the years, her alcohol consumption increased to the point of becoming an addiction.

> The alcohol was something I resorted to in order to cope in some way. Alcohol numbs emotions somehow. (…) But it was too much. (Anna, 74 years)

Anna said that she experienced an overwhelming sense of being unwanted and unworthy. Eventually alcohol was no longer effective as a distraction. One day she called up a relative and admitted that she was an alcoholic. Within days of that phone call, she engaged in a suicidal act.

Suicide as a way of coping

Three different patterns were evident regarding thoughts of death and suicide. Some participants could not recall thoughts of death or suicide prior to the suicidal act. Others said that prior to the act they had thoughts of death but not of suicide. Yet others reported suicide thoughts prior to the suicidal act.

Sam, Ben, and Cecilia reported feeling hopeless, fatigued, resigned and desperate. They also said that that had not experienced life-weariness or death wishes before their suicidal

act. The idea of suicide was so alien to them that they avoided speaking about their suicidal act with words like suicidal thoughts and suicidal act.

Tom and Anna remembered having had thoughts of death before their suicidal act. They recalled wishing to die quickly and painlessly. However, they did not recall having had thoughts of suicide prior to the act.

Johan had no previous history of suicidal thoughts but reported having had suicidal thoughts in short proximity of his suicidal act. Emma, Otto, and Jane had experienced suicidal thoughts earlier in life and talked openly about death and suicide. They said that thoughts of suicide and euthanasia offered them a mental escape when anxiety and depression became overwhelming. Suicide felt like an option, and a relief, when the other coping strategies did not work.

> I remember carrying it with me like a kind of … comfort or I don't know which word is quite right. Comfort or … consolation, the possibility that, even if it gets even more damn hard, if it gets even darker, then I get out. …so, it gave a certain relief … It sounds paradoxical, but it gave a kind of hopefulness … There was still a way out. (Otto, 75 years)

Emma described experiencing an almost constant wish to die. Because she had survived multiple suicidal acts, she came to doubt her ability to take her own life. Therefore, she found herself thinking about euthanasia.

> I have thought that out in detail … We go down (to Switzerland), both the children and the grandchildren. (…). We check in to a hotel, and then we have a good time there for an afternoon and an evening. And then the next day… (Emma, 80 years)

Emma explained how the idea of euthanasia made her feel more at ease, implying that she could avoid guilt and stigma if a physician prescribed the fatal dose.

The suicidal act: a time of inner chaos

All participants characterized the suicidal act as impulsive. None reported planning. As shown in Table 1, only one participant reported communicating their suicidal intention. This individual texted his spouse as he embarked on the act. Participants said that they experienced a sense of detachment during the suicidal act, an inability to think rationally, and a disregard for the outcomes and consequences of the act. From the participants' accounts, two patterns became apparent. For some suicide came to represent a way out of life struggles. For others the suicidal act was unexplainable.

The suicidal act as a way out of life struggles

This theme captures the experiences of those who acknowledged having had either death and/or suicidal ideation before the suicidal act. In their chaotic state, suicide appeared to be the only solution to escape their life challenges.

After feeling wronged by the health care professionals, Johan said that suicidal ideation came abruptly. He recalled having one thought - that he wanted to escape it all.

> In that situation, I'm so confused that I don't know what I'm thinking about - I don't have any anchor points then. (…). Then there was only one thought, ….I don't want to be here. There was nothing more to do, this was the solution I could come up with. (Johan, 81 years)

Emma remembered feeling unbearable pain in her leg. She was unable to get a hold of the home care service. Feeling desperate, she climbed onto the windowsill of her sixth-floor apartment.

> I didn't want to jump to my death, I never even thought that far. But maybe there was something there, in the back of my mind. It wasn't planned (…) But desperate. Because I mean, if you stand on the sixth floor and say you're going to jump, there's only death down there, I suppose, (…). I simply didn't think about the consequences. The only thing I wanted was someone to come and help me. (Emma, 80 years)

Emma said that the suicidal ideation that she had experienced in connection with her most recent suicidal act was different from the suicidal ideation of her prior acts. Her past suicidal acts had involved a conscious decision to kill herself, whereas the most recent suicidal act occurred in a chaotic state of confusion and despair.

Suicidal behavior without suicidal ideation

Some participants said that their suicidal act was not preceded by ideation. They described feeling confused and without comprehension of their behavior. It "just happened." They also said that they could not recall the details surrounding their suicidal act. These participants appeared to experience a lack of agency regarding their suicidal act. They said that they were "not themselves", and that the act was incomprehensible to them. These individuals also said that they had felt overwhelmed by unbearable emotions, an emotional chaos. They described the suicidal state as a state of mental breakdown.

Tom's recollection of the suicidal act was that he had acted on an impulse, and that the impulsivity frightened him. Tom realized that his act could have been lethal. What prevented his from killing himself is that the knot he had made in the rope did not hold.

> I didn't think about the consequences at all. It was absolutely insane. The idea was just to check the height and stuff like that (the rope). But why do you do that (try to hang yourself)? Because I really had no intention of doing it at the time. But it was so stupid … It's like I said … it's all a bit hazy. (Tom, 75 years)

Sam said that his suicide act was unplanned. He reported having no suicidal thoughts before the act. He described that he had felt sad, invalided and rejected. He maintained that he was not on his right mind when he took the tablets that could have killed him. Given his long-time health anxiety and fear of death, he could not explain why he had engaged in a suicidal act.

> I don't remember, I just took those damn tablets. I took a huge glass of booze too. I had a bottle ….at home, I took it (…). It was such a strange feeling; I don't know why. It's the opposite, I'm worried about my health. And I now think a lot, why did I do that thing, terrible. Why did I do it? (Sam, 76 years)

After the suicidal act: coping (or not) in the aftermath

Some respondents talked about how the suicidal act changed their relationships with health care providers and family members. For some, there were also shifts in self-awareness, which influenced their ability to seek help. Those who engaged in a suicidal act without ideation struggled the most in the aftermath because they felt clueless and helpless about the act they had engaged in.

Gained access to needed medical care

Several participants gained access to the medical care they needed after receiving psychiatric care following their suicidal act. Some related that their suicidal ideation resolved once their medical care needs were taken seriously.

Anna believed that the hospitalization at the psychiatric ward following the suicidal act facilitated her access to the surgery she had sought for a long time.

> I probably only got the operation because the doctor (psychiatrist) wrote something to someone … well, I don't know what they wrote, but I think they influenced it. (…) I felt … they took me seriously. After all, no one had done that before. (Anna, 74 years)

After the surgical procedure Anna reduced her alcohol intake and experienced no further suicidal ideation.

Ben told a similar story. In the aftermath of his suicidal act, he met a psychiatrist who initiated psychotropic medication appropriate for his condition. This experience restored Ben's trust in the healthcare system. Ben said he had learned that good professional support was available. He said that he would seek professional help if he encountered another suicidal crisis.

Understanding of own suicidal behavior catalyzes help-seeking

For those who explained their suicidal behavior as a response to a life problem and made changes to alleviate that problem, the suicidal act contributed to increased self-understanding. These individuals also developed a greater awareness of their own needs.

Johan recalled a suicidal ideation episode that occurred several months after his suicidal act. When the senior centre closed due to the pandemic, he experienced loneliness and isolation. Eventually, his thinking took a positive turn.

> I sat there and the walls were staring at me. It was a pandemic, everything was closed. This is not good for me. I can't sit here. Since I have thought about it before and made an attempt, the thought came quickly when I was in that situation. I felt no reason to continue living. Just because my life was sitting on the sofa … I wasn't allowed to go out, not to take the bus, not do anything … So, it was like, the world had shrunk. (Johan, 81 years)

This time Johan did not try to handle the problem alone. He engaged in conversations with his children and with care professionals at the geriatric psychiatry clinic. Johan reported that the suicidal act had enabled him to better recognize and understand his own needs, which made it possible for him to adapt to new conditions and make important life changes. He said that he had learned that social connections played a vital role in his well-being and started acting in ways more congruent with his social needs.

Some participants talked about changing their perspective on suicide as it became apparent that their suicide would have negatively impacted their loved ones. For Otto, seeing his wife's reaction after his suicidal act made him realize that his suicide would have hurt her.

> This feeling about relief was so enticing it overshadowed it … I didn't think through realistically what it would mean for other people. (…) Because I can't do this, to my wife in particular. So, like that, the door has been closed. It's like I've decided that I can't do it, I can't do it and … and that thought should have existed earlier… (Otto, 75 years)

Inability to explain the suicidal act may create vulnerability

Those who engaged in a suicidal act without awareness of prior suicidal ideation struggled to make sense of their suicidal behavior. Several said that they were not themselves or described themselves from the outside, distancing from their suicidal act by attributing it to their illness, or by minimizing the seriousness of the act and described it as impulsive.

Cecilia explained that she could not, and never would, understand why she had engaged in a suicidal act.

> This happened … and I'll never understand … and I can't understand … I cannot imagine anyone being able to

> understand that something like that happens to people. (Cecilia, 91 years)

For Sam, the question of why he engaged in a suicidal act occupied his thoughts, causing anxiety.

> I regret it something terribly, now. That's the worst. Why did I do that? I go and ruminate. Since I am so afraid of death and of diseases, why did I do it? That's the only thing I can think of. Why did I do that? (Sam, 76 years)

After the suicidal act, Sam lived in fear of having inflicted long-term damage upon himself.

Discussion

In this study we aimed to explore how individuals aged 70 or older understand their suicidal act and the changes that followed. A first set of findings is that the participants described their suicidal behavior as a response to feelings of alienation from oneself and from others, following aging-related losses (i.e., in physical and cognitive functions, social roles and relationships) that rendered their previous means of coping no longer viable. These findings are consistent with a diversity of evidence that late-life suicidal behavior often occurs in the context of aging-related losses (e.g., 25, 26). The participants expressed despair over their dependence on a healthcare system that they perceived as indifferent and dismissive of their suffering. Their experience could be construed as a lack of visibility. The latter, defined as "feeling invisible or disconnected from others" (15, p. 638) also emerged as a theme in the qualitative study by Crocker and colleagues. As older people are more dependent on the health care system, the quality of the interactions with health professionals may be particularly influential for well-being.

Participants in our study described a lack of response from primary care and specialist physicians concerning information and coordination of care as well as unhelpful responses to their feelings of life-weariness and other psychological concerns. They were left with a belief that there was no help available, which heightened their sense of hopelessness. In a few cases the participant said that such hopelessness triggered the suicidal act.

A second set of findings is that the suicidal act was described as impulsive. The participants experienced the suicidal state as a time of mental chaos. This contrasts with a dominant theme in the literature, that older adult suicidality typically follows long-standing planning (8). One reason for our findings may be that this study focused on nonfatal suicidal behavior. Planned acts may be more likely to be fatal. Another reason could be shame, given the stigma associated with suicidality; or guilt related to how their suicidal act hurt significant others. In high-income European-descent communities, women and men may have different reasons for describing their suicidal act as unplanned. For women a reason may be that they are socialized to view themselves as emotional and impulsive. For men, a reason may be to distance themselves from a behavior and an outcome (an "attempted" and "failed" suicidal act) that is associated with femininity. In European-descent communities, men are supposed to do suicide "right" the first time, that is, not to survive a suicidal act (see 27–29 for reviews). Given the negative meanings associated with surviving a suicidal act, there may be more variability in older-adult-suicide planning and death intentionality than has been assumed so far. The older-adult suicide planning question should be addressed in larger studies across geographical and cultural settings. Further, the finding that the suicidal state felt like a cognitive and emotional meltdown is consistent with a diversity of evidence derived from studies focusing on younger suicidal persons. Cognitive deficits have been observed in older adults who engaged in a suicidal act as compared to depressed controls who did not (30, 31). The participants in our study were older and had lower ratings of global cognition, compared to the participant of the studies by Crocker and colleagues (2006) and Bonnewyn and colleagues (2014). The age and cognitive characteristics of our study's participants were more similar to those of participants included in a previous Swedish study (18). In this latter study, 15% of the older adult participants reported having no explanation for their suicidal act. One question is whether late-onset suicidal behavior is a distinct type, with greater cognitive decline and distinct personality traits, for example, rigidity, than earlier onset suicidal behavior (32). In our study, the older adults whose first suicidal act occurred late in life were more likely to report an inability to recognize or adjust to age-related changes, which could suggest rigidity. For those participants the suicidal act was described as something that "happened to them" - emphasizing that their suicidal action occurred in a state of cognitive meltdown. Older adults with a previous history of suicidal behavior may be more similar in personality, coping and mental health history to younger adult individuals who engage in suicidal behavior (32).

A third set of findings is that the participants who reported having had suicidal ideation prior to the act and/or who had insights into its triggers experienced positive changes after the act. Some gained access to good medical care. Others said that they developed increased awareness about their own needs and became more effective at coping. In contrast, participants who said that they had not had suicidal thoughts prior the act and who could not explain their behavior did not report positive changes followed the suicidal act. Although the participants in our study did not directly talk about the act in terms of taking control over their own destiny, there are indication that for some the suicidal act was an attempt to escape a situation of lost control. Studies of control issues in suicide were recently reviewed by Owsiany and Fiske (33). This review concluded that engaging in suicidal behavior as a way to exercise control is relevant to older adult suicidal ideation and nonfatal suicidal behavior. Our study's results suggest that control and understanding may also be important for recovery.

All but one of the participants were on antidepressants at the time of their suicidal act. Such medication was initiated shortly before the suicidal act in two cases; one participant responded with a manic episode and one with increased anxiety. The debate as to whether antidepressants might increase or decrease the likelihood of suicidal behavior is ongoing. One study found increased suicide

probability in young adults who were taking antidepressants, and decreased suicide probability in individuals age 65 and over on antidepressants (34).

Methodological considerations

This study's findings should be interpreted in light of the study's cultural, social and economic context. Overall, the suicide rate in Sweden is lower than the average rate for OECD countries. The 2023 suicide rate was 20.7/100 000 in the 65+ population (women, 11.1/100 000; men, 31.6/100 000) (21). Sweden is a strong welfare state with a public pension system and publicly-funded healthcare. These data indicate that Sweden is a country that provides strong support and resources to its older citizens. Life expectancy is 84.9 years for women and 81.6 years for men. Sweden's investment in its population has translated in improvements in national health outcomes and high expectations on the part of persons seeking health care. There are also indications of distress in the Swedish older adult population. Antidepressants are widely prescribed to older adults, with substantial differences by sex (women aged 75+, 24%; men 75+, 15%) (35).

A contribution of this study is that it focused not only on what older adults said about what led to their suicidal act but also what changed in them and in their circumstances after the suicidal act. A strength of this study is that it used a two-interview approach. This allowed the participants time for rest and reflection between interviews, and the interviewer time to formulate follow-up questions.

Several methodological features of this study constrain the interpretation of its findings. First, this study sample was small (n=9). Second, it is not known whether the older adults who declined participation differed in systematic ways from those who chose to take part in the study. Third, the research team was mainly composed of professionals with clinical interests and experiences. While this study's research protocol was designed with a strong focus on the narrative of each participant, the IPA approach is interpretive and builds on the research team's experiences. The research team's clinical interest and experiences privileged attention to clinical theories of suicidality and clinical themes in the data. A team with other interests and frameworks (e.g., a gender framework, a socioeconomic framework) could bring to light other themes in the data. Finally, results of our study cannot be directly transferred to settings with other types of health care systems with more limited availability of services.

Clinical implications

Health care contacts can be suicidogenic as well as suicide-preventive. Some of this study's respondents described their suicidality as a response to health care professionals they perceived as indifferent and even dismissive of their physical and psychological suffering. In fact, a woman and a man reported that their suicidality resolved once they received the specialist medical care they needed for their physical issues. A potential clinical implication is that continued attention needs to be given to implicit ageism in medical professionals and systems. From this perspective our findings are relevant not only for general practitioners and psychiatrists but also for physicians working in specialist care settings. Older adults are less likely than younger adults to report symptoms related to suicidal behavior, even upon direct questioning (36). Taken together, the findings about older adult suicidality raise questions about the effectiveness with older adults of conventional suicide risk assessment protocols. If the participants in this study had been asked by their general practitioners about their suicidal thoughts, or even about life-weariness, most would likely have reported that they had experienced neither around the time of their suicidal act. What they might have described were feelings of hopelessness, fatigue, resignation and despair about various life challenges. Therefore, it might be more fruitful for professionals working with older adults to focus on life challenges and assess the feelings the older adults have about these challenges – in addition to or instead of conventional suicide risk assessment methods. Another clinical consideration salient to suicide prevention involves restricting means that can be employed in suicide. In our Swedish setting, as in many others, self-poisoning is commonly employed in late-life suicidal behavior (11). This points to the need to better monitor older adults' prescriptions and use of psychotropic medication.

The study's participants who lacked comprehension about their suicidal act might be at particular risk of future suicidal behavior. They might benefit from a psychological treatment that focuses on creating a narrative around the suicidal phase. Such treatment could help them regain a sense of control over their own life. A promising treatment is the Swiss-based Attempted Suicide Short Intervention Program (ASSIP) (37). In ASSIP the suicidal person's narrative is central for understanding reasons for living and decreasing dysfunctional coping (37). The ASSIP model is based on the premise that individual behavior is understandable through the lens of the person's life history, individual vulnerability, life goals, and basic needs.

Finally, the prevention of late life suicidal behavior should go beyond changes in the health care system. Community-based programs need to be developed for older adults (38). Also, public health interventions that reduce ageism and increase social connectedness are sorely needed.

Additional directions for future research

Research should continue to focus on the question of why suicide is the way of coping with various adversities, including aging adversities, for some older adults and not most others (28).

In this study some of the narratives of the suicidal trajectory and its aftermath were gendered. For example, challenges to their identity as caregivers in private relationships were highlighted by women, and challenges to their identity as related to mastery in public domains were emphasized by men. Building on gender- and older-adult suicide-scripts theory (39, 28) and evidence (e.g., 40)

future research should include questions about gender beliefs and norms of older adult suicidality and examine older adult women's and men's narratives in light of these beliefs and norms.

Considering the burden of physical illness and functional limitations that accompany aging, together with the challenges related to the health care system described by all participants in this study, we need to know more about how and why contacts with health care providers may increase rather than alleviate suffering. The role of cognitive impairment in the suicidal process in general, and in the switch from ideation to suicidal action, in particular is another area for future studies.

Data availability statement

The datasets presented in this article are not readily available because the data cannot be sufficiently de-identified to protect the privacy of the participants, making it unsuitable for sharing. Requests to access the datasets should be directed to sara.hed@gu.se.

Ethics statement

The study was approved by Gothenburg Regional Ethics Committee (EPN Dnr 2020-00321). The study was conducted in accordance with the local legislation and institutional requirements. The participants gave written informed consent to participate in this study.

Author contributions

SH: Writing – original draft, Writing – review & editing. AIB: Writing – review & editing. SW: Writing – review & editing. JS: Writing – review & editing. SSC: Writing – review & editing. MW: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. The study was financed by grants from the Swedish state under the agreement between the Swedish government and the county councils, the ALF-agreement (ALFGBG-942661 and ALFGBG-965525); The Swedish Research Council, Grantnumber 2016–01590; The Swedish Research Council for Health, Working Life and Welfare, Grant numbers: AGECAP 2013–2300, Waern's Program Grant 2016–07097, 2020–00547 and the Hjalmar Svensson Research Foundation.

Acknowledgments

We wish to express our deepest gratitude to the respondents who generously shared their stories, often with the expressed intent that knowledge of their experiences may help others. We also wish to thank the clinical staff at the geriatric psychiatric clinic for their invaluable assistance with recruitment.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1450683/full#supplementary-material

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 17 September 2024
DOI 10.3389/fpsyt.2024.1455247

OPEN ACCESS

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RECEIVED 26 June 2024
ACCEPTED 23 August 2024
PUBLISHED 17 September 2024

CITATION
Meda N, Zammarrelli J, Sambataro F and De Leo D (2024) Late-life suicide: machine learning predictors from a large European longitudinal cohort.
Front. Psychiatry 15:1455247.
doi: 10.3389/fpsyt.2024.1455247

Late-life suicide: machine learning predictors from a large European longitudinal cohort

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Background: People in late adulthood die by suicide at the highest rate worldwide. However, there are still no tools to help predict the risk of death from suicide in old age. Here, we leveraged the Survey of Health, Ageing, and Retirement in Europe (SHARE) prospective dataset to train and test a machine learning model to identify predictors for suicide in late life.

Methods: Of more than 16,000 deaths recorded, 74 were suicides. We matched 73 individuals who died by suicide with people who died by accident, according to sex (28.8% female in the total sample), age at death (67 ± 16.4 years), suicidal ideation (measured with the EURO-D scale), and the number of chronic illnesses. A random forest algorithm was trained on demographic data, physical health, depression, and cognitive functioning to extract essential variables for predicting death from suicide and then tested on the test set.

Results: The random forest algorithm had an accuracy of 79% (95% CI 0.60-0.92, p = 0.002), a sensitivity of.80, and a specificity of.78. Among the variables contributing to the model performance, the three most important factors were how long the participant was ill before death, the frequency of contact with the next of kin and the number of offspring still alive.

Conclusions: Prospective clinical and social information can predict death from suicide with good accuracy in late adulthood. Most of the variables that surfaced as risk factors can be attributed to the construct of social connectedness, which has been shown to play a decisive role in suicide in late life.

KEYWORDS

suicide, old adults, belongingness, social connection, illness duration

Introduction

Suicide among people of old age is a serious public health concern. It is well-known that populations around the world are getting older (1), and this trend sets a growing concern about the need to address the issue of suicide risk among middle-aged and older adults.

Globally, from 1990 to 2017, age-standardized suicide death rates decreased by 32.7% (2), and quality of life and access to health care improved (3). However, suicide rates among individuals aged 65 and over are still the highest among men and women in nearly all regions of the world (2, 4–6). In general, suicide rates tend to increase with advancing age: suicide in old age affects 27.45 individuals per 100,000 population in the age group over 70 years and approximately 17 people per 100,000 inhabitants in the 50-69 age group (5). Moreover, suicide rates are underestimated, especially among older people (7). In addition, the unequivocal attribution of a manner of death to suicide can sometimes be challenging due to a possible attempt of the person to disguise the suicidal intent (e.g., as in some single road traffic deaths (8),) or due to the peculiar circumstances of death (e.g., as in house accidents or falls (3, 7)).

Epidemiologists forecast that, in less than 30 years (9), there may be an almost doubling of the older adult population and a growing percentage of single-nuclear families. This prediction leaves researchers and mental health professionals afraid of an increase in loneliness and dependence, which are factors frequently implicated in suicidal behavior (10, 11). The aging process and death from suicide are two psychosocial phenomena linked by a multidimensional and multifactorial nature (12). Old age is generally associated with a decline in physical and mental functions and an increase in chronic and physical diseases that often result in functional limitations and disabilities (13). Changes in social status and loss of social networks and family support are also commonly experienced as individuals age. These are stressors that can affect the quality of life of individuals and increase vulnerability to mental health problems and suicide risk (14–16). Although several risk factors for suicidal behavior have been identified, practical tools to accurately predict which individuals, especially older people, will attempt or die by suicide are substantially lacking (17). A prevention-oriented risk assessment implies identifying longitudinal predictors that may significantly increase the odds of death from suicide and that can be addressed (i.e., mitigated) to decrease the risk of suicide (18, 19).

Important recommendations to improve suicide risk assessment include considering contextual and sociocultural factors of suicidal behavior (20, 21) and possibly leveraging large amounts of data and machine learning techniques to increase the calculation capacity and the possibility of identifying people at risk (22–24). The combination of all available information (data from questionnaires and socio-demographic and clinical factors) could provide better assessment capabilities for preventing suicide (25–28). Noteworthily, given the higher lethality of suicide attempts in late life [lethal to non-lethal suicide attempt ratio is 1:4 in late life and 1:200 in young adults (29)], there is potentially no room for secondary prevention. Thus, effective primary prevention of suicide is the most meaningful outcome to pursue in this population.

Implementing a machine learning-based predictive approach in suicide prevention offers solutions to the challenges of modeling complex, high-dimensional data with non-linear relationships. Overcoming these challenges with common statistical approaches is non-trivial. In particular, random forest models assess the importance of different features in predicting suicide risk while being less prone to overfitting compared to logistic regression.

In this study, we queried the large prospective dataset from the *Survey of Health, Aging, and Retirement in Europe* (SHARE) (30, 31), comprising more than 16,000 deaths from different causes (and 74 deaths from suicide), to develop a machine learning algorithm for suicide prediction in older people. We matched the case and control samples by suicide ideation and then implemented a random forest model, as previously done to predict suicide (32, 33). The expedient of matching by suicidal ideation ensures that the model will not rely on this variable. This choice is crucial for two reasons. The first is statistical, as suicidal ideation is only moderately associated with death by suicide (34); thus, the model could heavily bias its classification based on another suicide-related variable; the second is practical, as suicidal ideation (as well as death thoughts/wishes) can remain undisclosed (35, 36) or be denied (37). We hypothesized that social and physical health-related variables would be the most important variables that the algorithm leveraged to predict suicide (13–16). Thus, we aimed at developing a proof-of-concept algorithm as well as testing the association between constructs of social (dis)connectedness and suicide in older adults.

Materials and methods

Dataset curation

The *Survey of Health, Aging, and Retirement in Europe* (SHARE) (30, 31) is a research infrastructure that collects prospective data on physical, mental, social, and economic well-being and independence in activities of daily living of nationally representative samples of people aged 50 or over in Europe. Participants are residents of 28 European nations and Israel. Sampling bias was addressed by SHARE researchers by sampling SHARE participants using probability selection methods. This dataset is coordinated by the Munich Center for the Economics of Aging (MEA) in collaboration with the English Longitudinal Study of Aging (ELSA) and the U.S. Health and Retirement Study (HRS). Since 2005, the research consortium has collected data on the abovementioned variables in eight "waves." From the second wave onward, data on the cause, manner, circumstances, and antecedents (up to 1 year before) of death were collected if a participant died in the period between the waves. In such a case, the next-of-kin completed an interview as a proxy interviewee. From wave 2 to wave 9 (excluding wave three for reasons explained below), 16,548 deaths were recorded. Study design, sampling, and data resources for SHARE are described in detail elsewhere (30) and can be found online (https://share-eric.eu/).

Data retrieved from the SHARE dataset were managed with RStudio 4.1.2 (38). First, we grouped all interviews after death for each *n*-wave. We matched the information collected therein to the health, demographic, and social factors that the participant, who then died, provided in the *n-1* wave. We chose the interview preceding death as the baseline for the following reason: each participant, unless they dropped out of the study, had completed at least two interviews (one by themselves, the second by the next of kin had death occurred) and, among participants, the number of completed interviews (waves) could vary enough to make a data analysis plan non-trivial.

Since data on participants' mental health in wave three were not collected as in other waves, we opted not to consider the deaths that occurred in wave four. We thus obtained a dataset that matched before-death information on mental, physical, social, and economic well-being to the cause of death and its circumstances for each wave from 2005 to 2020. The variables considered in the analysis were demographics and household variables (e.g., household size, help received), antecedents to death, behavioral risks (e.g., smoking), cognitive functioning, financial and economic health, physical health (including measurement of grip strength), mental health (e.g., depressive symptoms). See the Supplementary Material for the complete list of variables (Supplementary Table S1). Given that the baseline measures could have varied from wave to wave, we harmonized the dataset by removing the variables not shared across the waves (all the variables included in the analysis are reported in Supplementary Appendix Table S1).

Statistical analysis

In the seven waves analyzed, 74 deaths by suicide were observed. One of such deaths was later not included in the analysis as the age of death was not collected. We matched the participants who died by suicide one-on-one, by nearest neighbor rule (39), with participants who died in an accident [as in (40, 41)] by gender, age at death, number of chronic physical illnesses, and wish to be dead (present, absent, "do not know" and refuse to report). If data regarding the outcome of interest (i.e., manner of death) or variables on which matching was performed (e.g., suicidal ideation/age at death) were missing, the participant(s) were excluded from further analysis. We used the default and most common matching technique for the nearest neighbor method, propensity score difference (42, 43).

Suicidal ideation was assessed by the interviewer with EURO-D scale item 4: "In the last month, have you felt that you would rather be dead?". Any mention of suicidal feelings or wishing to be dead was marked as the presence of at least some degree of wish to die. Therefore, active suicidal ideation and passive suicidal ideation were not differentiated in this dataset. The remaining NA values were imputed using median values of the same variable per timepoint (baseline or follow-up) (44). Furthermore, we transformed two variables, the frequency of contact with next-of-kin and the duration of illness, from categorical predictors (e.g., daily contacts = 6, …, weekly contacts = 4) to continuous numeric variables, since we thought that these data would be more informative in a numeric format.

Lastly, the dataset was divided 80/20 into two subsets [train and test (45)]. The larger subset (deaths by suicide = 59; deaths by accident = 58) was used to train a multivariable random forest model in R [(46) see also Methods S1] and thus identify which factors could be leveraged to distinguish death from suicide from death from accident; the remaining subset was used to test the metrics of the model (sensitivity, specificity, overall accuracy, etc.). We opted to employ random forest algorithms because we expected the dataset to contain a large number of potentially useful predictors, with some of them being collinear or interacting with each other in a non-linear fashion. Moreover, random forests deal well with high dimensional data (47). It has also been shown to be effective even with small sample sizes (48). A random forest is an ensemble learning method used for classification and regression tasks in machine learning. In our case, the random forest for classification starts by creating multiple bootstrap samples. For each bootstrap sample, a decision tree is constructed. Instead of considering all features (variables) for splitting at each decision tree node, a random subset of features is chosen. This process makes the trees decorrelated and reduces overfitting.

Once all decision trees have been constructed, predictions are made for each tree. For classification tasks, each tree's prediction is considered a "vote," and the class with the most votes becomes the final prediction. Performance metrics to evaluate the performance of a random forest model could be accuracy, sensitivity, and specificity. Data visualization was aided by the *randomForestExplainer* package (49).

Results

Population characteristics

A total of 146 individuals were included in this analysis (Table 1): half died by suicide, and the other half by accident. Most of the participants lived in Estonia (14.4%), Belgium (10.3%), France (8.9%), Austria (8.2%), Czech Republic (7.5%), and Greece (6.8%), while the rest were from various European countries. Approximately 75% of the deceased were men, and the total sample age of death was 68.05 ± 16.41 years. The next-of-kin who answered the after-death interview was the partner in 40.4% of cases and a son/daughter in 19.2% of cases; notably, a non-relative in approximately 1 out of 4 deceased (a next-of-kin could have also been a neighbor or someone helping in the house). The mean number of children still alive at the participant's death was 1.90 ± 1.92. Regarding when the deceased had contact with next-of-kin in the last year, in most cases (59.6%), the contact occurred daily. In 1 in 10 cases, the contacts occurred less than once a month or never in the last year.

Regarding the duration of the illness before death, the most frequent answers were one year or more (24%) and less than one month (59.6%). Regarding the total time spent hospitalized, 90.4% of the sample stayed in hospital between 1 and 4 weeks in the last year. Sensitivity analysis for groups of illnesses and reasons for hospital stays could not be conducted because of the reduced sample size and/or unavailability of further details. More than

TABLE 1 Sample characteristics of the overall sample and after stratification for cause of death.

		Overall	Accident	Suicide	*p-value*
Sample N		146	73	73	
Country (%)	Austria	12 (8.2)	5 (6.8)	7 (9.6)	n.s.
	Belgium	15 (10.3)	4 (5.5)	11 (15.1)	
	Czech Republic	11 (7.5)	4 (5.5)	7 (9.6)	
	Denmark	5 (3.4)	1 (1.4)	4 (5.5)	
	Estonia	21 (14.4)	8 (11.0)	13 (17.8)	
	France	13 (8.9)	4 (5.5)	9 (12.3)	
	Germany	4 (2.7)	3 (4.1)	1 (1.4)	
	Greece	10 (6.8)	10 (13.7)	0 (0.0)	
	Hungary	3 (2.1)	2 (2.7)	1 (1.4)	
	Israel	9 (6.2)	7 (9.6)	2 (2.7)	
	Italy	3 (2.1)	3 (4.1)	0 (0.0)	
	Latvia	1 (0.7)	1 (1.4)	0 (0.0)	
	Netherlands	3 (2.1)	2 (2.7)	1 (1.4)	
	Poland	9 (6.2)	5 (6.8)	4 (5.5)	
	Portugal	2 (1.4)	1 (1.4)	1 (1.4)	
	Romania	3 (2.1)	3 (4.1)	0 (0.0)	
	Slovakia	1 (0.7)	1 (1.4)	0 (0.0)	
	Slovenia	3 (2.1)	0 (0.0)	3 (4.1)	
	Spain	9 (6.2)	5 (6.8)	4 (5.5)	
	Sweden	4 (2.7)	2 (2.7)	2 (2.7)	
	Switzerland	5 (3.4)	2 (2.7)	3 (4.1)	
Gender (%)	Male	109 (74.7)	57 (78.1)	52 (71.2)	n.s.
	Female	37 (25.3)	16 (21.9)	21 (28.8)	
Age of death (mean (SD))		68.05 (16.41)	68.92 (16.52)	67.18 (16.36)	n.s.
Next-of-kin/Relationship to the deceased (%)	Husband/wife/partner	59 (40.4)	32 (43.8)	27 (37.0)	n.s.
	Son/Daughter	28 (19.2)	14 (19.2)	14 (19.2)	
	Son-/Daughter-in-law	2 (1.4)	2 (2.7)	0 (0.0)	
	Son/Daughter of husband, wife or partner	2 (1.4)	1 (1.4)	1 (1.4)	
	Grandchild	1 (0.7)	1 (1.4)	0 (0.0)	
	Sibling	6 (4.1)	3 (4.1)	3 (4.1)	
	Other relative	11 (7.5)	6 (8.2)	5 (6.8)	
	Other non-relative	37 (25.3)	14 (19.2)	23 (31.5)	
Frequency of Contact in the last year (%)	Never or Refused to disclose	8 (5.5)	2 (2.7)	6 (8.2)	n.s.
	Less than once a month	7 (4.8)	5 (6.8)	2 (2.7)	
	About once a month	4 (2.7)	0 (0.0)	4 (5.5)	
	About every two weeks	9 (6.2)	3 (4.1)	6 (8.2)	
	About once a week	6 (4.1)	1 (1.4)	5 (6.8)	
	Several times a week	25 (17.1)	9 (12.3)	16 (21.9)	

(Continued)

TABLE 1 Continued

		Overall	Accident	Suicide	*p-value*
	Daily	87 (59.6)	53 (72.6)	34 (46.6)	
How long Ill before death (%)	Was not ill before death	7 (4.8)	3 (4.1)	4 (5.5)	<0.001
	Less than one month	87 (59.6)	60 (82.2)	27 (37.0)	
	One month or more, but less than 6 months	12 (8.2)	2 (2.7)	10 (13.7)	
	Six months or more, but less than a year	5 (3.4)	0 (0.0)	5 (6.8)	
	One year or more, Don't know, or Refused	35 (24.0)	8 (11.0)	27 (37.0)	
Time in Hospital last year (%)	Less than one week	8 (5.5)	2 (2.7)	6 (8.2)	n.s.
	From one week to one month, Don't Know	132 (90.4)	67 (91.8)	65 (89.0)	
	From one month to three months	4 (2.7)	2 (2.7)	2 (2.7)	
	From three months to a full year	2 (1.4)	2 (2.7)	0 (0.0)	
Care from GP in the last year (%)	Don't know	8 (5.5)	4 (5.5)	4 (5.5)	n.s.
	Yes	93 (63.7)	48 (65.8)	45 (61.6)	
	No	45 (30.8)	21 (28.8)	24 (32.9)	
Hospital stays for therapy in the last year (%)	Yes	131 (89.7)	61 (83.6)	70 (95.9)	n.s.
	No	15 (10.3)	12 (16.4)	3 (4.1)	
Took Medications in the last year (%)	Don't know	10 (6.8)	2 (2.7)	8 (11.0)	n.s.
	Yes	99 (67.8)	52 (71.2)	47 (64.4)	
	No	37 (25.3)	19 (26.0)	18 (24.7)	
Difficulties in ADL (%)	Refusal	2 (1.4)	1 (1.4)	1 (1.4)	n.s.
	Don't know	7 (4.8)	3 (4.1)	4 (5.5)	
	No	37 (25.3)	20 (27.4)	17 (23.3)	
	Yes	100 (68.5)	49 (67.1)	51 (69.9)	
Hours of Help/Day needed (mean (SD))		6.23 (5.70)	6.96 (6.41)	5.49 (4.83)	n.s.
Decedent Had a Will (%)	Refusal	1 (0.7)	1 (1.4)	0 (0.0)	n.s.
	Don't know	9 (6.2)	1 (1.4)	8 (11.0)	
	Yes	20 (13.7)	10 (13.7)	10 (13.7)	
	No	116 (79.5)	61 (83.6)	55 (75.3)	
Owned.Home (%)	Don't know	1 (0.7)	1 (1.4)	0 (0.0)	n.s.
	Yes	95 (65.1)	52 (71.2)	43 (58.9)	
	No	50 (34.2)	20 (27.4)	30 (41.1)	
# Children Still Alive at death of participant (mean (SD))		1.90 (1.92)	2.05 (1.96)	1.75 (1.89)	n.s.
EURO-Depression Scale Score		2.15 (1.97)	2.12 (2.02)	2.17 (1.93)	n.s.
Suicidal Ideation (%)	Data not reported	92 (63.0)	48 (65.8)	44 (60.3)	n.s.
	Reported some degree of wish to die	6 (4.1)	2 (2.7)	4 (5.5)	
	Denied	48 (32.9)	23 (31.5)	25 (34.2)	
Any Long-term illness (%)	Yes	122 (83.6)	62 (84.9)	60 (82.2)	n.s.
	No	24 (16.4)	11 (15.1)	13 (17.8)	
Last Wave (%)	#2, year 2008	9 (6.2)	6 (8.2)	3 (4.1)	n.s.

(Continued)

TABLE 1 Continued

		Overall	Accident	Suicide	*p-value*
	#3, year 2010	18 (12.3)	9 (12.3)	9 (12.3)	
	#5, year 2015	28 (19.2)	11 (15.1)	17 (23.3)	
	#6, year 2016	33 (22.6)	18 (24.7)	15 (20.5)	
	#7, year 2017	26 (17.8)	12 (16.4)	14 (19.2)	
	#8, year 2018	29 (19.9)	15 (20.5)	14 (19.2)	
	#9, year 2020	3 (2.1)	2 (2.7)	1 (1.4)	

ADL, Activities of Daily; GP, General Practitioner Living; n.s., not significant; SD, standard deviation. Statistical significance was assessed with a Student's t-test for continuous variables or a Chi-square test for frequency data.

half of the sample were visited by their GP at least once in the year before death, and approximately 68% took medication for any physical or mental illness. Difficulties in activities of daily living (ADL) were present in 68.5% of the sample. Regarding long-term diseases, 83.6% of the sample reported having at least one. Only 6 participants (4.1%) reported making any mention of suicidal feelings or the wish to be dead. In contrast, 32.9% of the sample denied such feelings. For 63% of the sample, the interviewer did not report if suicidal ideation was present/absent or if the participant did not know or refused to answer.

Regarding the time gap between the last in-person interview with the participant and the end-of-life interview with the next-of-kin (due to the death of the participant), only one year passed for most death occurrences (43 deaths by suicide and 45 accidents). Two years passed for 11 deaths by accident and ten deaths by suicide (next-of-kin interviews that took place at waves 3 and 9); three years for 17 deaths by accident and 20 by suicide (next-of-kin interviews that took place at waves 2 and 5). Furthermore, 71.2% of the participants did not have a will at the time of death.

No significant differences emerged between participants who died by suicide and those who died by accident, except for the length of illness before death: participants who died by suicide (37%) had been ill for more than one year, while these figures were significantly lower for people who died by accident (11%), who, on the other hand, had a more recent illness onset (82.2% in the previous month compared to 37% of those who died by suicide). Before implementing the random forest model, we conducted a univariate analysis to discern which factors differed between the two population samples before the one-on-one matching (Supplementary-Table S2) and after the matching (Table 1). Before matching, people who died by suicide (n=73) differed significantly from people who died in accidents (n=420) in age at death (69.09 ± 11.78 and 76.72 ± 11.72 respectively – t = 5.041, df = 95.563, p-value <.001) and duration of illness before death (longer duration of illness for people who died by suicide – X-squared = 89.74, df = 5, p <.001). After one-to-one-matching, which included matching also based on age at death, only the duration of the illness before death was still significantly different (X-squared = 33.308, df = 4, p <.001). In the univariate analysis, no other statistically significant differences between the two samples emerged before or after one-on-one matching in the variables of interest.

Random forest model

We implemented a random forest algorithm to determine which factors reported at wave *n-1* (henceforth "baseline") or retrospective information collected from the next-of-kin during the end-of-life interview could be leveraged to improve the prediction of death from suicide at wave *n*.

The algorithm was trained on 80% of the sample to predict two possible outcomes: death from suicide and death from accident. Using the split mentioned above, the algorithm was asked to correctly categorize 58 deaths by accidents and 59 deaths by suicide. At the training level, the overall classification error (out-of-bag estimate of error - OOB) was 33.33% (s.d. = 3.3%), with no striking difference between the misclassification of death from accidents or death from suicide: 39 of 59 deaths by suicide were correctly categorized (error rate 33.89%); out of 58 deaths by accidents, 39 were correctly identified as such (error rate 32.75%). The most important variables (as measured via accuracy and Gini decrease) to tell apart deaths by accident and death from suicide were the following (Figure 1A): the relationship between the next-of-kin and the decedent (the next-of-kin of people who died by suicide was more likely to be a non-relative), the total length of hospitalization in the previous year, and if any access to the hospital was necessary for therapy administration (the need for hospitalization increased the risk of suicide, especially shorter-length hospitalizations), difficulties in the activities of daily living, how many hours of help the decedent needed (the fewer hours of help needed, the higher the risk of suicide) if they owned a home and had a will. The three most important variables identified by the algorithm were: longer duration of illness, less than daily contact with the next-of-kin, and less than three children still alive, which were all independent predictors of suicide. Moreover, we found relevant interactions between the duration of the illness, the number of children still alive, and the frequency of contact with the next of kin (Figure 1B). In particular, a longer-than-one-month illness duration increases the risk of suicide with respect to a shorter length; this risk could be further exacerbated if the participant had fewer than three children still alive (on the other hand, having three or more children mitigated the probability of suicide regardless of the longer-than-one-month illness duration). A similar interaction was present throughout the duration of the illness and contact with

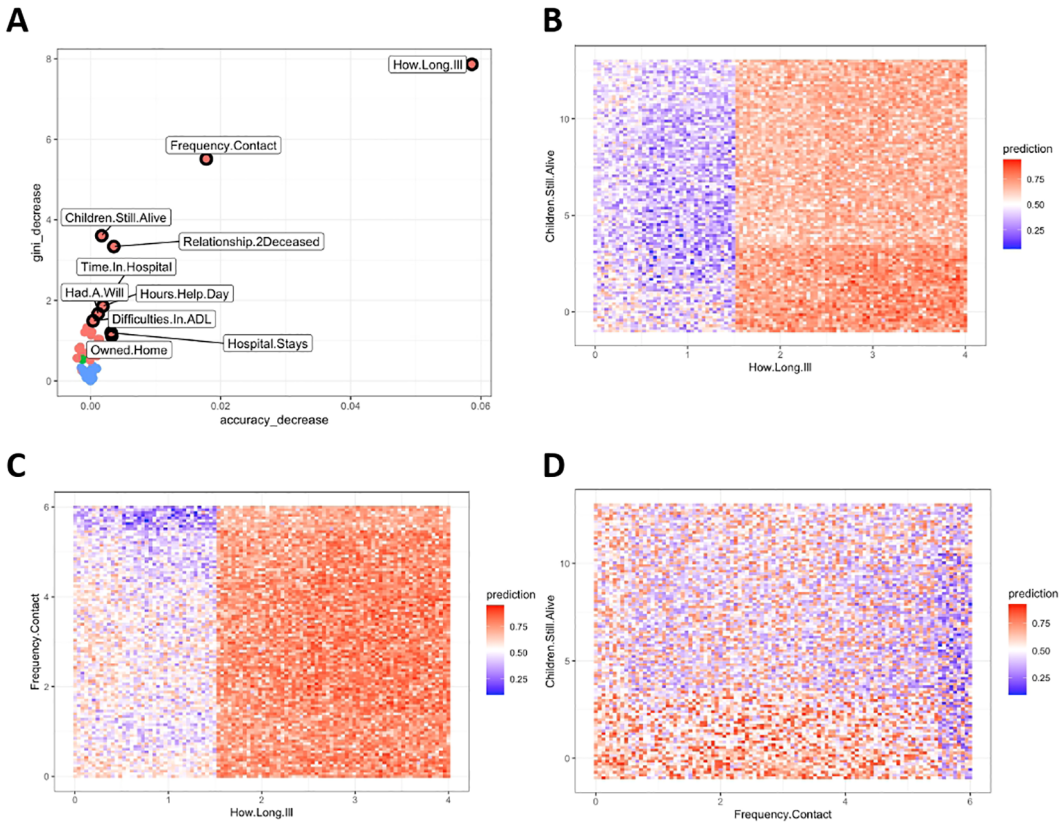

FIGURE 1
Predictors distinguishing death from suicide from death from accident. ADL, Activities of Daily Living. Gini Importance = This index estimates how much a random forest relies on a particular feature in classification. In particular, a decrease of Gini Importance measures how much a variable helps in the correct classification of cases (by assessing the loss of purity if that variable is excluded from the analysis). It measures the average gain of purity by splits of a given variable. If the variable (e.g., duration of illness) is useful, it splits mixed labeled nodes (mixed group of participants that died by suicide or accident) into pure single class nodes (two groups, one with people who died by suicide and one with people who died by accident). Accuracy decrease = It indicates the loss of model performance without each variable (excluded from the analysis one at the time). **(A)** The plot displays variables according to their contribution to the model's performance, as determined by metrics such as accuracy decrease and Gini decrease. Variables closer to the upper right corner have a greater impact to model performance, indicating their higher importance in distinguishing between outcomes (e.g., deaths by suicide vs. accidents). For instance, removing "Duration of Illness – How.Long.Ill" decreases the model's accuracy by 0.06 (6%) and its Gini index by 8 (in range 0-100). **(B)** This panel illustrates the predicted probability of death by suicide, influenced by the duration of illness and the number of children still alive. The color gradient from 0 (deep blue) to 1 (red) represents increasing suicide risk. For example, the lower right corner, where the probability approaches 1, indicates a high likelihood of classifying a death by suicide if the duration of illness is long and the number of children is low. The illness duration is categorized as follows: 1 = less than one month, 2 = 1-6 months, 3 = more than six months, 4 = a year or more. A longer duration typically increases risk, but this can be mitigated if the individual has three or more children alive. **(C)** This plot shows how suicide risk varies with the duration of illness and the frequency of contact with the next-of-kin. The frequency ranges from 0 (=never) to 6 (=daily), with 2 representing about once a month and 4 about once a week. Higher frequencies of contact, especially daily, generally indicated a reduced risk of suicide. However, this protective effect diminishes with longer illness durations. **(D)** This panel examines the relationship between contact frequency with next-of-kin and the number of children still alive on suicide risk. No distinct patterns are evident, but the data suggest that lower contact frequency and fewer children are associated with increased suicide risk.

the next-of-kin (Figure 1C). Noteworthily, less than daily contact with the next-of-kin increased the risk of suicide. Lastly, we found an interaction between the frequency of contact with the next-of-kin and the number of children still alive (Figure 1D). The algorithm identified an increased risk of suicide with a reduced frequency of contact and a smaller number of children still alive.

By leveraging the above variables, the random forest algorithm was required to categorize the deaths of the remaining 20% of the sample. Eleven of the 15 deaths by accidents were correctly identified. Regarding deaths from suicide, the prediction was corrected for 12 out of 14 deaths. This classification yielded an overall accuracy of 0.79 (CI [0.60 – 0.92], p = 0.002) with a sensitivity of.80 and a specificity of.78.

Discussion

In this study, we queried the *Survey of Health, Ageing, and Retirement in Europe* (SHARE) dataset to reveal the predictors of death from suicide in late adulthood. We applied a supervised machine learning (random forest) algorithm to automatically extract the variables deemed important in discerning death from suicide from death from accident after appropriate population matching according to sex, age of death, number of physical illnesses, and suicidal ideation. Our analyses returned several physical and social health variables that are central in distinguishing accidental death from suicide. These variables included the duration of illness, the frequency of contact with the

next-of-kin, the number of children, the time spent in the hospital in the last year, the hours of help per day needed, the presence of difficulties in the activities of daily living, the relationship between the next-of-kin and the decedent. We showed that great importance is placed on the duration of the illness (Figure 1): illnesses lasting more than a month in the year before death were more likely to predict death from suicide than death from accident, and longer-term illnesses (i.e., > one year) posit a higher risk of suicide. Nevertheless, the data from this sample seem to indicate that death from suicide was more probable with a duration of illness of 1-6 months. We argue that this should be considered at least in light of the age of the deceased and the nature of the illness itself: rapid-onset illnesses that hinder the daily activities of individuals or require extensive medical care with no apparent prospect of recovery (50), challenge daily living, and could further exacerbate a deterioration in physical or mental conditions of older people. Contact with healthcare providers has already been shown to be more likely to occur less than a month before death from suicide in older adults than in younger adults (51), probably correlated with a greater need for care. Although detailed analyses would be essential to determine the impact of specific illnesses on suicide, this was unfeasible, as it would have required a larger sample size. However, by leveraging the SHARE dataset, other authors reported that specific system diseases are more likely to be associated with suicidal ideation (52), although no correlation between suicidal ideation and death from suicide could be drawn (53). The most important factors were the frequency of contact with the next-of-kin (who also completed an end-of-life interview by proxy), their relationship with the decedent, and the number of children the individual had before death. In this sample, the next-of-kin of the individuals who died by suicide was a non-relative 31.5% of the time, with respect to 19.2% for those who died by accident, indicating a lesser presence of family members in the life of those who died by suicide. All these variables are related to the participant's social connections before death and indicate the role of interactions with family members (41). The role that family might play in suicide prevention has previously been evidenced, specifically by reducing feelings of loneliness, increasing belongingness, and possibly reducing anxiety and depressive symptoms (16). Here, we report that there could be a "dose threshold" for the frequency of contact with next-of-kin, above which the probability of death from suicide could be diminished. Specifically, we showed that people who had daily or multiple contacts a week with their next-of-kin had a reduced likelihood of dying by suicide, also considering the duration of the disease and the number of children still alive. The algorithm also identified that participants who had no children alive at their death were more likely to have died by suicide than those with children, particularly those with three or more. To further corroborate the hypothesis of the pivotal role of family support in suicide prevention in late life, the algorithm identified the relationship between the next-of-kin and the decedent as a predictor in differentiating death from suicide from death from accident. Few other studies investigated the link between loneliness and death from suicide (54), and a recent meta-analysis also highlighted that no studies published up to 2020 included suicide death as a distinct outcome measure (10). However, most of the published literature indicates a moderate to strong association between loneliness and non-lethal suicidal behaviors. These findings presented herein evidenced that factors related to loneliness may be a predictor of death from suicide, at least in older adults, as postulated by recent theories of suicide (55, 56). Further studies are needed to corroborate our findings in other geographical areas.

Limitations

Although this analysis is based on a prospective, harmonized dataset, it is worth noting that this data survey was not conceptualized for studying suicidal behaviors. Therefore, some important variables related to this phenomenon were not collected. For example, we highlight that no measures for grief, which was shown to be an important factor for suicide death (41, 57), were available; in addition, there was no direct information on previous or current mental disorders among the participants, but only data on current mood could be drawn from the EURO-D scale. Moreover, suicidal ideation was not thoroughly assessed with specific questions aimed at knowing if the respondent had the intention or plan to end their life, or, on the other hand, the frequency and intrusiveness of those thoughts. In particular, we highlight that for more than half of the sample, data on suicide ideation is either missing or the participant did not know if they had suicidal thoughts/refused to answer. This could be interpreted in light of the difficulty that elderly people experience in disclosing the wish to die. However, no strong conclusions can be made regarding the reason for missing data at this point. Similarly, details regarding the circumstances and dynamics of the accidents that resulted in the death of a person were not available. Therefore, it cannot be certainly excluded that some deaths by accidents were not suicide attempts. However, such events tend to be single-car accidents (less than 3% of all road fatalities are thought to be suicides (58)). In this sample, only three people (4.1%) who died by accident died outside of their house/hospital (compared to 14 people (19.2%) who died by suicide), making the chances of misclassification negligible. Furthermore, end-of-life interviews were conducted with the help of the next-of-kin and, obviously, in a retrospective manner. This likely implied recall bias. In addition, respondents might have reported purposefully inflated/deflated figures regarding the decedent's care to deal with the interviewers' desirability/sense of righteousness, although it would be impossible to prove if this has ever occurred.

Second, death from suicide represents approximately 1% of all deaths. Given the rarity of the event, thousands of deaths had to be recorded to have enough data to draw decently solid conclusions. In this dataset, 74 suicides were registered out of 16,548 deaths. Although this sample size might prove sufficient to evince strong associations and contributions of socio-demographic and clinical factors to suicide, some nuances might not be evidenced: for example, it was unfeasible to conduct further analysis on the role of the duration of illnesses of specific systems (e.g., cardiovascular, respiratory, etc.) on suicide. Moreover, some data were not reported for all participants and had to be imputed. This is a typical case for large datasets.

Lastly, it should be noted that the statistical approach presented herein differentiates deaths by suicide from deaths by accident

based on the quality and quantity of data provided, regardless of previous findings or authors' views.

Conclusions

We employed a machine learning algorithm to demonstrate the predictors of late-life suicide in a large longitudinal European cohort. When tested, the random forest algorithm yielded an overall accuracy of 0.79 (CI [0.60 – 0.92], p = 0.002). It highlighted that the most important variables used to discern deaths by suicide from deaths by accident were social connectedness-related (frequency of contact with the next-of-kin, the relationship with the next-of-kin, the number of children still alive) and physical illness-related (duration of illness before deaths, length of hospitalization in the 12 months preceding deaths, difficulties in the activities of daily living). The findings presented here provide a hierarchical importance of predictors for late-life suicide and highlight social connection and physical health as critical variables for assessing suicide risk. Replication of these findings and deepening our understanding of these predictors through experts by experience (i.e., survivors of near-lethal suicide attempts) will be instrumental in designing accurate prediction models and tailored interventions for suicide prevention.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: https://share-eric.eu/data/data-access.

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and the institutional requirements.

Author contributions

NM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. JZ: Writing – original draft, Writing – review & editing. FS: Conceptualization, Supervision, Writing – review & editing. DD: Supervision, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. Open Access funding provided by Università degli Studi di Padova | University of Padua, Open Science Committee.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1455247/full#supplementary-material

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 14 November 2024
DOI 10.3389/fpsyt.2024.1426876

OPEN ACCESS

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RECEIVED 02 May 2024
ACCEPTED 16 September 2024
PUBLISHED 14 November 2024

CITATION
Zong X and Wang H (2024) Do early-life circumstances predict late-life suicidal ideation? Evidence from SHARE data using machine learning.
Front. Psychiatry 15:1426876.
doi: 10.3389/fpsyt.2024.1426876

Do early-life circumstances predict late-life suicidal ideation? Evidence from SHARE data using machine learning

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Background: A number of studies have demonstrated that suicidal ideation in late life is associated with early-life circumstances. However, the importance of early-life circumstances in predicting suicidal ideation is not entirely clear. This study aims to use a machine learning approach to evaluate the importance of 32 early-life circumstances from six domains in predicting suicidal ideation in old age.

Methods: The data in this study come from a cross-national longitudinal survey, the Survey of Health, Aging and Retirement in Europe (SHARE). Participants recalled information on early-life circumstances in SHARE wave 7 and reported suicidal ideation in SHARE wave 8. The XGBoost model was employed to evaluate the importance of 32 circumstances in six domains (early-life socioeconomic status, early-life health and healthcare, early-life relationship, etc.) in predicting the suicidal ideation of middle-aged and older adults over 50.

Results: There were 46,498 participants in this study, of which 26,672 (57.36%) were females and 19,826 (42.64%) were males. XGBoost showed a strong predictive performance, with an area under the curve of 0.80 and accuracy of 0.77. Top predictors were mainly in the domains of childhood relationship, childhood socioeconomic status, childhood health, and healthcare. In particular, having a group of friends most critically influences suicidal ideation in old age.

Discussion: These findings suggest that early-life circumstances may modestly predict suicidal ideation in late life. Preventive measures can be taken to lower the risk of suicidal ideation in middle-aged and older individuals.

KEYWORDS

childhood adversity, suicide in older adults, mental health of older adults, XGBoost, artificial intelligence, life course, health aging, social determinants of health

1 Introduction

With the aging population increasing all over the world, the suicide of older adults has become a crucial public health problem (1). Large empirical studies have indicated that suicidal ideation is closely associated with completed suicide (2). In Europe, the lifetime prevalence of suicidal ideation was 7.8%, and there are significant variations in suicidal ideation by sex among middle-aged and older adults (3, 4). There is a need for knowledge about the causes and prevention of suicidal ideation in older adults. However, most studies exploring the predictors have mainly focused on late-life predictors (5, 6). Previous studies have established strong associations between (7, 8) childhood adversity and the increased likelihood of suicide in late life, including factors like childhood physical health (7–10), psychological, physical, and sexual abuse (7, 8, 10–13), family socioeconomic status (7, 9), parental divorce (10), exposure to holocaust and wars (14, 15), and hunger (16). In particular, childhood physical health, including physical illness and self-reported health, is closely associated with the risk of suicidal ideation in old age (9, 10). For instance, a US study revealed that individuals with poor health in childhood had 1.99 times greater odds of suicidal ideation than healthier counterparts (9). The correlation may stem from the fact that poor health during childhood increases the risk of mental health problems, chronic diseases, and poor social support (17–19), all of which can contribute to suicidal ideation in old age. Although the relationship between childhood adversity and suicidal ideation is widely established, the importance of these early-life circumstances in elderly suicide has not been sufficiently explored. Additionally, previous studies have demonstrated that there are variations in suicidal ideation by sex (20–22), pointing out the gender inequality in this phenomenon. The existing literature investigated the associations between early-life circumstances and suicidal ideation in late life mainly using conventional statistical models that struggle to deal with non-linear relationships and high-dimensional problems. Machine learning models show promising potential in coping with such problems and have been widely used in studies of medicine and psychology (23–25). So far, machine learning models have been applied to predict suicide using several datasets such as healthcare data, clinical data, registry data, and national survey data (26–29). For example, a study of the use of machine learning to predict the suicidal ideation of Korean adults, showed that the predictive performance of machine learning models outperformed conventional statistical models such as the logistic regression model (30). However, these studies applied machine learning models to predict suicidal ideation risk using late-life factors rather than early-life factors, which may make it difficult to comprehensively understand the relative importance of life-course factors in predicting elderly suicidal ideation (31, 32). In addition, these studies mostly utilized single-county datasets.

In this study, we aimed to leverage XGBoost, a machine learning model, and cross-national survey data, to examine the importance of early-life circumstances in predicting suicidal ideation in late life. In addition, 32 early-life predictors were constructed based on the rich information about life history from the Survey of Health, Aging and Retirement in Europe (SHARE). The survey collected various information about individuals through face-to-face computer-aided personal interviews. A range of studies have used SHARE data to identify the risks of suicidal ideation in older adults (33–35), but few of them examined the early-life risks. Strengthening the understanding of the life-course predictions of suicidal ideation can enhance targeted prevention measures for older populations who have experienced adverse early-life circumstances.

2 Data and methods

2.1 Data

2.1.1 Participants

The data used in this study come from SHARE, a longitudinal cross-national survey that has been running from 2004 to the present (36). Until 2024, it has covered 28 European countries and Israel, and provided rich information on middle-aged and aged adults in health, social, economic, and other aspects. This study obtained the data of participants who were interviewed in SHARE wave 7 and wave 8 and were aged 50 years or above. After excluding the participants who were aged below 50 years, the final analytical samples consisted of 46,498 participants.

2.1.2 Assessment of suicidal ideation

In SHARE wave 8, participants were asked 'In the last month, have you felt that you would rather be dead?' This study constructed a binary variable to assess suicidal ideation. The answer 'Any mention of suicidal feelings or wish to be dead' is assigned a value of 1, and the answer 'No such feelings' is assigned a value of 0. Previous studies offered evidence for a binary measurement of suicidal ideation of older adults (33–35).

2.1.3 Assessment of predictors

Participants were asked to recall their life history in SHARE wave 7. Derived from SHARE wave 7, 32 early-life circumstances were constructed, including six domains: childhood socioeconomic status, childhood health and healthcare, childhood relationship, childhood war, childhood residence conditions, and childhood cognition. Previous studies have shown that these predictors contribute to the occurrence of suicidal ideation in late life (8, 11, 15, 37). Moreover, we included 23 late-life predictors that have been proven to influence suicidal ideation in old age, such as gender, marital status, age, education level, health conditions, and economic situation (5, 38, 39). Detailed descriptions of these predictors can be found in Appendix A, B. Considering the potential high correlation between the predictors, we calculated the correlation matrix for all predictors, which is shown as a heatmap in Appendix D. Additionally, it was observed that the majority of the predictors are not highly correlated.

2.2 Methods

XGBoost, which stands for eXtreme Gradient Boosting, is a powerful machine learning model with exceptional performance and efficiency in classification and regression. This model is based

on the gradient boosting framework and good at dealing with large datasets and complex tasks. It has recently been applied to examine the predictors of suicide (40–43).

In this study, XGBoost was applied to evaluate the importance of 32 early-life circumstances in predicting suicidal ideation in old age. This model has several unique advantages in prediction compared with conventional linear regression models. First, XGBoost is good at capturing non-linear relationships between predictors and outcomes, which is often missed by linear models. Second, XGBoost can deal with multicollinearity effectively in which features are highly correlated. Third, XGBoost is a non-parametric model and allows the capture of a wider variety of patterns in the data. XGBoost Python package was used to develop the XGBoost model in this study. The 'xgboost' library in Python (version 3.10.9) was used to develop the XGBoost model in this study. Figure 1 shows the methodology process, including data pre-processing, model development, and model evaluation.

2.2.1 Data pre-processing

In this study, the average percentage of missing data across all variables was approximately 11%. Random forest imputation takes into account non-linearities and interactions and does not require the specification of a specific regression model (44). We employed random forest imputation to minimize bias from missing data, ensuring that our analysis remained robust and accurate.

2.2.2 Model development

To evaluate the generalization ability of the XGBoost model, the data of this study was first divided into training data and test data, comprising 70% and 30% of the data, respectively. Parameter tuning was performed exclusively on the training data using 10-fold stratified cross-validation with GridSearchCV, which ensured the balance of the outcome variable across folds. In addition, scale_pos_weight of the XGBoost model was adjusted to further accommodate the class imbalance problem as only a few older adults (5.88%) had suicidal ideation. After identifying the optimal hyperparameters, the model was re-trained on the whole training data. Finally, we evaluated the model's predictive performance on the test data.

2.2.3 Model evaluation

We used a range of indicators to evaluate the predictive performance of the XGBoost model. These indicators include the area under the curve (AUC), accuracy, positive predictive value (PPV), negative predictive value (NPV), sensitivity, specificity, and F1 score.

2.2.4 Feature importance

In this study, the XGBoost model provides the importance of each feature by calculating each feature's importance score. This is based on the 'gain' method.

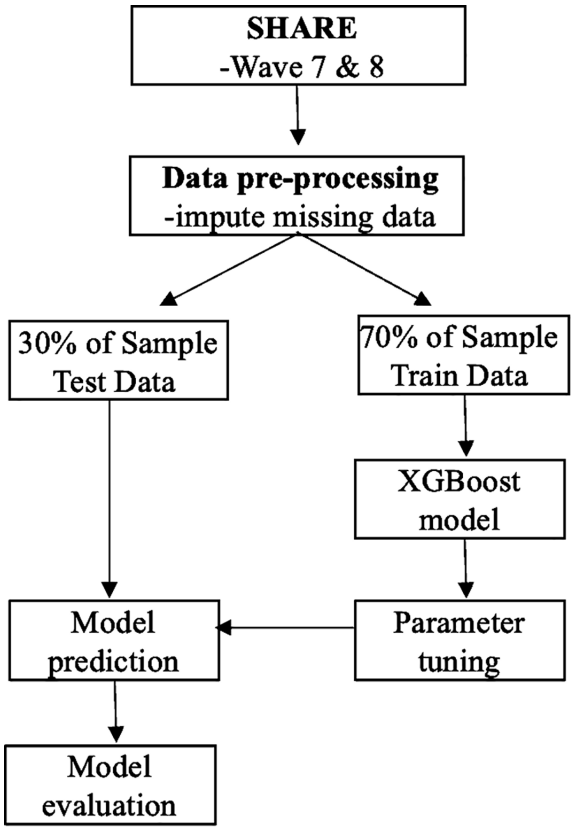

FIGURE 1
Methodology process.

3 Results

3.1 Descriptive analysis

In this study, the total number of final analytic samples was 46,498. Of these participants, 2,736 (5.88%) individuals aged 50+ years reported having suicidal ideation in the last month, whereas 43,762 (94.12%) did not. To assess whether there were statistically significant differences in the bivariate relationships between having suicidal ideation and not having suicidal ideation with other variables in the study, we conducted a *t*-test for continuous variables and a chi-squared test for categorical variables. The mean age of participants with suicidal ideation was 73.75 years (SD = 10.25), which was higher than those without at 70.19 years (SD = 9.23). Females (7.09%) exhibited higher rates of ideation than males (4.27%), and the prevalence was notably higher among widowed (10.71%), divorced (7.86%), and separated (7.97%) individuals than among married ones (4.24%). Education also played an important role, with those having less than an upper secondary education showing the highest ideation rate (8.38%) and those with tertiary education showing the lowest rate (3.75%). Although differences between urban (5.81%) and rural (6.03%) participants were not significant, living in nursing homes was associated with a significantly higher rate of suicidal ideation (14.73%). Across countries, the prevalence ranged from 3.35% in Northern Europe to 6.86% in Western Europe. Overall, participants who are female, unmarried, widowed, or divorced, have lower levels of education, and live in nursing homes and Western European countries, are more susceptible to harboring suicidal ideation. Detailed characteristics of the sample refer to Table 1.

3.2 The prediction of suicidal ideation

The XGBoost model demonstrated robust predictive ability on the test data for predicting suicidal ideation among middle-aged and aged individuals. The XGBoost model achieved an AUC score of 0.80, accuracy of 0.77, sensitivity of 0.69, specificity of 0.77, PPV of 0.16, NPV of 0.98, and F1 score of 0.25. The best parameters were a learning_rate of 0.05 and a maximum depth of 3,200 estimators. Details regarding the importance of early-life and late-life predictors can be found in Appendix C. Additionally, we evaluated the predictive ability of the XGBoost model only using early-life predictors, with an AUC score of 0.64, an accuracy of 0.65, a sensitivity of 0.56, a specificity of 0.65, a PPV of 0.09, an NPV of 0.96, and an F1 score of 0.15, which are somewhat lower than those using early-life and late-life predictors together.

3.3 Variable importance

Table 2 presents the importance and ranking of 32 early-life circumstances from six domains in the XGBoost prediction model. In the domain of childhood socioeconomic status, the father education level had the highest importance, suggesting the important role of father education level in children's suicidal ideation in old age. However, a family's financial situation during childhood had no obvious effect. It concludes that some socioeconomic circumstances, including parental education and breadwinner occupation, are crucial and others, such as family financial difficulty, may not be direct predictors of suicidal ideation. In the domain of childhood health and healthcare, self-reported health status and access to healthcare resources, such as receiving vaccinations and regularly visiting a dentist, were the strongest predictors, emphasizing the critical role of early health intervention and preventive healthcare in mitigating suicidal ideation in late life. In the domain of childhood war, early exposure to war World War I and World War II had a lower importance in predicting suicidal ideation in old age than most predictors from the domain of childhood health and healthcare. In the domain of childhood relationship, childhood friendship had the most critical effect in prediction, including whether having a group of friends and whether feeing lonely. Living with father during childhood was also a significant predictor. In the domain of childhood residence conditions, the importance of having a cold running water supply ranked first, indicating the importance of basic amenities in affecting children's future mental health. In the domain of childhood cognition, academic performance in mathematics and language ranked 12 and 10, respectively, suggesting that early cognitive development can influence late suicidal ideation.

We further utilized the XGBoost model to identify the ten most crucial early-life circumstances contributing to suicidal ideation among middle-aged (50–59) and older individuals (60+), as detailed in Table 3. There was heterogeneity between the two age groups. For instance, the mother education factor was more predictive for middle-aged individuals than for older adults. The predictive performance of the model by age groups is shown in Appendix E.

Figure 2 shows the importance of the top 10 early-life predictors in suicidal ideation. The majority of the top 10 predictors were from the domains of childhood relationship (having a group of friends, feeling lonely for friends, and living with father), childhood socioeconomic status (father education and living arrangement), and childhood health and healthcare (vaccination and regularly visiting the dentist). This highlights that predictors during childhood are strongly linked to suicidal ideation in late life.

4 Discussion

This study applied the XGBoost model to evaluate the importance of 32 early-life circumstances in predicting suicidal ideation in middle-aged and aged European and Israeli populations using cross-national data. Seventy percent of the study data was used to train the prediction model and 30% was used to assess the trained model. Scale_pos_weight of XGBoost was used to handle the class imbalance problem and 10-fold cross-validation was used to deal with overfitting problem. The performance indicators show the good predictive ability of the XGBoost model, with an AUC of 0.80 and accuracy of 0.77. The results demonstrate that the top predictors are mainly in the domains of childhood relationship, childhood socioeconomic status, childhood health and healthcare,

TABLE 1 The demographic characteristics of participants in this study.

Characteristics	Having suicidal ideation		Not having suicidal ideation		Total		*p*-value
	n	%	n	%	n	%	
Total	2,736	5.88	43,762	94.12	46,498	100	
gender							<0.001
Male	846	1.82	18,980	40.82	19,826	42.64	
Female	1,890	4.06	24,782	53.30	26,672	57.36	
marital_status							<0.001
Married	1,305	2.81	29,451	63.34	30,756	66.14	
Registered partnership	32	0.07	591	1.27	623	1.34	
Separated	38	0.08	439	0.94	477	1.03	
Divorced	300	0.65	3,515	7.56	3,815	8.20	
Widowed	914	1.97	7,618	16.38	8,532	18.35	
Never married	147	0.32	2,148	4.62	2,295	4.94	
education							<0.001
Less than upper secondary education	1,360	2.92	14,868	31.98	16,228	34.90	
Upper secondary and vocational training	970	2.09	18,483	39.75	19,453	41.84	
Tertiary education	406	0.87	10,411	22.39	10,871	23.26	
rural_urban							> 0.1
Urban	1,819	3.91	29,482	63.40	31,301	67.32	
Rural	917	1.97	14,280	30.71	15,181	32.65	
living_in_nursing home							<0.001
No	2,660	5.72	43,322	93.17	45,982	98.89	
Yes	76	0.16	440	0.95	516	1.11	
region							<0.001
Northern Europe	190	0.41	5,484	11.79	5,674	12.20	
Southern Europe	512	1.10	8,103	17.43	8,615	18.53	
Eastern Europe	1,033	2.22	16,562	35.62	17595	37.84	
Western Europe	938	2.02	12,743	27.41	13,681	29.42	
Israel	63	0.14	87	1.87	933	2.01	
	Mean	SD	Mean	SD	Mean	SD	
age	73.75	10.25	70.19	9.23	70.40	9.33	<0.001

SD, standard deviation.

and, especially, whether having a group of friends, which have the most critical influence on suicidal ideation in old age.

To the best of our knowledge, this study is the first to shed light on the relative importance of 32 early-life circumstances from six different domains, leveraging the advantages of the XGBoost predictive model. Some findings align with previous studies emphasizing the importance of childhood socioeconomic status, childhood health and healthcare, childhood resident conditions, and early-life war exposure in predicting suicidal ideation among older adults (8, 11, 15, 37). This study also provides new findings, such as the high importance of childhood friendship and childhood cognition in predicting late suicidal ideation, which lacked sufficient attention in previous studies. Related studies attempted to explore the associations between early-life peer relationships, childhood cognitive function, and mental health in old age (45, 46), but there are still few studies exploring the influence of these childhood factors on late-life suicidal ideation. This study is beneficial in providing new evidence for the targeted and precise intervention to

TABLE 2 The importance of early-life circumstances in suicidal ideation prediction.

Domains	Predictors	Importance	Ranking of importance
Childhood socioeconomic status	mother_education	0.008150	13
	father_education	0.010683	6
	occupation_breadwinner	0.007983	14
	family_finance	0.000000	29
	living_arrangement	0.009240	8
	religion_importance	0.008660	11
	books	0.005770	27
Childhood health and healthcare	health_before_15	0.012695	3
	missed_school	0.007901	15
	confined_to_bed	0.000000	29
	childhood_diseases	0.007416	18
	childhood_illnesses	0.006424	24
	in_hospital	0.006444	23
	vaccinations	0.015134	2
	dentist_visit	0.009406	7
Childhood war	World_War_I	0.000000	29
	World_War_II	0.006270	26
Childhood relationship	physical_harm	0.007103	20
	lonely_for_friends	0.010788	4
	group_of_friends	0.017511	1
	lived_mother	0.007743	17
	lived_father	0.009224	9
	drank_heavily	0.000000	29
Childhood residence conditions	number_of_rooms	0.006332	25
	number_of_people	0.006485	22
	cold_running_water	0.010745	5
	hot_running_water	0.007324	19
	bath	0.006496	21
	toilet	0.005723	28
	heating	0.007755	16
Childhood cognition	math_performance	0.008151	12
	language_performance	0.008695	10

mitigate some lasting effects of early-life circumstances in later suicidal ideation. Additionally, this study emphasized the significance of exploring the causes of suicidal ideation from the life-course perspective.

The top 10 factors among 32 early-life circumstances may inform suicide prevention efforts. These top factors belong to five domains: childhood socioeconomic status, childhood health and healthcare, childhood relationship, childhood residence conditions, and childhood cognition. First, in the domain of childhood relationship, having a group of friends is associated with better social support and mental health. Empirical studies demonstrated that a lack of such a network can lead to loneliness and social barriers, which are known risk factors for suicidal ideation in adulthood (6, 47). This study identified having a group of friends as the most crucial early-life factor for predicting suicidal ideation, aligning with these studies. Therefore, encouraging children to build

TABLE 3 Top 10 early-life circumstances for middle-aged and aged individuals.

Ranking of importance	Middle-aged individuals (50–59)		Older adults (60+)	
	Predictors	Importance	Predictors	Importance
1	mother_education	0.045515	group_of_friends	0.020894
2	lonely_for_friends	0.033787	living_arrangement	0.012020
3	childhood_diseases	0.028626	father_education	0.011299
4	math_performance	0.026914	health_before_15	0.010497
5	health_before_15	0.025918	hot_running_water	0.010496
6	number_of_rooms	0.025255	vaccinations	0.010413
7	hot_running_water	0.022624	lonely_for_friends	0.010021
8	number_of_people	0.021400	missed_school	0.009966
9	father_education	0.021156	number_of_rooms	0.009016
10	physical_harm	0.019877	lived_father	0.008852

friendships is crucial in reducing the risk of suicidal thoughts later in life. Feeling lonely is also a critical factor that can lead to persistent mental health problems, including suicidal ideation. Evidence revealed the association between childhood loneliness and a long-term disruption in mental health that extends into adulthood (48). Addressing loneliness in children and adolescents is vital in preventing suicidal behaviors in adulthood. Living with a father provides stable emotional support and healthy socialization patterns. It was demonstrated that a fatherless childhood is associated with higher risks of mental health (49). This suggests that maintaining a supportive family environment is crucial for suicide prevention.

Second, in the domain of childhood health and healthcare, vaccinations had a long-term impact on health. A study found that vaccinations before the age of 15 have positive associations with cognitive and educational outcomes (50), which may decrease the risks of mental health. Thus, improving access to vaccinations is beneficial for indirectly decreasing suicide risk. Early health conditions persistently impact health outcomes in late life. Poor health in childhood is associated with higher odds of work-limiting

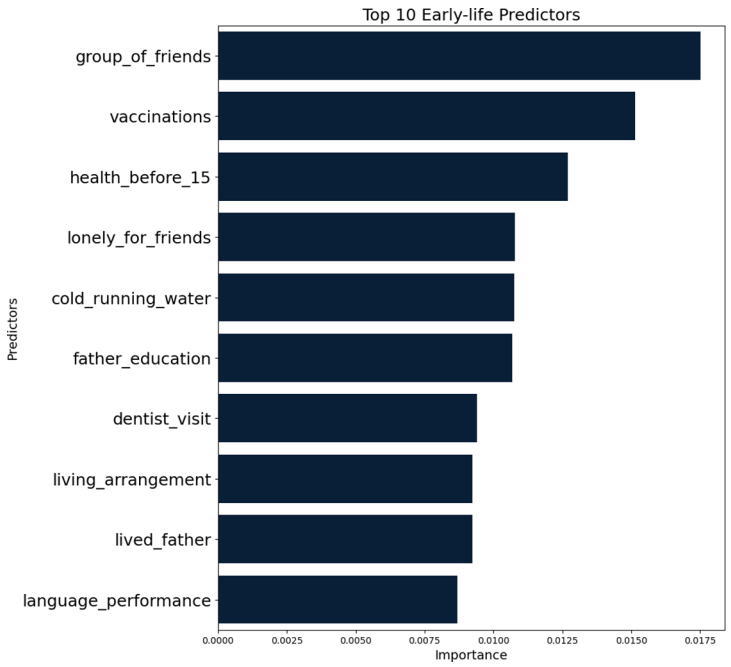

FIGURE 2
Importance of top 10 early-life circumstances predictors for suicidal Ideation.

disability and chronic health conditions (51), which may increase the suicide risk. In terms of suicide prevention, addressing early health concerns allows for timely interventions that may decrease the risk of later suicidal ideation. Regular dental visits indicate a family's exposure to preventive care. Evidence shows that regular dental visits during childhood positively impacts the quality of life in old age (52). Improving the availability of preventive care for children may lower the risk of suicide in old age.

Third, in the domain of childhood residence conditions, residential conditions such as access to cold running water affect children's mental and physical health. Research has shown that poorer residential conditions are linked to adult mortality (53). Therefore, improving early residential conditions is an effective strategy for reducing long-term health issues, ultimately aiding in suicide prevention. Fourth, in the domain of childhood socioeconomic status, father education often correlates with the family's socioeconomic status, in which higher education levels can decrease the risks of depression and other mental health problems (54). Focusing on individuals from disadvantaged childhood socioeconomic backgrounds may reduce their risk of developing suicidal ideation. Difficult living arrangements, including living in an orphanage and being fostered by another family, may cause emotional and behavioral problems, increasing long-term psychological stress. Evidence has proven the associations between living in an orphanage and cognitive disease in late life (55). Early intervention measures of paying more attention to children with difficult living arrangements can reduce adult mental health issues. Finally, in the domain of childhood cognition, early language performance has an impact on late-life health. A study has shown that low linguistic ability in early life is a strong predictor of poor cognitive function in late life (56). Enhancing language performance may improve social interactions and psychological adjustments, thus reducing suicide risk.

The study has strengths in four aspects. First, it used a large set of early-life circumstances from six domains, providing a comprehensive analysis of how different early-life circumstances contribute to the risk of suicidal ideation in old age. Second, this study used the cross-national data that included the majority of European countries, rather than data of a single country, enhancing the generalizability of the identified early-life risks. Finally, this study considered the heterogeneity of the importance of early-life circumstances for late-life ideation among middle-aged individuals and older adults, which is crucial for designing targeted interventions based on age.

There are several limitations to this study. First, the information about suicidal ideation was self-reported by participants, and early-life circumstances were based on the participants' recall, which may introduce information bias. Second, there was a survival bias in this study as individuals with adverse early-life circumstances may have died earlier and therefore were not included in the study. Third, this study identified the association between early-life circumstance and late-life suicide rather than examining the causality. Additionally, the XGBoost predictive model was developed using SHARE data that primarily includes high-income countries. It is uncertain whether the model will be robust when applied to data from middle- and low-income countries.

5 Conclusion

In this study, the findings illustrate that early-life circumstances play a crucial role in predicting suicidal ideation in late life, especially the predictors in the domains of childhood relationship, childhood socioeconomic status, and childhood health and healthcare. The predictors identified in this study were in line with previous studies, reaffirming the long-term effect of early-life circumstances on suicidal ideation. In addition, this study highlights the promise of machine learning models in identifying the risk for suicidal ideations. Based on our findings, several preventive measures can be helpful to lower the risk of suicidal ideation in late life. On one hand, early-life stage interventions are crucial. For example, encouraging children to build friendships, improving access to preventive care such as vaccinations, improving early health conditions, and improving residential conditions, may contribute to lowering the risk of suicidal ideation in late life. On the other hand, the identified key early-life circumstances, such as the top ten circumstances, may be used to screen older populations for further diagnoses and care. However, there is the heterogeneity of the importance of early-life circumstances for late-life ideation between middle-aged individuals and older adults. The heterogeneity is crucial for designing age-specific interventions when screening susceptible populations.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: SHARE (the Survey of Health, Ageing and Retirement in Europe), https://share-eric.eu/.

Ethics statement

The Ethics Committee of the University of Mannheim approved the ethical review for SHARE waves 1 to 4, and the Ethics Council of the Max Planck Society approved the ethical review for SHARE wave 4 and its continuation.

Author contributions

XZ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Visualization, Writing – original draft, Writing – review & editing. HW: Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This study was supported by China Scholarship Council, award number 202106140038; University of Helsinki provides article processing charges.

Acknowledgments

We would like to express our sincere gratitude to the Transnational Access Visits (TAV) as part of the COORDINATE project (Grant Agreement Number: 101008589) and European Centre for Social Welfare Policy and Research for their invaluable support in providing training on data related to this research. This training significantly enhanced our understanding of the dataset used in this study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1426876/full#supplementary-material

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 26 November 2024
DOI 10.3389/fpsyt.2024.1489874

OPEN ACCESS

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RECEIVED 02 September 2024
ACCEPTED 21 October 2024
PUBLISHED 26 November 2024

CITATION
Irías Escher MJ, López Castro VJ and Yup de León P (2024) Suicide in older adults in Honduras: a retrospective analysis (2008-2022).
Front. Psychiatry 15:1489874.
doi: 10.3389/fpsyt.2024.1489874

Suicide in older adults in Honduras: a retrospective analysis (2008-2022)

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Introduction: This study examines suicide among older adults in Honduras over a 15-year period (2008-2022).

Methods: Data were collected from the National Violence Observatory attached to the University Institute of Democracy, Peace and Security of the National Autonomous University of Honduras (ONV-IUDPAS-UNAH), and 593 suicide cases were analyzed with a quantitative approach of descriptive scope, to identify suicide decedent characteristics and patterns in the cases.

Results: It was observed that 94.1% of the suicide decedents were male, with an average age of 70 years, predominantly from urban areas; the highest prevalence was in 2021 (7.77), generally in the mornings and mostly by hanging or asphyxiation in private spaces.

Discussion: There is a significant difference in the prevalence of suicide by gender (16 males per female). Similar to worldwide reports, an increase in post-pandemic suicides is observed. The aging of the population and the increasing incidence of suicide in older adults gives relevance to this study, which has been limited by the lack of systematic data collection and previous research that would allow a better understanding of the problem and, in turn, the generation of public policies focused on the mental health of older adults.

KEYWORDS

mental health, epidemiology of suicide, depression, suicide in elderly, older adults, suicide methods

1 Introduction

The World Health Organization (WHO) estimates that around 703,000 people die by suicide each year worldwide, 77% of which occur in low- and middle-income countries (1) such as Honduras. Between 2015 and 2019, more than 93,000 suicides were reported in the Americas (2), of which 1,801 occurred in Honduras, the country with the lowest suicide rate in Central America (3).

Globally, the age-standardized suicide rate is estimated to be 2.3 times higher in males than in females (1). While in the Americas, 79% of suicide decedents are males (2), in Honduras, this figure rises to 83% (4). In terms of age, the highest suicide rate in the American region is observed in people aged 45 to 59 years, followed by the population aged 70 years and older (2). In Honduras, according to ONV-IUDPAS by 2021 the highest incidence of suicides corresponds to persons aged 30 years or below, while only 62 suicide decedents (59M:3F) over 60 years were recorded.

Population aging is a growing global concern, especially regarding suicide among older adults. By 2050, the global proportion of people aged 60 or older is expected to nearly double from 12% to 22% (5). Honduras is a Low-Middle Income Country (LMIC) with a population of 10.593.798 people (6). According to data from the University Demographic Observatory (ODU-UNAH), the aging rate ranges from 20 to 32 elderly for every 100 children and is projected to reach 79 by 2045 (7). Locally, these figures are influenced by socio-economic inequalities, high rates of poverty and unemployment, violence, social exclusion, forced migration, and the stigma associated with corruption and crime. These factors, coupled with the predominantly Christian religious landscape, contribute to the unique challenges faced by older adults in Honduras.

There are few data and few studies on suicide among older adults in the Honduran population. In 1992, a study based on the general suicide registry found that 4% of the suicide decedents were adults aged 60 years and above, the lowest percentage of the analyzed group (8). In another study, Palacios (9) characterized the suicide cases registered between 2015 and 2017 at the Institute of Forensic Sciences in Tegucigalpa and identified that 6.2% of the suicide decedents were people aged 63 to 82 years. In both studies, variables such as sex, geographic location, and suicide methods were addressed, but the data are not specific to the older adult population.

Studies worldwide have identified risk factors and epidemiological characteristics of suicide in older adults; depressive disorders predominate among them, followed by other mental disorders such as anxiety, bipolar disorder, dementia and schizophrenia. Loneliness, physical illness, substance use and abuse, economic problems, marital and family problems, among others, are also included. Of all of them, Conwell et al. (10) and Obuobi-Donkor et al. (11) highlight depression as a key risk factor (greater than physical illness and family problems). On the other hand, male sex, violent self-injury, psychiatric disorders, poor medical conditions, stressors, chronic somatic diseases and living alone predict deaths by suicide (12–15).

Depression is more prevalent in females; however, the suicide fatality rate increases with age in males, but not in females (16). This is associated with the fact that males tend to use more lethal methods and are more reluctant to seek psychological help (11, 17). According to WHO (1) the most common method worldwide is pesticide poisoning and the use of firearms. Other studies add hanging to these methods. (11, 16, 18).

Although all these data provide useful information for the understanding of suicide in older adults, there are no studies available in Honduras. The objective of this study is to describe the occurrence of suicide in people over 60 years based on the records of the National Violence Observatory attached to the University Institute of Democracy, Peace and Security of the National Autonomous University of Honduras (ONV-IUDPAS-UNAH) from 2008 to 2022. Beyond the limitations related to the limited data available, it is expected that this study will serve as a basis for further research, which will favor the evaluation, design and implementation of prevention plans in the future.

2 Methods

The data were collected from the ONV - IUDPAS - UNAH which takes part of an inter-institutional table of violent deaths made up of the National Police (PN), the General Directorate of Forensic Medicine (DGMF) of the Public Prosecutor's Office (MP) and the National Registry of Persons (RNP). This table records deaths in a database and validates the variables of time, person and place, case by case, of homicides, suicides, traffic events and unintentional events. The age and sex of the suicide decedents as well as the year, month, day and time of the event are recorded consistently and in a non-systematic way the marital status, area (rural/urban), situational context (conflicts/mental illness), the mechanism of death, place of the event (public/private).

The DGMF is who provides the cause and the mechanism of death according to the autopsies performed; on the other hand, the PN is who provides the contexts of suicide, from informants at the scene, such as relatives, neighbors, acquaintances, among others. Therefore, this section usually has gaps. In cases where the autopsy information is not decisive to identify the type of death, for example, suicide, the ONV - IUDPAS - UNAH classifies it as "unknown intent" and defines it as: "those where official sources have not determined the manner of death because some link in the criminal investigation chain is pending." (19). The ONV - IUDPAS - UNAH sends a non-compliance report to official institutions with the list of cases of deaths of unknown intent for investigation. Until an official response is obtained, the ONV records remain the same. In this study only the cases where the official source classifies the death as suicide are presented.

This study did not require an ethic approval since the data are public or available under request at ONV-IUDPAS-UNAH guaranteeing the confidentiality and anonymity of the suicide decedents [1].

The available data were structured in three groups (Figure 1). The first group includes 593 cases corresponding to the total

1 Available data as fact sheets at https://iudpas.unah.edu.hn/areas/observatorio-de-la-violencia/boletines-del-observatorio-2/boletines-nacionales/ and open raw data online at https://iudpas.unah.edu.hn/areas/observatorio-de-la-violencia/datos-abiertos/.

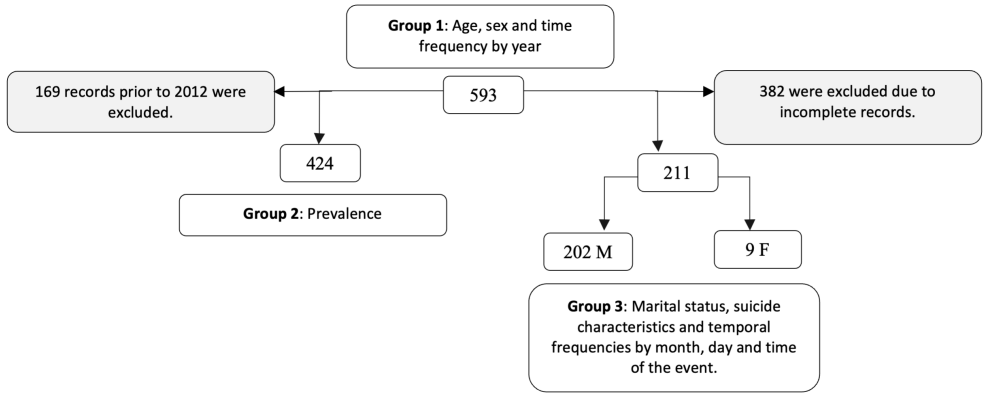

FIGURE 1
Structure of the data by groups.

registry of individuals who died by suicide over 60 years old registered in the period 2008 - 2022; with this group, the variables of age was divided in third age: defined as a person who has reached sixty (60) years of age and fourth age: defined as a person who has reached eighty (80) years of age or older (20, 21), for a detailed analysis, the third age were divided into five-year periods (Table 1), sex of the suicide decedent and temporal frequency by year were analyzed. The second group consists of 424 cases resulting from the exclusion of 169 records prior to 2013, since there are no adjusted population projections according to the 2013 national census; with this group the prevalence analysis was performed. The third group contains 211 (202M:9F) cases resulting from the exclusion of 382 incomplete records in at least one of the following variables: marital status, characteristics of suicide (zone, context, location and mechanism), and temporal frequencies by month, day and time of the event; these were the variables analyzed in this group.

A quantitative approach was used, consisting of a descriptive analysis of cases of suicide in older adults. The data were systematically analyzed using the Jamovi system version 2.3.12 (data processing) and Microsoft 365 Excel (graphs and tables). Groupings and categorizations were performed to identify patterns and statistics were applied to obtain descriptive measures of the variables analyzed. Chi-square tests were also performed to obtain descriptive measures of the variables analysed. Prevalence data were calculated by dividing the number of suicide cases by 100,000 inhabitants aged 60 years and older. For the trend of the data, a linear function was used with the R statistical analysis software. Where the equation of the line is $y = -3609.06 + 1.81 * x$ with an R^2 of 0.44.

3 Results

3.1 suicide decedent characteristics

3.1.1 Sex of suicide decedents

Of the 593 cases, the highest incidence (defined as the number of new cases reported each year) occurred in males, with a ratio of approximately 16 male suicides for every one female suicide (Table 1) with a chi-square statistical significance of 61.6598. Significant at $p < .05$.

3.1.2 Age of suicide decedents

The average age of males was 70 (± 8) years, with a range between 60 and 96; in females the average age was 69 (± 7) years, with a range between 60 and 87. The five-year period with the highest incidence was from 60 to 64 years old with 29.2%, a similar proportion in males (28.7%) but higher in females (37.1%). In general, there are more individuals who died by suicide in the third age group (60 – 79 years old) than in the fourth age group (over 80 years old) in a ratio of 6:1. The incidence rate ratio (IRR) of suicide is 5.25 times higher for the first than for the second in males and 15.66 for females (Table 1).

3.1.3 Marital status of suicide decedents

In the 211 cases analyzed (202M:9F), 57.9% of the males were married or in common-law unions, while 77.8% of the females were single, divorced or widowed (Table 1).

3.2 Prevalence

Of the 424 cases recorded between 2013 and 2022, the highest prevalence for both the third (7.10) and fourth age (11.42) is 7.77, recorded in 2021. In contrast, the lowest overall prevalence is 4.62 in 2013, with a variation between age groups of 4.69 in 2013 for the third age and 2.85 in 2017 for the fourth age (Table 2).

3.3 Characteristics of suicide

After discarding the cases with incomplete information, we proceeded to the analysis of the remaining 211 cases that had complete records available (Table 3). According to the area of occurrence, in both sexes, a higher frequency of suicides was identified in the urban area (62.4% M: 77.8% F). When it comes to the context, meaning the potential key contributors to the suicide decedent making the decision to end his or her life, depressive

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TABLE 1 Suicide decedent characteristics by sex and age, Honduras, 2008-2022.

	Sex					
	Males		Females		TOTAL	
	n	%	n	%	n	%
Age in years (n=593)						
Third age						
60-64	160	28.7%	13	37.1%	173	29.2%
65-69	131	23.5%	6	17.1%	137	23.1%
70-74	96	17.2%	7	20.0%	103	17.4%
75-79	83	14.9%	7	20.0%	90	15.1%
Fourth age						
80 +	88	15.8%	2	5.7%	90	15.1%
Total	558	94.1%	35	6.3%	593	100%
Marital Status (n = 211)						
Married, free union	117	57.9%	2	22.2%	119	56.4%
Single, divorced, widowed	85	42.1%	7	77.8%	92	43.6%
Total	202	95.7%	9	4.26%	211	100%

problems are observed as the main motive (71.3%M:100%F). Other contexts include family conflicts and conflicts with a partner.

Regarding the place of the incident, private spaces were the most common (72.3% M:88.9% F) versus public spaces. The mechanism used was as follows: hanging or asphyxiation (53.5% M; 44.4% F), firearm (23.8% M; 33.3% F) and poisoning (21.3% M; 22.2% F).

3.4 Time frequencies

Taking the 593 cases available, suicide among males and females shows oscillations. Although there is a general increase, there are years with significant fluctuations. For example, after an increase in 2009, there was a drop in 2010. However, from 2014 onward, the trend appears more stable and generally upward. By the year 2024, approximately 56 suicides of older adults would be expected to occur, however, this result is only indicative, given that the goodness of fit of the model is 0.44 (Figure 2).

When analyzing the frequency throughout the year, of the 211 cases analyzed, it is observed that more than 10 males die by suicide every month, but in May this number is 2.8 times higher, followed by August and July (> 20 accumulated cases per month); in females, July and October were the months with the highest frequency. The highest percentage of suicides in males was on Tuesday (18%) and Monday (17%); in females, on the other hand, the highest percentage occurred on Friday (33%). Most suicides (59.9%) occur between 09:00 and 17:59 in both sexes. In males, the time with the highest percentage (21%) is from 09:00 to 11:59; in females, there are three intervals with the same percentage (22%), the first from 09:00 to 11:59, the second from 15:00 to 17:59 and the third from 21:00 to 23:59 (Figure 3).

4 Discussion

4.1 Suicide decedent characteristics

This study examined data on suicides in people aged 60 and above in Honduras between 2008 and 2022, stratified by age and sex. These adults, still functional, face significant evolutionary challenges, such as job retirement and changes in family roles, which may affect their adaptability (22). It was found that 29.2% of cases correspond to people between 60 and 64 years old, and the incidence decreases with increasing age. Although studies such as those of Lee et al. (23) and Razai et al. (24) report similar results, others, such as Garnett et al. (25) and the PAHO/WHO (26) show the opposite in the United States and the Americas region.

The gender disparity in suicide rates is notable, with a significantly higher prevalence in males (94.1%). This finding is consistent with other studies (11, 14, 18, 25, 27) and with data on the general population in Honduras (8, 9). Following the approach of Wen et al. (28) on the Chinese population, further research is suggested to understand this gap in Honduras. Preliminarily, this disparity could be attributed to the fact that 71.9% of males in Honduras are heads of household (29) and retirement from the labor market could entail the loss of traditionally male cultural and social roles, with fatal consequences. These changes are more abrupt for males than for females, who mostly retain roles linked to the home and family regardless of their age.

Most of the males who die by suicide were married or in common-law unions, which contrasts with the overall data for Honduras, where 64% of suicides between 2015 and 2017 corresponded to single people (9). According to data from the Permanent Household Survey of the National Institute of Statistics (30) by 2016, 40.6% of people aged 35 to 59 were married compared to 36.8% of people over 60 years old. In other cases, previous studies, such as those by Goretti et al. (15) and Sadek et al. (31) indicated a higher prevalence of suicide in males who live alone or have experienced a recent loss, such as the death of a spouse. This difference could be linked to the pressures associated with the role of head of household, which persists despite changes in the environment and can trigger family and couple conflicts, leading to depressive symptoms and, ultimately, the decision to die by suicide.

4.2 Prevalence

Globally, the suicide rate in older adults ranges from 18-22 per 100,000 males and 3.5-4.5 per 100,000 females (31). In Europe, de Souza Minayo and Cavalcante (32) reported a prevalence of 29.3 per 100,000 people over 65 years old. In contrast, in Honduras, the

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TABLE 2 Suicide prevalence rate in older adults, Honduras, 2013-2022 (n = 424).

Year	Population 60 +	Population 3rd age (60 -79)	Population 4th age (80 +)	Urban population	Rural population	Victims 60 +	Victims 3rd age (60 -79)	Victims 4th age (80 +)	Victims 60 + urban area	Victims 60 + rural area	Prevalence	Prevalence 3rd age	Prevalence 4th age	IRR	Urban prevalence	Rural prevalence
2013	605,667	511,821	93,846	317,821	287,846	28	24	4	21	5	4.62	4.69	4.26	1.10	6.61	1.74
2014	626,546	529,772	96,774	332,188	294,367	36	33	3	15	21	5.75	6.23	3.10	2.01	4.52	7.13
2015	648,322	548,852	99,470	347,011	301,320	30	27	3	19	11	4.63	4.92	3.02	1.63	5.48	3.65
2016	670,961	568,765	102,196	362,299	308,671	39	33	6	27	12	5.81	5.80	5.87	0.99	7.45	3.89
2017	694,510	589,277	105,233	378,109	316,412	38	35	3	24	14	5.47	5.94	2.85	2.08	6.35	4.42
2018	718,969	610,209	108,760	394,441	324,540	37	31	6	22	15	5.15	5.08	5.52	0.92	5.58	4.62
2019	744,438	631,527	112,911	411,360	333,091	42	34	8	23	19	5.64	5.38	7.09	0.76	5.59	5.70
2020	770,905	653,308	117,597	428,841	342,077	51	45	6	34	15	6.62	6.89	5.10	1.35	7.93	4.38
2021	798,410	675,776	122,634	446,919	351,505	62	48	14	24	15	7.77	7.10	11.42	0.62	5.37	4.27
2022	827,056	699,257	127,799	465,602	361,468	61	52	9	28	20	7.38	7.44	7.04	1.06	6.01	5.53

Prevalence calculated as rate per 100 thousand population.

prevalence in 2022 was 7.38, which is 14.1 times lower than the global rate. This interpretation may be limited by the lack of data and underreporting, recognized problems in Honduras, as well as by stigmatization associated with sociocultural factors (33).

4.3 Characteristics of suicide

Wen et al. (28) found that the suicide rate is higher in rural than in urban areas in China. Their analysis highlights that urbanity represents a better financial situation, access to health systems and insurance coverage, while rurality brings loneliness and lack of care for the elderly, as young people migrate to cities. However, in Honduras there was a predominance of suicides in urban areas in both sexes. Unlike China, urbanity in Honduras faces aggravating factors such as violence, insecurity, lack of public recreation areas and inefficient public transportation, which imposes greater challenges for older adults in cities.

Biological factors (such as physical illness, sexual dysfunction, and severe pain) and social factors (such as isolation, economic pressures, infidelity, and living alone) have been identified as leading to depression and, consequently, suicide in older adults. According to Sadek et al. (31) Major Depressive Disorder (MDD) is a key indicator of suicidal behavior in this population. Obuobi-Donkor et al. (11) also highlight depression, mental health disturbances and perceived stress as predictors of suicidal ideation and behavior. In Honduras, the reason for suicide is unknown in most of the cases analyzed in this study (382 of 593), due to the lack of records and previous studies exploring these risk factors. However, available data indicate that most cases are associated with depressive, family or couple problems, which is consistent with other studies (15, 32, 34–39).

Most suicides occurred in private spaces, with 88.9% of cases in females and 72.3% in males. This finding suggests that older adults may choose places where they feel more comfortable and less exposed to social judgment, which is consistent with other studies indicating that suicides in private spaces are common due to the search for privacy and avoidance of associated stigma.

Hanging is, internationally, the most frequent mechanism for suicide (11, 18, 27, 40). Other methods include the use of firearms, poisoning, jumping from heights, electrocution, and traffic accidents. In the Honduran context, it is observed that older adults present a prevalence of hanging, firearms and poisoning in that order, while the general population follows the pattern of hanging, poisoning and firearms (4). The predominance of hanging may be explained by the accessibility of the necessary materials and the high lethality of the method, as suggested by Zeybek et al. (18).

4.4 Time frequencies

Analysis of the seasonality of suicides reveals an increasing trend in males, while in females the pattern is less clear. A peak in suicides was observed in older male adults in 2009, the year in which a political situation occurred with the withdrawal of power of the then president of the country, which generated negative social

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TABLE 3 Suicide characteristics by sex, Honduras, 2008-2022 (n=211).

		Sex			
		Male		Female	
		n	%	n	%
Zone	Urban	126	62.4%	7	77.8%
	Rural	76	37.6%	2	22.2%
Context	Depressive problems	144	71.3%	9	100.0%
	Family conflict	27	13.4%	0	0.0%
	Conflicts with the partner	21	10.4%	0	0.0%
	Others	10	5.0%	0	0.0%
Location	Private	146	72.3%	8	88.9%
	Public	56	27.7%	1	11.1%
Mechanism	Hanging (asphyxiation)	108	53.5%	4	44.4%
	Firearm	48	23.8%	3	33.3%
	Poisoning	43	21.3%	2	22.2%
	Others	3	1.5%	0	0.0%

and economic effects that could have affected the mental health of older adults, making them more vulnerable to suicide, however, this study does not have data to confirm this association. The increase observed in 2020 and 2021 is aligned with reports linking this increase to the COVID-19 pandemic, which affected mental health globally and exacerbated psychosocial risk factors such as isolation, economic stress, and anxiety, which can lead to depression and suicidal behavior (28, 31, 41).

Regarding the day of the week and time of the day, it was observed that suicides occur mainly during the week (Tuesday and Monday for males and Friday, Monday and Wednesday for females). These findings differ with the data for the general population, where Sunday is the day of highest incidence (4). A possible explanation for this finding is that older adults may choose weekdays because they are the time when they are alone while their family members work or get educated, which allows them to have more access to materials with which they can die by suicide without being discovered. In addition, most suicides occur in daytime, with 59.9% in older adults and 35.8% in the general population (4).

5 Limitations

This study is the first in Honduras to describe the sociodemographic variables of suicide deaths in older adults. It suggests that certain factors contributing to suicide risk may have cultural and socioeconomic aspects, making them relative/contextual factors rather than absolute, hence the need for caution in applying results from other cultures. Although it is informative and provides a baseline, it has some limitations, including the unspecific data, mainly related to the cause of suicide such as mental illness; the possible biases associated to cultural factors, such as religion and stigmatization which favors subrecording; and the substantial limitation of systematic and accurate collection of these data, which is why 64.5% of the cases in this study were lost. These aspects need to be improved in order to carry out more in-depth research and comprehensive approaches that favor a better understanding of this phenomenon (26). This would allow the analysis of trends and the development of multivariate models to identify protective and predictive risk factors. This is the only way to generate and implement public policies and intervention programs aimed at preserving the mental health of older adults, mainly in urban areas where the incidence is higher.

6 Conclusion

This study provides significant insight into suicide in older adults in Honduras, a topic little explored in the national scientific

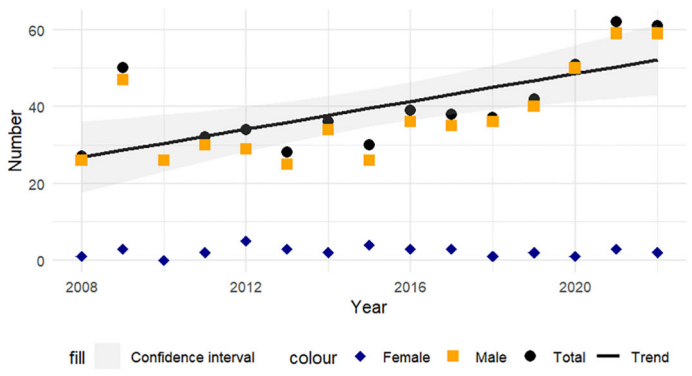

FIGURE 2
Spatial distribution of suicides by sex, Honduras, 2008-2022.

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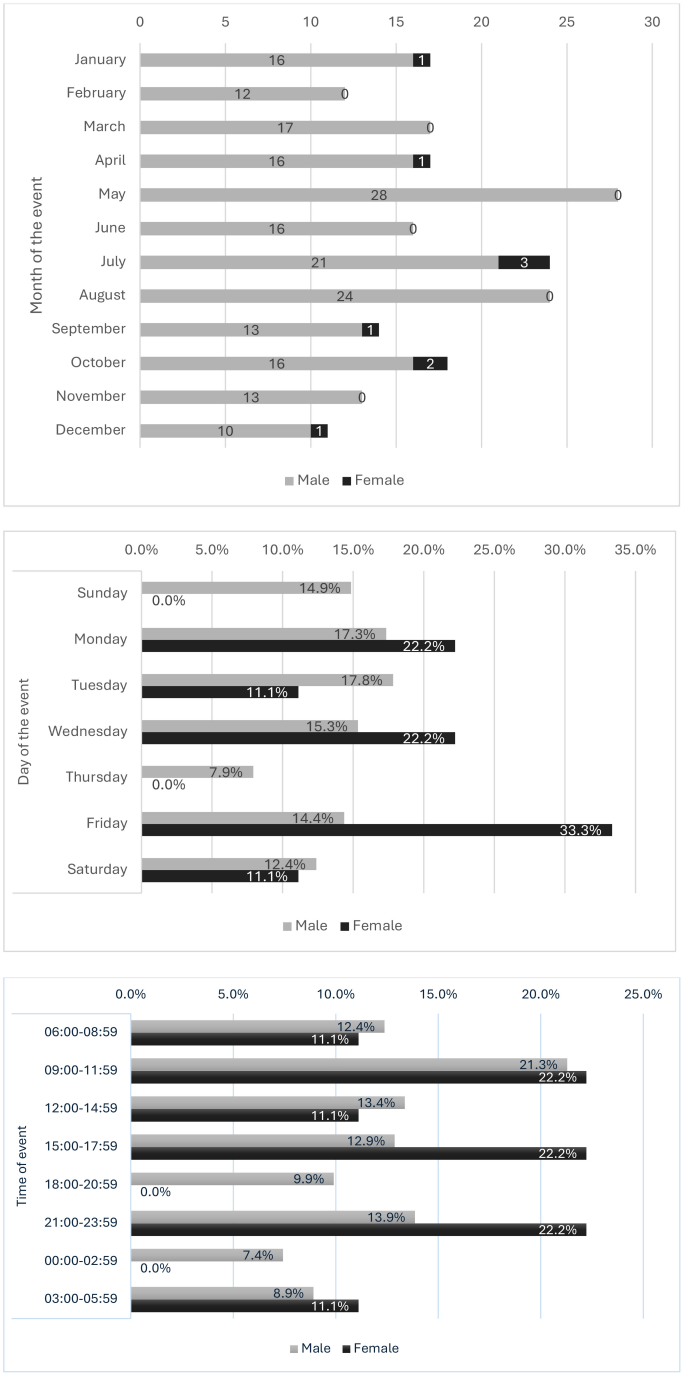

FIGURE 3
Frequency of suicides by sex according to month, day and time Honduras, 2008-2022 (n = 211).

literature. Through a retrospective analysis of ONV-IUDPAS-UNAH data, patterns were identified that highlight the high incidence of suicide in older males, the predominance of hanging as a method, and the concentration of cases in urban areas.

These findings, coupled with population aging, underscore the urgent need to address suicide in this population with specific and well-targeted strategies. Interventions should focus on implementing contextualized suicide awareness and prevention programs, mental health promotion, and well-being of older adults. Furthermore, it is critical to improve the collection and analysis of suicide-related data to enable a more detailed and effective understanding of risk factors in this population.

Finally, the need for a coordinated and well-founded response to address the problem of suicide in older adults in Honduras with practical and public policy approaches is clear. Likewise, the training of health professionals should be strengthened to identify

and treat early signs of suicide risk in this population. It is suggested that future research delve deeper into the analysis of risk factors and effective interventions, with the objective of reducing the incidence of suicide and improving the quality of life of older adults in the country.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

MI: Conceptualization, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. VL: Conceptualization, Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing. PY: Data curation, Formal analysis, Methodology, Software, Writing – original draft.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 24 February 2025
DOI 10.3389/fpsyt.2025.1538877

OPEN ACCESS

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RECEIVED 03 December 2024
ACCEPTED 31 January 2025
PUBLISHED 24 February 2025

CITATION
Siraj S, Belete H, Beka M, Shegaw M, Belete A and Birhan Z (2025) Determinants of suicidal behavior among elders in Northwest Ethiopia: implications for prevention. *Front. Psychiatry* 16:1538877. doi: 10.3389/fpsyt.2025.1538877

Determinants of suicidal behavior among elders in Northwest Ethiopia: implications for prevention

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Background: Worldwide suicide rates increases with age. Globally, suicidal behavior is a leading cause of injury and death. In many countries, older adult suicidal behavior is highly lethal because old people are unwilling to talk about their emotional problems and are less likely to report depression and suicidal thoughts. Exploring the phenomenon of suicide in the elderly in Ethiopia can provide a dependable source of reflection and add to the global aging, and suicide prevention conversation, generally in the low-income countries and middle-income countries (LMICs). This study aimed to assess the prevalence of suicidal behavior and its associated factors among elders in Bahir Dar city, Northwest Ethiopia.

Method: A community-based cross-sectional study and multistage sampling technique were conducted among elders in Bahir Dar city. A systematic random sampling procedure was used to choose 626 elderly people over 65 years old in total who had lived in Bahir Dar city. Utilizing the revised Suicidal Behavior Questionnaire (SBQ-R), suicidal behavior was assessed. We quantify the related components using multivariable logistic regressions. The factors' associations were delineated with odds ratios, 95% confidence intervals, and p-values that were deemed statistically significant at less than 0.05.

Result: Overall, 12.8% (95% CI: 10.2, 15.3) of the population engaged in suicidal behaviors. The lifetime prevalence of suicidal ideation, plan, and attempts were 13.9%, 8.15%, and 1%, respectively. The prevalence of suicidal ideation in the past 12 months was 10.86%. The odds of being single (AOR: 2.19, 95% CI: 1.18, 4.06), having no social networks (AOR: 2.25, 95% CI: 1.01, 5.01), being depressed (AOR: 4.01, 95% CI: 1.97, 8.17), having a chronic illness (AOR: 3.03, 95% CI: 1.69, 5.44), and geriatric mistreatment (AOR: 7.81, 95% CI: 4.06, 15.05) were the independent predictors of suicidal behavior.

Conclusion: The extent of suicidal behavior was found to be high in this study. The associated factors of suicide behavior include being unmarried, having a poor social network, having depression, chronic illness, and geriatric mistreatments. Therefore, clinicians should do routine mental health examinations for older persons, focusing on those who have a history of elder abuse or chronic illnesses, as these are major risk factors for suicide behavior. To detect and treat suicidal thoughts in elder populations, healthcare professionals

should get culturally appropriate training. For legislators: create policies that address elder abuse by instituting community reporting mechanisms and legal protections for elder citizens, and give top priority to developing national healthcare initiatives that include elder-specific mental health and suicide prevention programs.

KEYWORDS

elders, Ethiopia, suicidal attempts, suicidal behavior, suicidal ideation

Introduction

Suicidal behavior includes a variety of self-harming thoughts and behaviors, such as suicidal ideation (thinking about, considering, or planning suicide), suicide attempts (doing something that could harm oneself with the intention of dying), and completed suicide (death brought on by self-directed harmful behavior with the intention of dying) (1). Three categories exist for suicidal behavior: suicidal thought, suicidal plan or intent, and suicidal attempts. The belief that one is acting as their own death's agent is known as suicidal ideation; the degree of suicidal purpose and the complexity of one's preparations determine how serious an ideation is. Suicidal intent is the subjective hope that one will die from a self-destructive act. Self-injurious activity with a nonfatal consequence and either overt or covert indications that the person meant to die is known as a suicide attempt (2).

According to a 2017 World Health Organization (WHO) estimate, 800,000 people die by suicide each year (3). Suicide is a very big problem almost in the whole world, and around 703,000 deaths reported annually due to suicide, and many more individuals engaging in non-fatal suicidal behaviors and among the elderly population, suicidal behavior is particularly alarming due to its high lethality and often undetected nature (4). Approximately 78% of all suicides that are completed worldwide take place in low- and middle-income nations (5). According to US polls conducted in 2017, there were over 42,000 suicide attempts annually across all age groups (6). Later-life suicide is a worldwide public health concern, with most nations having the greatest suicide rate among people 65 and older (7).

The worldwide incidence of suicide increases with age, with the rate of suicide in those aged over 75 years reaching up to twice or three times the rate in those under 25 years in most countries (8). Older adults in most countries constituting those 85-90 years age group have the highest prevalence of suicidal behavior and suicidal rate (9). Therefore, relative to the younger age groups, older people have a greater chance of dying by suicide in developing countries (10). The worldwide suicide rate for both men and women expands inexorably with age, reaching its highest peaks in the 85 and older age group (11).

Loneliness, poor family connections, and inflammation, neurodegeneration, and hypothalamic-pituitary-adrenal (HPA) axis dysregulation are contributors to late-life depression and suicide risk. Additionally, chronic diseases such as diabetes, cardiovascular disease, and chronic pain conditions bring additional harm to the mind, thus worsening the suicides in the elderly (12).

The occurrence of suicide amongst the elderly was high, with the change ranging from 2.2% to 21.5% (13). WHO in 2017, showed that suicide in elders occurs almost equally in high- and low-income countries (14). Globally, women are about three times as likely as men to attempt suicide, yet men are significantly more likely to complete suicide due to the use of more lethal methods (15). However, it remains unclear whether this pattern is consistent among the elderly population or in low- and middle-income countries (LMICs) like Ethiopia. However, old age is markedly characterized by diverse losses for many elderly people: physiological, functional, social, cognitive, financial, and environmental isolation, a subjective sense of loneliness; anxiety; depression, and frequently loss of motivation to continue living often arise from such losses (16).

Suicidal ideation significantly increases the risk of suicide attempts and completions (17). In the first year after the beginning of ideation 60% of changes from ideation to preparation and attempt occur (18). The most frequent reasons for suicidal ideation are diseases or disorders, the second most frequent was 'loneliness' (17.2%), and the third was financial problems (11.9%) (19). Suicide attempts among the elderly are more likely to be lethal due to several factors, notably the presence of physical health factors, alcohol abuse, stressful life events, social isolation, and psychiatric disorders (especially depressive disorders) (20),

Abbreviations: ADL, Activity of Daily living; AOR, Adjusted Odd Ratio; BDU, Bahir Dar University; BSc, Bachelors of Science; CI, Confidence Interval; COR, Crude Odd Ratio; ETB, Ethiopian Birr; GDS, Geriatrics Depression Scale; LSNS-6, Lubben Social Network Scale; MDD, Major Depressive Disorder; MNA-SF, Mini Nutritional Assessment Short Form; MSc, Masters of Science; PI, Principal Investigator; QOL, Quality of Life; SB, Suicidal Behavior; SBQ-R, Suicidal Behavior Questions Revised; SPSS, Statistical Package for Social Science; USA, United States of America; WHO, World Health Organization; WHOQOL-HIV-BREF-Eth WHO, Quality of life Human immune virus Ethiopia version (WHOQOL-HIV-BREF-Eth).

whereas, socio-economic status, marital status, physical health, mental health, influence of major events, religious belief and social interaction, poverty, lack of social support, and untreated mental health conditions are mainly the factors responsible for suicidal ideation for the elderly population (21, 22).

However, suicides are frequently underreported or incorrectly classified as accidents or natural deaths due to religious and societal standards; this pattern has also been seen in other LMICs. Suicide prevention initiatives are made more difficult by these cultural barriers, which impede reliable data collecting and public health measures (23). Specifically, Ethiopia's unique societal, religious, and economic characteristics make it a unique place to investigate suicide behavior in older populations. Suicide is highly stigmatized since it is frequently seen as immoral by dominant cultural and religious ideas. In addition to influencing reporting, this stigma also affects how suicidal conduct is experienced and interpreted. Furthermore, there is an urgent need for context-specific data to guide policy and initiatives due to the nation's rapidly aging population and the dearth of geriatric and mental health care. Thus, the goal of this study was to evaluate the prevalence of suicide behavior among older people residing in Bahir Dar city, Northwest Ethiopia, as well as the characteristics that are linked to it.

Methods

Study area and period

The research was carried out in the Northwest Ethiopian city of Bahir Dar between March 10 to April 18, 2021. The capital of the Amhara regional state, Bahir Dar, is situated 565 kilometers northwest of Ethiopia's capital, Addis Ababa. According to a 2019 city administration report, from the total population, 15,620 are 65 years and older.

Study design

A community-based cross-sectional study was conducted.

Population

The source population consisted of all the elderly people residing in Bahir Dar city, while the study population consisted of the elderly people who were randomly selected from households in the study area during the study period.

Eligibility criteria

The study included all elderly people over 65 who had lived in Bahir Dar city permanently for more than six months; those who were unable of communicating or who were with severe illness were excluded.

Sampling size determination

Since no research has been done in Ethiopia, the sample size in this study was determined using a single population proportion formula based on the expected prevalence of suicidal behaviors, which was set at 50%. In order to guarantee sufficient power to identify meaningful correlations between the three main variables (depression, elder abuse, and suicidal conduct), the sample size was determined by a power analysis. A targeted power of 80% and a significance level of $\alpha = 0.05$ were employed. In order to identify medium-to-large effect sizes ($d = 0.5$), we therefore calculated that a sample size of 424 participants would be adequate. This estimate was exceeded by the final sample size, which included 636 people in total by applying designing effect, guaranteeing that the study had the power to identify meaningful relationships.

Sampling procedure

A method of multi-stage systematic random sampling was employed. Four subcities were chosen at random using lottery techniques from a total of six subcities in the first stage. The sample size was dispersed to the chosen kebele (the smallest administrative unit in Ethiopia, similar to a neighborhood or a community) proportionate to the household size after eight kebeles from a chosen sub-city were chosen by lottery. After determining an initial beginning household through the lottery method, households in the chosen kebele were chosen by systematic random sampling approaches (Figure 1).

Eligible participants in the selected household were further selected and interviewed. In cases where there was more than one eligible participant in the household, the lottery method was used to include only one. The interviewer visited the household three times at different times in case the eligible participant was not found at the designated time. If the interviewer was unsuccessful in finding the participant, the household was marked as a non-response. If the selected household did not contain any eligible elders, the next household was chosen.

Data collection tools and procedures

Four BSc data collectors and one MSc supervisor were chosen from the field of psychiatry, and the primary investigator offered training on data collection methods and instruments. The data was collected by interview-administered questionnaires, and to ensure consistency and understandability, a third party translated a questionnaire from English to Amharic and back to English using language experts. To ensure questionnaire clarity, 32 participants in Adet town outside the study area were given a pretest one week before the actual data collection began. It was ensured that all required data were correctly collected by regular supervision by the primary investigator and the supervisors. Prior to processing and computer entry from paper, the gathered data was thoroughly examined and cleansed.

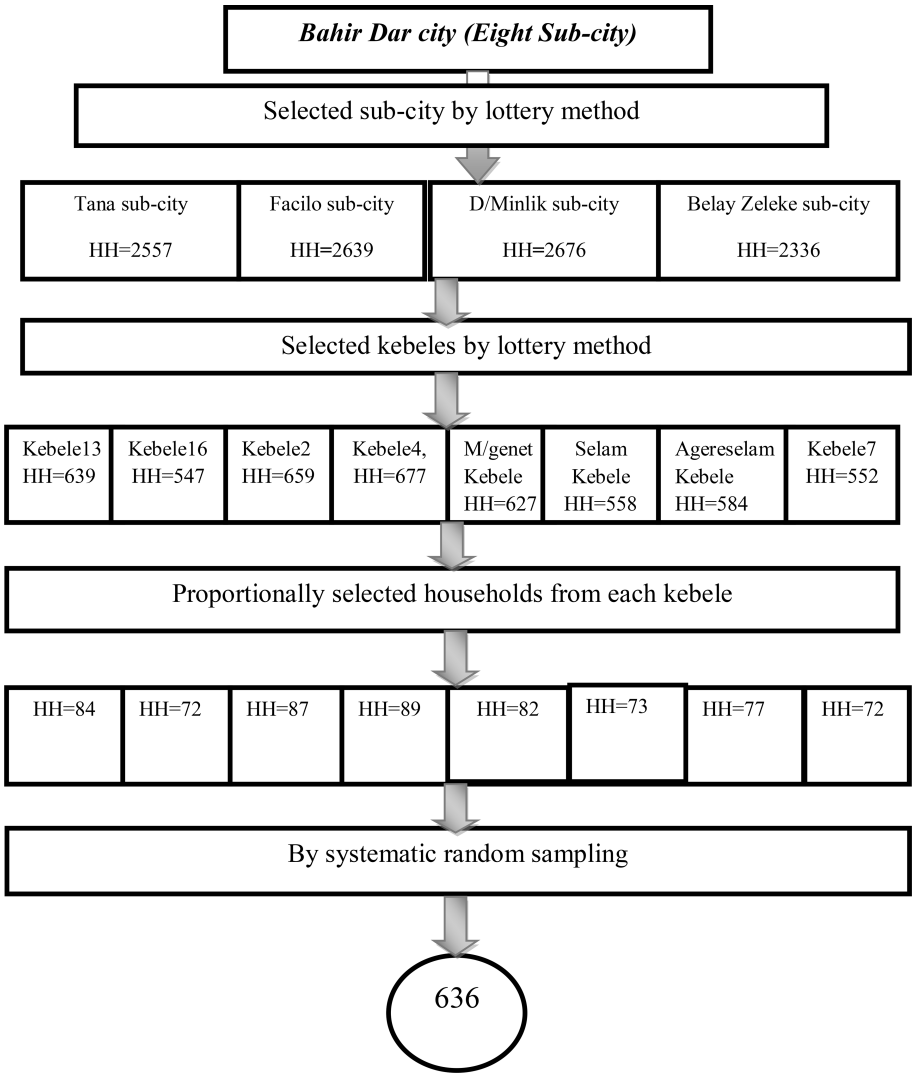

FIGURE 1
Schematic presentation of sampling technique on the prevalence and associated factors of suicidal behaviors among elders in Bahir Dar city, Northwest Ethiopia, 2021

A structured interviewer-administered questionnaire was used, which has 9 sub-sections: Suicidal behavior was assessed by using the Suicidal Behavior Questionnaire-Revised (SBQ-R), which is broadly used in Ethiopia to screen suicidal behavior (24, 25). It has a sensitivity of 93% and a specificity of 95% with a score of 3-18 and a cutoff point of ≥7 for the non-suicidal or non-clinical sample (26). In this study, the internal consistency was checked and found to have a Cronbach's α = 0.76. Depression was measured using the Geriatric Depression Scale (GDS) Short Form Scale, which has a standard 15-item cutoff point score of 0-4, which is normal, and a score ≥5 indicates depression. The sensitivity was 81.3%, and the specificity was 78.4% (27).

Chronic diseases were measured by separate ratings of the presence or absence of chronic diseases obtained by asking respondents whether a doctor had ever told them (28). Functional disability was assessed by the Katz scale, which is used to measure the individual's ability to carry out everyday activities such as bathing, dressing, toileting, transfer, continence, and feeding. Cronbach's alpha ranged from 0.80 to 0.92 (29).

Nutritional status was measured by using the Mini Nutritional Assessment Short Form (MNA-SF). This tool has 0.85, sensitivity, and 0.87, specificity, with a cutoff point ≤ (11). For body mass index cutoff point ≤ 11, 0.85. Using calf circumference instead of body mass, cutoff points are ≤ 11, and 0.84 (30). It also validated in Ethiopia and had the overall accuracy of the full MNA of 91%. The sensitivity and specificity of the full MNA tool using an established cut-off point were 87.9% and 89.6%, respectively (31).

Quality of life was measured using the 26 items of WHOQOL-BRFE, which is a cross-culturally validated instrument to measure the quality of life, particularly useful when addressing the impact of physical and psychological well-being, but also on several domains beyond health, and had good sensitivity and specificity to assess the quality of life of people in health care settings and community settings (32). There is an Ethiopian validated version of the WHO Quality of Life Human Immune Virus Ethiopia version (WHOQOL-HIV-BREF-Eth) with good psychometric properties (33). The Cronbach alpha was 0.82. QOL scores range between 0 and 100. Scores are scaled in a

positive direction (i.e., higher scores correspond to a better health-related quality of life and vice versa).

Social network was measured by LSNS-6, which is a validated instrument designed to gauge social isolation in older adults by measuring the number and frequency of social contacts with friends and family members and the perceived social support received from these sources. Cronbach's alpha coefficients for family and friend subscales were 0.84 and 0.90, respectively (34). Perceived loneliness was assessed by using the DeJong Gierveld Loneliness Scale, which has a 6-item scale. Three statements are made about 'emotional loneliness' and three about social loneliness. The DJGLS showed good internal consistency (Cronbach's alpha 0.71) and high test-retest reliability (r = 0.93) (35) and the overall loneliness score from 0–6, with higher scores indicating a higher experience of loneliness. Participants were considered to be lonely (score ≥ 2) (36).

Life Events Stressors assessed using yes/no questions about the occurrence of particular stressful life events in the preceding three years. All respondents were asked if they have experienced stressful life events (37). Elder mistreatment can be defined as a single or repeated act or lack of appropriate action occurring within any relationship where there is an expectation of trust, which causes harm or distress to an older person. It can take various forms, such as physical, psychological, sexual, and financial, and it can also be the result of intentional or unintentional neglect (38). And it was assessed by the Geriatric Mistreatment Scale, which was developed in 2013 by Geraldo-Rodriguez and Rosas-Carrasco to assess elder mistreatment, and the Cronbach's alpha was 0.80 (39). It has 22 items designed to assess five different categories of elder abuse: (a) physical abuse, (b) psychological or emotional abuse, (c) neglect, (d) financial or material abuse, and (e) sexual abuse. The answer to each item is either 'yes' or 'no', and 'yes' for a question equals one point (0=No=No abuse, 1=Yes=Abuse). Each question aims to identify whether there was any mistreatment in the last 12 months, and a 'yes' answer to at least one question means that the individual was abused (38). Substance use was assessed by yes/no questions for ever use and current use.

Data processing and analysis

After the data was coded and checked to be complete, it was imported into Epi-data version 4.6 and exported to SPSS version 25. Adjusted odds ratios and 95% confidence intervals were used to evaluate and show the strength of the relationship between the dependent and independent variables. Data were presented using frequency tables. The final set of confounders was chosen using statistical criteria that took into account both theoretical knowledge and statistical significance. The justification for each confounder's inclusion is now given, with a focus on how they might affect the association between suicidal conduct and the independent variables (elder abuse, depression). To evaluate the relationship between potential confounders and suicidal behavior, we conducted a number of bivariate studies. For the multivariate logistic regression model, variables that had a significant correlation ($p < 0.05$) with suicidal behavior were taken into consideration. We performed a multicollinearity check to further improve the model by making sure the included confounders did not show strong correlation and the Hosmer and Lemeshow Test for model fitness, and the result was 0.75, showing that the model fit the data well.

Results

Socio-demographic characteristics of the respondents

There were 626 participants in all, yielding a 98.4% response rate. Participants' median age was 69 (IQR = 5), and 360 (57.51%) of the responses were female. The majority of the respondents were Orthodox in religion (454 (72.52%), married (349 (55.75%), had no formal education (247 (39.56%), were homemakers 203(32.43%), had income above the poverty line 526(84.03%), and 538 (85.94%) were living with their families (Table 1).

Clinical and psychosocial factors

Of the study participants, 255 (40.73%) reported having depression. Almost half of the respondents, 307 (49.04%), reported having a poor quality of life, 9 (1.44%) reported having limitations in their daily activities, 71 (11.34%) were at risk of malnutrition, and 183 (29.23%) had at least one chronic disease diagnosed. 292 (46.65%) respondents said they felt lonely, and 44 (7.03%) respondents said they had a weak social network status. For the previous three years, at least one stressful life event was reported by 70 (11.18%) of the participants, and 202 (32.27%) of the participants reported being mistreated. Out of all the participants, 88 (14.06%) had ever used khat, 188 (30.03%) had ever consumed alcohol, and 21 (3.35%) had ever used tobacco (Table 2).

Prevalence of suicidal behaviors

The overall prevalence of suicidal behaviors was 12.8% (95% CI; 10.2%, 15.3%) (Figure 2). The lifetime prevalence of suicidal ideation, plan, and attempts were 13.90% (95% CI; 8.8%, 16.41%), 8.15% (95% CI; 6.4%, 12.5%), and 1.0%, respectively. The prevalence of suicidal ideation in the past one year was 68 (10.86%); out of those, 54 (8.63%) had once and 14 (2.24%) had twice suicidal ideation at two different points in time. Eighty-nine (14.22%) respondents had the threat of a suicide attempt or they told other people they were going to commit suicide; out of those, 73 (11.7%) once and 14 (2.24%) more than once told others. The likelihood of suicidal behavior in the future was reported by 186 (29.71%) participants (Table 3).

Factors associated with suicidal behavior

The multivariable analysis revealed that suicidal behavior was significantly correlated with several factors, including not being married (AOR: 2.19, 95% CI; 1.18, 4.06), having a risky social network (AOR: 2.25, 95% CI; 1.01, 5.01), having a chronic illness (AOR: 3.03, 95% CI; 1.69, 5.44), having depression (AOR: 4.01, 95%

TABLE 1 Socio-demographic characteristics of the elder people in Bahir Dar city, Northwest Ethiopia 2021.

Variables	Category	Frequency	Percentage (%)
Age	65-74 75-84 >or=85	492 90 43	78.59 14.37 6.87
Sex	Female Male	360 266	57.51 42.49
Religion	Orthodox Muslim Protestant Catholic	454 132 23 17	72.52 21.09 3.67 2.72
Level of Education	No formal education Elementary (1-8) Secondary (9-12) College and University	247 189 102 88	39.46 30.19 16.29 14.06
Marital Status	Married Single Separated Divorced Widowed	349 4 42 113 118	55.75 0.64 6.71 18.05 18.85
Job	Merchant Farmer Daily Labor homemakers Retired Other*	189 32 29 203 134 36	30.19 5.11 4.63 32.43 21.41 5.75
Income	≤2248 >2248	100 526	15.97 84.03
Living condition	With Family Alone Other**	538 47 41	85.94 7.51 6.55

(n=626).
Others*: church, mosque. Others**: child, neighbors, and other relatives like sister and brother.

TABLE 2 Clinical and psychosocial factors of elderly respondents in Bahir Dar city, Northwest Ethiopia, 2021.

Clinical factors	Category	Frequency	Percentage (%)
Depression	Yes No	255 371	40.73 59.27
Quality of life	Yes No	307 319	49.04 50.96
Chronic disease	Yes No	183 443	29.23 70.77
Functional disability	Dependent Independent	9 617	1.44 98.56
Nutritional status	Malnutrition Risk malnutrition Normal	13 71 542	2.08 11.34 86.58
Social Network	Risk to social isolation No risk of social isolation	44 582	7.03 92.97
Perceive loneliness	Yes No	292 334	46.65 53.34
Geriatrics mistreatment	Yes No	202 424	32.27 67.73
Stressful life event	Yes No	70 556	11.18 88.82
Ever substance use	Khat Tobacco Alcohol	88 21 188	14.06 3.35 30.03
Current substance use	Khat Tobacco Alcohol	66 22 97	10.54 3.51 15.49

(n=626).

CI; 1.97, 8.17), and experiencing geriatric mistreatment (AOR: 7.81, 95% CI; 4.06, 15.05) (Table 4).

Discussion

Elderly suicidal behavior has a serious detrimental effect on people as well as society. This covers the social, psychological, and physical effects on the elder population, their families, healthcare systems, and communities. Therefore, this study showed that the overall prevalence of suicidal behavior was 12.8% (95% CI: 10.2-15.3%). The lifetime suicidal ideation, plan, and attempt were 13.90%, 8.15%, and 1.0%, respectively. The result was in line with a meta-analysis study in European countries, which shows a 12% (40), a study in China 14.5% (37), and a study done in the United States 12% (20).

Our results, however, were less than those of earlier research that found 15.7% in Brazil (41) and 43% in Austria (42). The possible discrepancy may be a lack of knowledge and attitudes toward suicidal behavior, in which participants may hide; the Ethiopian community cultural and religious beliefs often stigmatize suicide, viewed as morally or religiously unacceptable. Such stigma may discourage individuals from acting on suicidal thoughts or reduce the likelihood of suicide being reported which may contribute to lower reported rates (43, 44). Additionally, those over 60 were included in Brazil's study (41). With a compression of

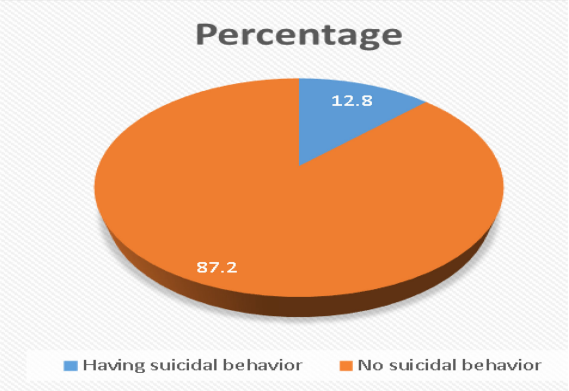

FIGURE 2
The overall prevalence of suicidal behavior among elders in Bahir Dar city, Northwest Ethiopia, 2021.

TABLE 3 The prevalence of suicidal behaviors among elders in Bahir Dar city, Northwest Ethiopia, 2021.

Variables	Category	Frequency	Percentage (%)
Life time suicidal ideation, intent and/ or attempts	Ideation Plan Attempt	87 51 6	13.90 8.15 1.00
Frequency of suicidal ideation in the past one year	Once Twice One year all suicidal ideation	54 14 68	8.63 2.24 10.86
Suicidal threats	Once Twice or more 3-4 times	73 14 2	11.66 2.24 0.32
Likely hood of suicide in the future	No chance at all Rather unlikely Unlikely Likely Rather likely Very likely	97 41 10 32 4 2	15.49 6.55 1.60 5.11 0.64 0.32

(n=626).

the one-year prevalence of suicidal ideation at 10.86% and 11%, respectively, the study's results were comparable to those of the Austrian study (42).

It was also less than the results in Iran (21.07%) (45) and 30.7% in Turkey (46). This may be because the study carried out in Turkey was done in an outpatient psychiatric clinic, and it is commonly known that suicidal behavior is more common in psychiatric patients (47). This is corroborated by a study carried out in the teaching hospital of Jimma University, which found that 28.6% of patients had suicidal behavior (48). The Suicidal Ideation Scale, a tool designed to measure suicidal ideation intensity, individual attitudes toward these thoughts, intention to carry out plans, and factors influencing intention and determination to carry out plans, may also be used as an explanation (49). the information gathered from hand-filled reports from the Mental Health and Suicide Surveillance Systems, which included the death cases in the Iranian study, which may increase the suicide rate (45).

On the other hand, our result was higher than the other studies, including 4.5% in Japan (50) 6% in Hong Kong (28). This might be due to the cultural acceptance of suicide in Ethiopia, whereby the stigma attached to suicide may deter people from reporting it, hence making people less likely to seek help. On the other hand, in European countries, cultural attitudes toward mental health may

TABLE 4 Bivariate and multivariable independent factors of suicidal behavior among elders in Bahir Dar city, northwest Ethiopia, 2021.

Variable	Category	Suicidal behavior		COR(95% CI)	AOR(95%CI)
		No	Yes		
Marital Status	Married Unmarried*	327 219	22 58	1 3.94(2.34-6.62)	1 2.19(1.18-4.06)*
Income	Low High	75 471	25 55	2.86(1.68-4.86) 1	1.07(0.51-2.23) 1
Social Network	Risk Not Risk	22 524	22 58	9(4.72-17.31) 1	2.25(1.01-5.01)* 1
Perceived Loneliness	No Yes	315 231	19 61	1 4.34(2.55-7.53)	1 1.034(0.50-2.16)
Quality of Life	Poor Good	250 296	57 23	2.93(1.76-4.90) 1	1.57(0.67-2.86) 1
Nutrition	Malnutrition Risk	6 49	7 22	11.23(3.6-34.7) 4.32(2.42-7.72)	3.74(0.85-16.43) 1.38(0.68-3.13)
	Normal	491	51	1	1
Chronic Illness*	No Yes	415 131	28 52	1 5.88(3.57-9.70)	1 3.03(1.69-5.44)**
Depression	No Yes	359 187	12 68	1 10.88(5.74-20.6)	1 4.01(1.97-8.17)**
Geriatrics Mistreatment	No Yes	410 136	14 66	1 14(7.73-26.12)	1 7.81(4.06-15.05)**
Stressful Life Event	No Yes	500 46	56 24	1 4.66(2.65-8.20)	1 1.04(0.69-3.13)

(n=626).
1 = reference group, *p<0.05; **p<0.01, COR, crude odds ratio; AOR, adjusted odds ratio.
Unmarried*: include single, separated, divorced, and widowed participants.
Chronic Illness*: CHF, COPD, Diabetes, Hypertension, and others.

be more open, thus leading to higher reporting. The other possible difference between the later and current study might be due to the tool used, which was derived from six items of the Geriatric Mental State Examination-Version A and prepared a semi-structured interview designed for elderly subjects; however, the current study used a structured tool (51). Elder care support programs, regular mental health screenings, stigma-reducing education campaigns, and elder abuse reporting systems, which ultimately offer recommendations for integrating mental health into national aging policies and creating legal protections for elders, are some examples of suggested interventions (22). In order to provide a comprehensive framework for preventing elder suicide, multisector collaboration promotes alliances between social service agencies, healthcare providers, and legislators.

Furthermore, this finding was higher than that of a study conducted in Nigeria, which revealed 4.0%, 0.7%, and 0.2%, respectively, of suicidal ideation, plan, and attempts (52). The disparity could be due to the fact that the assessment of suicidal conduct was limited to the period since the respondents turned 65, rather than their entire lives (52). This study took into account the elders' lifetime of suicidal behavior. Another reason could be that the tool utilized, the Composite International Diagnosis Interview (CIDI), has a low sensitivity score of 0.52.

In this study, the odds of having suicidal behavior were 2.19 times higher in unmarried respondents than in married participants. This may be due to the separated/widowed/divorced individuals who may feel lonely and helpless, thus increase the suicidal tendencies (52, 53). In addition, unmarried individuals have limited social connectedness and poor social networks, which will be associated with suicidal ideation and suicide in later life (7), and social isolation has a strong association with suicidal thoughts and attempts for the elderly (3). The loss of a spouse through death, separation, or divorced has been associated with poorer well-being, loneliness, depression, and suicide (54).

Participants who had poor social networks were 2.25 times more likely to have suicidal behavior than those who had good social networks. This could be due to life stressors and social isolation contributing independently to risk for suicide in later life, whereas social support may help protect against the emergence of suicidal states (55). Establishing and bolstering networks of community support, such as peer support programs and elder care groups, which have been demonstrated to improve mental health and lessen social isolation; encouraging regular mental health screenings and incorporating suicide prevention into primary healthcare, especially in settings where elders are receiving treatment for chronic illnesses or other medical conditions; and reducing stigma by educating families, caregivers, and community leaders about depression, elder abuse, and suicide (56, 57).

Encouraging multispectral collaboration among healthcare providers, social workers, and policymakers to develop a comprehensive suicide prevention framework; promoting elder protection laws that address mistreatment and provide easily accessible reporting mechanisms; and strengthening mental health services for elders by incorporating elder-specific mental health programs into national healthcare strategies. This is supported by a previous study done in Taiwan (17).

Participants with chronic medical illnesses had a 3.03-fold increased risk of suicidal behavior than those who had not. The possible reasons could be due to physical illnesses that are common in late life and may lead to loss of autonomy, isolation, pain, and increased burden on social networks, which will intensify the suicide rates (58). The other reason could be that older persons who experience physical decline and chronic illnesses frequently feel frustrated and powerless, which might raise their risk of suicide. Chronic illnesses like dementia, heart disease, or arthritis can cause people to lose their independence, which can cause mental distress and a feeling of burdensomeness to family members (59). This is consistent with the previous findings in Taiwan (17), and China (60).

The odds of developing suicidal behavior were 4.01 times higher among individuals who had depression when compared to respondents without depression. This might be due to having depressive symptoms reduce the quality of life of older persons and can result in suicidal ideation or behavior (61). The other possible reasons could be suicide behavior in older persons is depression. Suicidal ideas and attempts are more common in older populations with depression, which is frequently underdiagnosed and undertreated. Suicide risk may rise as a result of complex interactions between the biological, psychological, and social components of depression. Depression can be made worse by functional disability, loss of independence, and chronic illness, which can result in pessimism and despair (62). This is consistent with the study done in Korea (63), and China (28).

Those participants who had been mistreated (abuse) by their relatives, family, and friends where there is an expectation of trust were 7.81 times more likely to have suicidal behavior than those had excellently treated (not abused). This could be because their own relatives, family, and friends abused them, as they expected trust from them. Consequently, they may experience sadness, hopelessness, and guilt, and emptiness, which increase the suicidal tendencies (64–66). The finding was supported by a study conducted in on USA (67), and China (68).

Limitation of the study

The study may not be entirely representative of the Ethiopian population as a whole because it was carried out in urban areas of Northwest Ethiopia. The prevalence and characteristics of suicidal behavior may be influenced by the substantial differences between urban and rural locations with regard to socioeconomic considerations, healthcare availability, and cultural attitudes about suicide.

Recall bias may be explained by the fact that those who do not exhibit suicidal behavior may be less motivated than those who do to recollect past thoughts of suicide events. A cause-and-effect link cannot be shown due to the study's cross-sectional design. Therefore, longitudinal research is required to investigate causative relationships: causality between depression, elder abuse, and suicide behavior must be established.

Due to the fact that the data was collected through interview-administered, social desirability bias may potentially be an issue.

This is because participants may be more likely to give answers that are socially acceptable when answering questions on substance use.

Conclusion

The extent of suicidal behavior was found to be high in this study. The associated factors of suicide behavior include being unmarried, having a poor social network, having depression, chronic illness, and geriatric mistreatments. Therefore, clinicians should do routine mental health examinations for older persons, focusing on those who have a history of elder abuse or chronic illnesses, as these are major risk factors for suicide behavior. To detect and treat suicidal thoughts in elder populations, healthcare professionals should get culturally appropriate training. For legislators: create policies that address elder abuse by instituting community reporting mechanisms and legal protections for elder citizens, and give top priority to developing national healthcare initiatives that include elder-specific mental health and suicide prevention programs.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Institutional Ethical Review Board of Bahir Dar University, College of Medicine and Health Science. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SS: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. HB: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing. MB: Conceptualization, Methodology, Supervision, Visualization, Writing – review & editing. MS: Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing. AB: Methodology, Software, Supervision, Visualization, Writing – review & editing. ZB: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We would like to thank Bahir Dar University College of Medicine and Health Sciences and Bahir Dar city administrators for their support and assistance throughout the study process.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 11 March 2025
DOI 10.3389/fpsyt.2025.1537038

OPEN ACCESS

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RECEIVED 29 November 2024
ACCEPTED 29 January 2025
PUBLISHED 11 March 2025

CITATION
Castelli Dransart DA and Pedrazzini Scozzari E (2025) Assisted suicide within long-term care facilities for older adults: organizational issues and processes experienced by health and social care providers in Switzerland. *Front. Psychiatry* 16:1537038. doi: 10.3389/fpsyt.2025.1537038

Assisted suicide within long-term care facilities for older adults: organizational issues and processes experienced by health and social care providers in Switzerland

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Introduction: Assisted suicide is still a controversial issue among health and social care providers. They are likely to face challenges in end-of-life care in long-term facilities for older adults, both on organizational and professional levels. Although Swiss professionals are not involved in the final act, they are involved to various extents in the process which leads to the death.

Methods: This qualitative study was carried out in 12 facilities in French-speaking Switzerland, which had been faced with requests for suicide assistance from older adults. A total of 36 professionals (physicians, nurses, nursing assistants, social workers, directors) were interviewed. Data were analyzed according to Grounded Theory principles.

Results: The results uniquely describe how the process unfolds within facilities, from the initial request for suicide assistance to the aftermath of death. This process gives rise to many questions concerning the most appropriate ethical, professional and organizational way to respond to the requests and provide specific support to the requesting person, their family, and staff within the institution. Institutional life and daily operations are significantly impacted. Major adjustments are required to procedures, usual care routines, resource allocation and communication management within the facility. Institutions that set out a clear framework for the way in which the request is handled and provide sufficient and appropriate support for staff are the least disrupted, not only in terms of their operations, but also in terms of cohesion within teams and relationships between care teams and management.Throughout the process, communication within the institution is fundamental to enable staff members to find their bearings and make sense of the situation.

Discussion: Several cross-cutting issues are identified: the need to strike a balance between respecting the procedures laid down by law or the directives of professional associations, and the need to open up spaces for exchange and the construction of meaning for those involved in the process. Further issues include the preparation and training of professionals, and the support provided to

them throughout the process. Training and support seem critical to maintaining the continuity and quality of care, motivation and the health of staff.

KEYWORDS

assisted suicide (MeSH), assisted death, nursing home, attitudes of professionals, ethical and organizational issues, communication, qualitative study, Switzerland

1 Introduction

Given the increasing number of countries that have legalized or decriminalized it, ever more health and social care providers (professionals) are likely to be confronted with requests for assisted dying. Realities, practices, and terminology vary across countries and over time. The administration by a healthcare provider of a lethal substance to terminate the life of a mentally competent patient who has explicitly requested it has been called voluntary euthanasia in some European countries (e.g., the Netherlands and Belgium) or medical aid in dying in Canada. The provision of the lethal substance by a physician has been called physician-assisted suicide in the USA, when this practice was first allowed in Oregon. More recently, the term "assisted dying" has been adopted. It includes voluntary euthanasia, medical aid in dying, and assisted suicide. In assisted suicide, a mentally competent patient takes a lethal dose of a prescribed substance and puts an end to their life.

Assisted dying is still controversial among professionals. The moral and ethical issues of both pros and cons are often discussed (1, 2). In the Quah et al. literature review (3), professionals were in favor of assisted dying in 16 studies, whereas in 23 studies, they opposed it. Some consider assisted dying as pertaining to their professional practice, while for others, it is inconsistent or even incompatible with their role and professional ethos (4, 5). Assisted dying is likely to represent a serious dilemma for professionals (5–7). That is why, in countries where it is permitted, professionals can usually invoke a conscientious objection clause (8, 9).

Some studies have reported higher endorsement of assisted dying if the physician had a strong relationship with the patient (10, 11) or if patients had terminal illnesses (12, 13). Professionals who have previous experience or exposure to assisted dying seem to be more willing to accept and carry it out, most of all if they have received requests in the last 12 months (14).

Some studies have mentioned a discrepancy between professionals' attitudes and practice in Switzerland, Quebec, or the USA (8, 12): for example, in the Hetzler et al. study (15), 60% of American physicians supported the legalization of physician-assisted suicide, but only 9% said they would carry it out (25% said they might).

Professionals having faced or performed assisted dying have reported feelings of heavy responsibility, emotional burden (16), and moral or professional dilemmas (5). Medical aid in dying in Canada was found to be impactful for nurses (17); the same is true for assisted suicide for other professionals (5). In some studies, practitioners experienced guilt, powerlessness, moral distress, and loneliness (3–5, 16).

Miscommunication in assisted dying is a source of concern for physicians (18). Communication is also a key issue for nurses (19). Physicians are also increasingly facing different and changing interpretations and expectations of good practices with regard to assisted dying (20).

Data on the experiences and impact of assisted dying at the organizational level are very scarce. It is mostly debated whether assisted dying should be considered a healthcare intervention or, as in the literature review of Franke et al. for the prison setting (21), how the legal or ethical criteria should be interpreted or applied. In palliative care settings, assisted dying has given rise to lively debate or controversy. In particular, it has been questioned whether assisted dying can be compatible with the core purpose and philosophy of palliative care and whether it is acceptable or appropriate to accept it within residential palliative care settings (22, 23). The issue of institutional non-participation has mostly been framed in terms of conscience and religious beliefs (24), but other reasons may be relevant such as quality of care and communication both within staff and with patients (25), the institution's right to self-governance based on capacity and expertise, principled considerations, philanthropic funding implications, or still the possible conflation of palliative care and assisted dying in the public consciousness, among others (24). Some of these reasons have been debated in the public arena and within Swiss institutions as well where the government has no obligation to guarantee the access and where institutions, depending on the canton in which they are located, have the choice of accepting or refusing assisted suicide. According to Hurst and Mauron (26), the Swiss situation is unique because of the normative context shaped not only by legal provisions but also by ethical guidelines developed by professional bodies and the policies of the Right-to-Die associations themselves, on the one hand, and because of the less medicalized nature of assisted suicide, on the other. There are no federal regulations governing assisted suicide. Assisted suicide is decriminalized under certain circumstances. Any person who provides assistance will not be prosecuted if three criteria are fulfilled: (a) the person who wishes to end their life has capacity and (b) can self-administer the fatal substance, i.e., carry out the final act themselves; (c) the person who assists has no self-interested motivations, as defined by Art. 115 of the Swiss Criminal Code (27). In some Swiss French-speaking cantons, assisted suicide is regulated

by state laws on Public Health, which apply to long-term care facilities financially supported by the state. In the canton of Vaud, the law enforcement directives (28) of art. 27d of the Law on Public Health (29) lay down the following criteria: the person must be capable of discernment/must have capacity; their desire to die by suicide is persistent; they must be suffering from a serious and incurable illness or its after-effects. If mental disorders or external pressures are suspected, the opinion of an expert psychiatrist must be sought.

Physicians involved in the process must also comply with the Swiss Academy of Medical Sciences guidelines (30). The provision of medical assistance for an assisted suicide must be in accordance with four criteria that partially overlap those of state law: the capacity of the patient; an enduring wish to die, which is well-considered and not due to external pressure; severe suffering, substantiated by an appropriate diagnosis and prognosis; and alternatives must be sought, discussed with, and offered to the patient.

In Switzerland, suicide assistance is not usually provided by professionals in the course of their duties but mostly by volunteers of Right-to-Die associations. EXIT ADMD Romandie (EXIT), a Right-to-Die association that operates in the French-speaking cantons of Switzerland, requires the person to be affiliated to the association, living in Switzerland, over 18 years old, and suffering from an incurable disease, and have unbearable suffering or invalidating polypathologies linked to older age (31).

People aged 65 or above represent 19.3% of the resident population in Switzerland (10.6% are women) (32). Approximately 5% (4.9%) live in long-term care facilities (33).

Median age at death by assisted suicide between 1999 and 2018 was 82 years (78 for men and 85 for women), and over the same period, the number of assisted suicide cases doubled for each 5-year period compared with the preceding period (34). In 2023, assisted suicide accounted for approximately 2.4% of all deaths (33). Persons over 65 years old accounted for 90.7% of all assisted suicide, and women accounted for 59.8% (34). In Switzerland, there is no obligation to report assisted suicides to a central national registry (35). To our knowledge, no data at the federal level are available concerning assisted suicide within long-term care facilities. However, 19.4% of all assisted suicides carried out by French-Speaking EXIT (one of the several Right-to-Die associations that operate in Switzerland) took place in care facilities in 2023 (36).

According to a Canadian study, people residing in an institution are less likely to die by medical aid in dying (6.3% vs. 28.0%) (37).

So far, most of the data in the literature concerning professionals relate to attitudes, moral positions, or emotions experienced in connection with assisted suicide, and is focused mainly on physicians and nurses (16, 38), principally those working in hospital settings or sometimes in palliative care. There is a lack of data on the whole process, from the request to the final act of assisted dying, and from a perspective that considers not only personal experiences but also organizational issues. However, the integration of assisted dying into care settings is likely to raise specific questions about the purpose of the institution, the continuity and quality of care, and the management of this particular type of end-of-life situation in terms of institutional operations. For example, management may need not only to deal with conflicting reactions and attitudes among staff to assisted suicide, but also to provide a framework that allows professionals to adapt individually and collectively to new situations that may challenge their roles and the provision of care within the institution. In addition, to our knowledge, assisted suicide has not been extensively researched in long-term care facilities for older adults. Long-term care facilities may face specific challenges due to the dual nature of their mission: they provide individual healing or care and are a collective living environment where social relationships and interactions are important, span time, and result in proximity of all actors involved. The aim of this article is to describe the processes that took place within long-term care facilities for older adults as experienced by the various professionals involved, to show how a request for assisted dying was managed within the organization and how the management and professionals dealt with the challenges posed by the request.

2 Materials and methods

The qualitative study was carried out in long-term care facilities in two French-speaking states, one of which is the canton of Fribourg, which has no legislation on assisted suicide. Institutions there follow guidelines established by the umbrella organization overseeing long-term facilities providing care for older adults. In the canton of Vaud, state regulations govern procedures for assisted suicide in institutions.

A two-step recruitment process was carried out. In the first step, in the absence of public data concerning assisted suicide within long-term care facility for older adults, and given that assisted suicide is a rare event, all residential homes (226) listed in official registers in the two cantons included in the study were invited by a letter to participate provided that they had been confronted with requests for assisted suicide (whether carried through or not). A written reminder was sent out 3 weeks after the first call.

In the second step, professionals working in facilities wherein management answered the call were then recruited on a voluntary basis and through a purposive sampling procedure. The management of these institutions forwarded the invitation flyer and information about the study. All professionals who were involved in the assisted suicide process within the facilities that answered the call were invited to a semi-structured interview. If they agreed to participate, they were contacted by a researcher by e-mail or phone and a convenient appointment was arranged at the workplace. No one dropped out after giving their consent. The face-to-face interview was carried out during working hours at the workplace, in the sole presence of the interviewer. The inclusion criteria were to be over 18 years old, to be able to express themselves in French, and to have been faced with a request for assisted suicide or involved in the process leading to a death by assisted suicide. For each participating institution but one, two to four professionals were interviewed. This allowed us to better understand the process that led to the assisted suicide from multiple points of view, and to situate the requester within it.

The project was reviewed and approved by the ethical commission in charge for the canton of Fribourg (030/13-CER-FR).

Interviewees provided consent both verbally and in writing. Confidentiality was assured and data were processed according to Swiss Federal legislation and Fribourg Cantonal legislation on the protection of personal data. Only the interviewer accessed raw data. Team members accessed anonymized transcriptions.

Interviewees were given the opportunity to receive the interview transcription and a synthesis of the results if they wished. Data presented in this article were collected from 12 long-term care facilities for older adults (5 in the canton of Fribourg and 7 in the canton of Vaud). Among them, six were considered as large institutions (>70 beds), four were considered as average institutions (40–70 beds), and two were considered as small institutions (<40 beds).

The interview guide was elaborated according to scientific literature and themes were identified during the exploratory interviews with stakeholders (one doctor, one officer at the federal Department of Justice, and one member of the board of an umbrella association for long-term care facilities). It was tested with three professionals (one director, one nurse, and one social worker, not included in the sample of the article). The interview guide (see the Supplementary Material) covered the following topics:

- the institution's official position and internal procedures with regard to assisted suicide.
- how the management and the professionals dealt with the assisted suicide request and how the assisted suicide process unfolded within the institution; and.
- the stances (personal and professional) of the professionals with regard to assisted suicide and the reactions and impacts they experienced during or after the assisted suicide or the impacts they observed among colleagues and residents.

Whenever necessary to clarify and deepen understanding, prompts were used. A total of 36 professionals (26 women and 10 men) aged between 24 and 64 were interviewed: 1 physician, 7 directors, 10 head nurses, 6 nurses, 10 nursing assistants or care assistants, and 2 socio-cultural animators. The large majority (26/36) had more than 20 years of experience and 27 professionals had more than 10 years of service in their current position. A total of 23 had training in end-of-life, palliative care or aging, psychology, or gerontology. The interviewees did not know the interviewers prior to the study.

The older people who requested assisted suicide were 11 women and 5 men, aged between 64 and 95. Professionals took care of them for periods ranging from 3 weeks to 7 years prior to the assisted suicide. According to the respondents, six people had multiple pathologies (an accumulation of several physical conditions such as diabetes with amputation, rheumatic diseases, and chronic diseases); five had cancer and five had a heart, respiratory, vascular, or ophthalmologic condition linked to old age. Other issues such as loss of quality of life, depression, and weariness of life were reported by the interviewees.

The interviewers (three women including the two authors, and one man) were trained in social work (one professor with PhD), social sciences (the research assistant with MA), sociology (one professor with PhD), and nursing (one professor with PhD).

Interviews (from 38 to 107 min in length) were audio-taped, transcribed verbatim, and analyzed with ATLAS.Ti (39) and Microsoft Excel software in several stages.

After every interview, a debriefing occurred, involving the interviewer and at least one other member of the research team. Field notes about the location, the interview process, non-verbal information, and interactional aspects were written down by the interviewer. A reflexive journal was kept by each interviewer over the research period and analytical memos were written consistently over the analysis period.

Because of the lack of data and the relative novelty of assisted suicide in long-term care institutions, we chose a grounded theory approach with the aim of developing theoretically relevant insights from a number of case studies and their comparison, i.e., constructing an explanatory scheme from data that integrates various categories (40, 41). Theoretical sensitivity was achieved through immersion in the data by comparison, by exchanges within the research teams, and by theoretical questioning (42). The analysis of empirical material made it possible to map the way in which institutions and professionals responded to requests for assisted suicide and how they dealt with them. The analyses was carried out through constant comparison and identification of relationships between the conceptual categories that emerged from data and that were established and verified throughout the study (43). The grounded theory uses three types of coding: open, axial, and selective (44). A list of descriptive codes (open coding) was established after having identified emerging and recurring topics through repetitive reading of the material. These descriptive codes were then classified into conceptual categories (axial coding: e.g., management of communication and support), from which dimensions and characteristics were extracted, for example, in communication management: open disclosure of assisted suicide/not, modalities of disclosure, content of disclosure, and people to whom the information was disclosed. Thematic and analytical syntheses for each interview were then written. Following this, metacodes (selective coding) were ranked based on the relationships observed between them: this allowed us to raise the level of abstraction and identify core categories (e.g., the various phases of the process and their components see Table 1). Regular meetings between team members provided an opportunity to discuss the development of the list of codes, analyze strategies, and group codes thematically and conceptually into categories, as well as to address possible interpretation biases and researchers' own representations in relation to assisted suicide. DACD and EPS (the authors) coded the interviews and performed the analysis. Codes, categories, and themes were thoroughly discussed within the research team (four people, see Acknowledgments). Saturation was reached when no new themes emerged after 25 interviews (45). For ethical reasons, and in order to honor the motivation of the professionals and not to exclude any of the people who had announced themselves for an interview, we conducted and analyzed 36 interviews.

3 Results

In what follows, we present the principal stages of the process that takes place in long-term care facilities for older adults when assisted suicide is requested from the point of view of the interviewees: how the older adult's request materializes and is formalized, how their request is handled and processed by professionals and management involved in preparing for the assisted suicide, and what happens on the day of death and following the assisted suicide.

3.1 Materialization and formalization of the request

Our data highlighted two types of scenario related to how the older person's request for assisted suicide materializes and is formalized: the first type was a request that occurred in stages. Some older persons, for example, indicated that they had registered with EXIT upon entry to the care facility. Others spoke about it when undergoing their annual care assessment.

> "*She always said, right from the moment she arrived, that she was a member of EXIT. And in fact, it was during the summer that she started talking about it again, about her need to move ahead with this undertaking and to put an end to her life. So, after that, all the protocols were followed about having discussions with the people involved*" (9_S_head nurse).

In this first scenario, the older persons initially evoke their wish orally, often to the carers looking after them on a daily basis. When this wish becomes a more concrete project, it is relayed to management or to managing carers either by the persons themselves, or by the intermediary of the carer who relays the information to their supervisor. At this point, management invites the person concerned to formalize their request in writing.

> "*And when I received her letter - I said to her 'Well, Mrs. X, I have received your request, I will respect it, (…) we will go through the procedure, it's your choice, it's your right. So I am going to pass it on to the doctor and, well there you are, if that's your choice*'" (12_D_director).

However, the person making the request must also undertake steps to begin the process with the association EXIT that will provide real-life assistance with the suicide. People who have difficulty with putting their request in writing are often helped to do so by family members. In our sample, concrete assistance from a carer was only provided on one occasion: the professional held the phone handset for the older person, as she was disabled, which enabled her to contact EXIT (in the same way that she aided this person to call her family). In general, both management and staff members refuse to participate materially in putting the request into action, in order to avoid any confusion between the role of the carer and that of the person assisting with suicide, or to avoid being accused of having influenced the person.

In the second type of scenario relating to the materialization and formalization of the request, the request was directly submitted to management, without the older person having shared their thoughts and wishes with those caring for them on a daily basis. As a result, the carers perceived the decision as abrupt and drastic. In two of the situations examined, the ones that occurred the longest time ago, the care facilities and their staff were presented with a *fait accompli*, as the date determined for the assisted suicide was only communicated to them a few days beforehand either by the requesting person or by EXIT. Faced with this situation, the professionals felt helpless.

> "*So if I go back over it all now, how it was all set up, it was the rush in which it all happened. Two and a half days, three at a push, between the Monday afternoon at two pm and the Thursday morning at ten am, that was really something that was hard to handle. Because really, we're not prepared, we don't know what's going to happen. We have to deal with a team, an institution, a doctor, a family, a resident, everything. And that, that rush was really hard to handle. The fact that we weren't able to talk things over with the family, was something I found really hard to handle*" (4_D_head nurse).

The request for assisted suicide resulted in quite a bit of questioning on behalf of the professionals involved, both on a personal and a professional level. Those whose personal values or professional ethos did not align with assisted suicide were those who were the most profoundly affected. In particular, staff members who came from a country where assisted suicide is not allowed, or is not possible for cultural or religious reasons, found it difficult to accept the request and the institution's involvement in the process. Some of them tried to question the older person's decision, despite the directives given by most of management of the institutions who, sometimes out of fear of EXIT, asked their employees not to influence the older person and to "remain professional and neutral" (12_D_director).

Once the request is official, the management almost always involves the establishment's doctor, the person's own doctor and care managers in its discussions. Together, they become the guarantors of the process or the procedure that will be put in place.

Regardless of whether or not the assessment of the person's situation and condition was conducted in-house or by EXIT, most institutions took the time to discuss things with the person concerned and to understand what had led them to make such a request. Often, the institutions offered care and pain relief alternatives to the older person.

> "*We offered this lady other alternatives: we got the doctor to come, we offered pain relief, which she took. We also offered psychological support. We were there, too, for psychological support, which she took up, that lady. She didn't say no to*

TABLE 1 Various phases of the process according to some categories of analysis and major challenges faced.

Process/cross-cutting categories	Materialization of the request		Preparation of the request		Enactment of the request		After death	
	PRO	MAN	PRO	MAN	PRO	MAN	PRO	MAN
Information + communication management	Elicit candidate's point of view	Consideration of request Involve doctors and head nurses	Adapt communication modalities with candidate and family	Decision-making (partially agreed with the candidate) on - Timing of information - Amount of information - Circumstance/setting of information (regular or special meeting)	Adjust communication with the candidate, their family, other residents, EXIT, and authorities	Guidance on information to share/ not within the institution	Adjust communication with family and other residents	Instructions regarding information to share and communication modalities
	Forward information to superior	Decide with the candidate on the scope + modalities of information disclosure–official information	Team communication alignment	Clarify responsibilities and tasks related to the process and to the information or communication management.			Communication among professionals about assisted suicide	Manage information among employees: clarify, reframe, answer questions
		Officially start the process and inform employees					Report to management and answer questions from medical examiners and police	Answer questions and cooperate with police and medical examiners
Dealing with moral/ professional/emotional or institutional issues	Dealing with surprise and/or helplessness	Establish an organizational framework and/or official stance on assisted suicide (integration or not into institutional purpose)	Choose whether to work on day of death and choose whether to be in contact with candidate	Allow and organize for conscientious objection or authorization to be in the room Adjust work schedules (staff substitution/ reinforcement) and room usage (privacy)	Living the experience - Dealing with emotions such as fear, anxiety, satisfaction, or feeling excluded - Watching/facing the process unfold	Reminding institutional stance and professional frameworks Act as guarantor of the process	Find ways of closure.	protect/do not expose staff and residents to medical–legal proceedings (i.e., bringing police officers through less-traveled routes)
	Facing moral and professional challenges Controversies over compatibility of assisted suicide with professional purpose	Facilitate the expression of diverse viewpoints and frame discussions	Deal with emotions, both on a personal and team level	Address controversies and deal with dynamics or potential tensions within teams (Re-)clarify institutional position	Preparation of the body in advance	Regulate employee involvement Provide/supervise additional staff on the day of death	Deal with different emotions associated with death (sadness, unfinished business, satisfaction for peaceful death, etc.)	Frame emotional expression within institution
	Learn about legal and ethical frameworks about assisted suicide		Adjust care for applicant	Set standards and reference points for continuity and quality of care until the time of assisted suicide	Waiting for death	Waiting for death	Preserve the candidate's room and deal with emotions associated with the medico-legal procedure	Allocate private spaces for medico-legal procedures

(Continued)

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TABLE 1 Continued

Process/cross-cutting categories	Materialization of the request		Preparation of the request		Enactment of the request		After death	
	PRO	MAN	PRO	MAN	PRO	MAN	PRO	MAN
		Contacts with EXIT about their assessment of the situation	Assist candidate in preparation of death	(Re-)establish a clear internal organization for division of labor and use of spaces	Follow directions concerning spaces and movements	Organize spaces to avoid contact between EXIT and residents or police and residents	Participation in rituals following medico-legal procedures	Organization of rituals
					Contacts with EXIT's volunteer	Contacts with EXIT regarding their assistance—monitoring their actions	Take the time to elaborate the experience	Replacement of personnel as and when required
Support	Confrontation with peers and/or peer support	Clarification of the legal/ethical framework, guidelines, or institutional protocols	Informal and formal mutual support (receiving/giving)	Ensure clear and sufficient communication throughout the preparation phase		Allocation of additional internal/external resources: -To care for the applicant and family (to be with them) -To care for the staff involved on the day of the death (working in pairs, meetings, defusing or debriefing).	Mutual informal support (discussions within units)	Provide additional internal/external resources for family and staff for meetings, rituals, supervision, opportunities for venting and collective processing of emotions related to assisted suicide
		Provide/Organize spaces for exchanges Discussions of request in meeting (ordinary or extraordinary)		Allocation of additional internal/ external resources:- For daily support of the candidate and their family - For staff: to enable discussion and facilitate collective elaboration of the process				
		Call on internal or external expertise for consideration of request		Determine the level and type of support to be provided on the day of death and beyond				
				Contacts with EXIT to coordinate their intervention				
				Contact with candidate's family				

PRO, professionals; MAN, management; Candidate, person requesting assistance in suicide.

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everything" (5_D_head nurse).

3.2 Preparation for the day of death

Concrete preparation for assisted suicide generally begins when EXIT communicates its acceptance of the person's request and continues up until the day of death. Depending on the time frame, the preparation was more or less significant and involved a variable number of professionals, as well as the families.

> "*It took nearly six months from the time she began saying: 'I want to go', the time for her to talk to the doctor, the time for her daughter to talk to the doctor, to speak with the team, the time for them to call, yeah, it was several months, you know, it didn't just happen from one day to the next*" (7_E_head nurse).

There are a number of important moments during the preparation period: setting up the accompaniment process for the requesting person, managing information and communication both within and outside the institution, and providing support for care teams and staff, as well as organizational logistics.

3.2.1 Accompanying the requesting person

According to the interviewees, both the management and the staff have invested significant amounts of time and energy in accompanying the person who has requested assisted suicide. In the professionals' view, the person's decision was respected, as were their wishes as to how that decision should be implemented, within the limits of what was possible for the institution. For the practitioners involved, this often meant having to think about and find new ways of supporting and accompanying the person, adapted to their particular situation.

According to the interviewees the persons concerned were generally able to choose the date and time of their passing, with one exception: in one situation, the management did not wish the assisted suicide to take place just before the weekend, due to their understaffing.

> "*So when, all of a sudden, you have to settle on a date, it's just … it's quite a tough moment, huh? (…)I think she wanted to do it on a Friday - and so I said 'But we can't'. I said, 'I, with my team, I have to protect my team, we won't do that before the weekend, I think there are things relating to it … that need to be done, we also need a bit of time. So we left things at least for a good week. And I think that for us, it allowed to think'. 'How are we going to do this, to think about how we can make everything go as smoothly as possible?*'" (12_D_head nurse).

Generally, the professionals supported the person concerned in several areas: in dealing with their belongings, in leaving certain objects to third parties, and in organizing where the person was able to say farewell to their loved ones, to staff members, or to other residents (if they had been told what was happening).

3.2.2 Managing and communicating information within the institution

The question of how to manage information relating to the assisted suicide request has always been considered a very delicate one: a great deal of time and energy are dedicated to it.

According to the professionals, the wishes of the person in question were taken into account, both in relation to the information given to staff and that given to other residents. If the person did not wish for their decision to be widely known, discretion was the mode adopted within the institution: only the information necessary for the institution to function normally was passed on internally. Nonetheless, on several occasions, it was the person themselves who informed some of the carers or residents, which went against the desire for discretion they had expressed to and agreed upon with management. The management had different ways of informing their staff. Five directors chose to provide information right throughout the assisted suicide process, for example, when the formal request was submitted to management, when the request was assessed, or when EXIT agreed to provide assistance to the person. Other directors decided to provide information from the moment that EXIT set the date for the assisted suicide.

The scope of people informed also varied: some institutions told the whole staff.

> "*[…] We told the whole institution, well the care staff first, hey, the people who were involved and so on. And each time, we thought about it and set it up, so that it was a transparent process, from what we do, what we say, how we say it, with what, what do we need to put in place for the team, and there you go, we went ahead step by step like that, because we have procedures, well really a cross-sector meeting every fortnight. So, from that fact, there were things, we also put it in writing for the carers but also for the service personnel, (author's note, to know), huh*" (12_D_head nurse).

Three institutions elected to only inform the teams involved with the older person on a daily basis when the request was made, but then once the date had been determined, they provided information on a broader level. Finally, some institutions only informed the immediate circle of carers, right up until and including the day of death.

> "*So there were several team meetings and when the date had been set, we didn't tell the team straight away, but [we did] on the Thursday in relation to the following Monday*" (9_E_head nurse).

Generally, it was only the assisted suicide situations that occurred the longest time ago that were hidden to some degree within the institution.

> "*In the first case, only the nurse manager knew and the staff watched as the police arrived. It had been done a bit secretively (…) Me, I came along later, but I saw that the staff had been really, really upset by this happening*" (7_E_nurse).

The management and supervisors informed staff during the usual team meetings or sometimes by organizing get-togethers or unplanned meetings.

Regarding the other residents, the information was circulated in various ways. No management spoke openly of the person's assisted suicide to other people living in the institution before it occurred. There were different reasons for this: either because the institution had agreed with the person that a certain level of discretion was required to avoid effects such as inciting others, shocking people whose beliefs were incompatible with assisted suicide, attracting unwanted media attention, or affecting the reputation of the care facility; or, again, because the person wished themselves to keep it quiet. On one occasion, however, it has happened that the person confided in some of their closer residents, which sometimes makes it difficult for the professionals.

3.2.3 Accompanying staff

Managing information and communication is undoubtedly one of the key strategies when accompanying and supporting staff. In choosing different times to relay information, the management and nurse supervisors helped to ensure regulation at various levels (affective, cognitive, and individual–collective), by allowing the professionals to follow the process and to find their place in it. All the interviewees considered that an assisted suicide that takes place in a collective environment entails significant issues, which is why a great deal of thought was put into it beforehand, with a particular focus on staff. Some directors considered that all staff needed to be supported, while others focused their efforts and the support they offered on staff who were likely to be actually involved in accompanying the person who had requested suicide assistance.

Several institutions chose to provide regular reference points, situating each stage within the internal procedure or in relation to cantonal law, enabling staff to follow the progress of the request and deal with emotions.

> "*And always, every time a stage passed, let's say the doctor had sent the letter, we said to the team, 'There you go, that's where we're at', and we chatted about it. Afterwards, I can't remember if it was the psychiatrist from the mobile unit or the psychiatrist who came after to see the lady, he was also there for the team, putting things into perspective, you know, to open the discussion and all. That was something that was really appreciated. The care staff, even if the residential area there is very Protestant, I think that the carers are far and away Catholics in the majority, with other habits and customs too. So I think that there as well, well, they were able to express their emotions, how they were feeling*" (12_D_head nurse).

Support was offered mainly in the form of opportunities to express and perhaps even vent emotions about the real-life situation, both individually and collectively, in sessions. It was almost always the nurse managers who were made responsible for providing support to their colleagues.

> "*As a team, we were able to say well, here we are and then say 'well yes, it's normal, you have the right to say what you feel, to say that I'm afraid, afraid that it will be too hard for me' and to be able to ask the questions that some of the carers had, like 'is the person getting everything that they need?'*" (2_E_nurse).

Sometimes, sessions were organized using external resources (psychiatrists or other resident physicians) to help people to express themselves. Having these spaces to get information and express emotions was deemed very important by the managers in helping to control interactions and internal team functioning, and continuing to ensure their cohesion.

> "*I think that we anticipated it all really, we thought about it a lot, we really put everything in place, considering the psychological aspects for everyone: the care team, the family, yeah, the service team, the kitchen staff if necessary, really all the people who are around the person*" (12_D_head nurse).

However, a number of professionals would have liked the discussions to also touch on other fundamental questions and not only the feelings, for example, by addressing the question of whether assisted suicide was compatible with the institution's mission, or with professional responsibilities or ethics.

3.2.4 Organizational logistics

Once the date for the assisted suicide has been set, the institution has to make the necessary arrangements and prepare the staff so that everything goes as smoothly as possible. This involves the organization of work schedules and spaces.

> "*We were able to let the team know the date. And we left people the choice, because some of them were still against the person's decision and really didn't accept it on the inside of themselves, in relation to their values, we said to the team that those who didn't want to work that day could have the day off, we looked at who agreed to it. In any case, we knew that for the other residents we'd have enough people to work, because you still have to look after the others. We left it up to the team. Only one person from the team wanted to be off that day*" (5_D_head nurse).

According to the directors, only a small minority of staff members asked not to be present on the day of assisted suicide. The institutions accepted their request and found replacements for the team, so that they were not confronted by the situation. This was sometimes a delicate operation in the smaller institutions.

The management also reinforced the teams on the day of death, in anticipation of one or even two professionals needing to take care of the older person for longer or manage the situation (final wash, interacting with EXIT, and receiving the police and the medical

examiner), and so that time would be available for exchanging within the teams following the event, without anything affecting the routine running of the institution.

> "*So we reinforced the numbers on the team so that carer only had that lady to look after and didn't need to run around to other rooms and so that we had time to have a team meeting. As I said, we had a debriefing afterwards. So that, that's something you have to organize, because you need time. So we increased the numbers on the team*" (5_D_head nurse).

Management also ensures that the person concerned and their family can enjoy a certain degree of privacy, and that neither staff not directly involved nor other residents are unnecessarily disturbed by the assisted suicide act.

> "*On that floor, honestly, we had emptied it out. The activities team had taken a number of the residents to have a meal, those who were mobile. Those who were more disabled went to the dining room, so [in] the whole zone where the assisted suicide was going to happen, I knew we weren't going to see anyone*" (4_D_head nurse).

Finally, the management had to coordinate with EXIT. According to the interviewees, collaboration with EXIT during this preparatory phase was variable: in some situations, it was seen as positive, i.e., the exchange of information was fluid. In these cases, EXIT planned and indicated when its visits to the older person would occur, keeping the institution informed of the situation, discussing things with the team and explaining what was going to happen and how, or taking into account organizational imperatives in setting the date and time for the assisted suicide (e.g., not setting a date on the weekend). This was greatly appreciated by the institutions and associated professionals, who felt that this type of support was respectful, both of the older person and of the institution and its staff. On the other hand, when the institution or staff were exceptionally presented with a *fait accompli*, collaboration was deemed problematic and difficult to cope with.

> "*And so things went very fast (…) and between the moment when the Exit volunteer told us and when it actually happened, there were only about 48 hours … Which was huge and which put a huge amount of pressure on Management, so the institution and on the doctor. And the doctor was confronted with - well, I was too - but the doctor mostly, was faced with completely stupid threats from the EXIT doctor and others, like 'If you don't do this, well we're going to sue you, because everything is settled, it's all in order', even though that wasn't the case. And our thoughts, I'm telling you, that were foremost there, were 'What happens to this person if we don't?*'" (11_S_nursing assistant).

These difficulties contributed to mounting tensions within the institution.

In most situations, contacts with EXIT fell somewhere between these two extremes, with a variable level of information exchanged and communication of the selected date with several days' notice.

3.3 The enactment of assisted suicide

On the appointed day, special support for the person concerned was planned for and provided.

The act of assisted suicide took place in the resident's room within the institution, except in two cases: in one, the death took place in a room intended for family gatherings, as the resident shared their room with another person; and in the second, the resident returned to their home to carry out the act.

Four directors told their staff that they were not allowed to be present during the act, while others allowed it if the person had requested it and the attending carer agreed. Professionals were thus confronted with one of four scenarios: either they were not in the institution at the time of the assisted suicide; or they were in the institution but had no contact with the older person on the assisted suicide day; or they accompanied them until EXIT arrived (washing them, tidying up, and spending the last hours with them) but then left the room; or they were present during the act in the person's room.

The professionals who had final contact with the person were not automatically selected by their supervisors but could choose whether or not to take on this task, on a voluntary basis. In the majority of cases, they did not wish to be alone in facing the situation. Two professionals were therefore sent to accompany them. The institution therefore had to adjust to this self-designation process and make additional resources available in the days leading up to and on the day of the assisted suicide.

The majority of people interviewed left the room before the person took the lethal substance. Four were present when the substance was administered, with the permission of their managers. One person subsequently regretted having been there.

Generally speaking, all interviewed reported a particular atmosphere on the day of assisted suicide, with the words most often used to describe it being: tense, a heavy atmosphere, difficult to concentrate on the usual tasks, a feeling of time suspended, agitated, and questioning things.

> "*Well, it wasn't always just waiting, because at the same time, we kept doing the rest, we were with the other residents, we talked about other things. But it's true that when all of a sudden - I can't remember the time anymore - but let's say at nine am, that was the planned time for her to drink the substance, I did look at the time and said to myself "But how's it going, is she going to do it or at the last minute, will she say 'no, after all, I won't'?*"" (9_E_head nurse).

All of them said they felt relieved when "everything was over". According to them, some deaths were quick (in a few minutes) and trouble-free, while others, those that occurred furthest in the past, were more laborious (over a few hours).

Collaboration with EXIT on the day of assisted suicide was assessed in different ways: some institutions considered it constructive. In these cases, the volunteer introduced themselves to the caregivers, reported when the person had died and talked to the professionals following the death. Other institutions reported that they did not really exchange much with EXIT on the day of death. One institution said that they had not been told that death had occurred:

> "*And so I simply asked them, 'Listen, I'm just asking you, when she dies, to let us know'. And so I chose to stay in the nurse's station on the floor, five meters away from the room. Tenam, they went into the room, 10.20, 10.30, 11.45, still nothing. We said to ourselves 'Well, seems like there's been a problem' OK. Seems like it's something that can happen. In the end, I went back down to the ground floor and found myself face to face with a man in uniform […] I said, 'But wait a minute, no one said anything to me' 'Oh yes, we were just called a moment ago'. There was a series of misunderstandings between us and Exit that I found hard to cope with*" (4_D_head nurse).

Most interviewees appreciate the distinction between tasks and roles that exist between the staff on one hand, and EXIT on the other, especially on the day of death. None of them, with one exception, feel that it is their responsibility to provide material assistance with suicide, and therefore do not see assisted suicide as something that could perhaps be integrated for all intents and purposes into the end-of-life care of residents, or as something that the institution should be involved without the assistance of an association.

3.4 Following the death

Assisted suicide represents a particular type of end-of-life and death within an institution. Even the professionals who support it the most point to its uniqueness and to the differences in process between assisted suicide and other types of death occurring within the institution. For example, staff cannot carry out a post-mortem wash, prepare the body, or arrange the room (placing flowers) as they usually would. The care providers together with the older person therefore have to anticipate a number of things and "prepare" the person in advance:

> "*We got her dressed beforehand. So I washed her, I got her dressed before (…) she was ready. Afterwards, we didn't touch her again, no. No, we had to leave her in the bed, just laid her down because she was sitting up and was tipping over, just laid her down, we couldn't touch her after that. Because they had to take photos, the police were taking photos. Because when there's a suicide, there are photos of the body and so on. (…)It was a different kind of death. Everything was really different and that, it was different too, the preparation*" (5_E_nursing assistant).

In fact, as assisted suicide is classified as an unnatural death, the police are called and the medical examiner comes to carry out checks, to ensure that there has not been any undue external influence. During this time, staff are forbidden from going near the body and from going into the room where the death took place. These forensic procedures often reinforce the feeling of having been excluded from end-of-life care, and of not having been able to accompany the deceased to the end.

The interviewees find the investigation trying, even though they recognize it is necessary. The investigation is the moment when the "cold, hard reality" breaks into the proceedings, despite the best efforts of the police and the medical examiner. Caregivers present in the room at the time of death are questioned by the police, and their status shifts from being observers to witnesses. In some cases, the police also questioned carers who were not present at the time of the act about the deceased's state of health and the care provided up until the time of death. Some institutions had to produce the files and all documents related to the process that led to the assisted suicide. In certain situations, investigations were opened when the police had doubts about whether the legal criteria for eligibility had been respected.

> "*So they (author's note, the police) went much further than EXIT (author's note, they checked to make sure…) that she wasn't depressed, that she was capable of discernment, so that we could not be accused of non-assistance to a person in danger*" (5_E_nurse).

The investigation situations that were most detailed were also the ones that occurred the longest time ago of those in our sample. According to the interviewees, the increase in the number of situations occurring in institutions has been accompanied by a simplification of procedures.

Some directors commented on the delicate position in which they find themselves: in cantons where there is existing legislation, the institutions have to agree to allowing an assisted suicide to take place on their premises. Notwithstanding, they are often only involved peripherally and do not have much influence on the evaluation that EXIT makes. Despite this, they do have to answer to the police and may be implicated in criminal proceedings if the public prosecutor decides to open a case on the basis of the report made by the medical examiner or the police. As a result, some directors would prefer to see the investigation, or at least some State-supervised, formal process of criteria verification, taking place before the death by assisted suicide, rather than as a post-mortem procedure.

Generally, after the assisted suicide, management or supervisors bring together staff who were involved in accompanying the deceased person, to share, to debrief, and sometimes for a moment of contemplation. If the professionals were present at the moment of passing, they share their impressions and accounts of how things went with their colleagues. More rarely, psychiatrists or other external professionals are called upon to meet with teams or staff if they wish it.

Approximately half of those interviewed said they had been greatly affected by the assisted suicide (feelings of confusion, sadness, revolt, dreams, and questioning their professional duties). Those most affected would have liked to receive more support, and for a longer period of time. In fact, with one exception, after debriefing on the day itself, none of the institutions offered any further opportunity to discuss the experience afterwards. The institution whose management offered support a few weeks after the death saw that there was a real need for it among staff:

> "*Because we had a little debriefing session a few weeks afterwards with someone specialized, so that the team could let go of it all […] It went well. There were members of other teams who came as well, because they also had things they needed to let go of (…). And it's true, I didn't realize it, but there were a lot of people who had dreams, had nightmares, who had recurring ideas, who were asking themselves (author's note, how that happened), all of that. I had a nursing colleague who dreamed of me, that I was strangling the deceased person in their bed*" (3_D_nurse).

A number of professionals have called for the creation of spaces where they can reflect on their professional mission and ethos, and on the care they can offer in these special situations, beyond organizational management and procedure. Similarly, a need for training in this area was noted on several occasions following the event.

The period after the assisted suicide is also a delicate moment for the institution's other residents, who often only realize that something unusual has happened in the institution when the police arrive. According to most interviewees, the police arriving in the institution left many with questions and even frightened some of the residents. Management and supervisors find ways of limiting such effects, often bringing police officers through less-frequented ways (back entrances and fire escapes).

Two institutions spoke in detail about how the death had occurred after the event. Ten institutions gave no information at all to other residents, either because the practice within the institution did not provide for disclosure of the cause of death; or to "protect" the person concerned, their family, and the institution's reputation; or so as not to upset the other residents. However, most professionals in these facilities answered the residents' questions, some not explicitly mentioning assisted suicide, while others did:

> "*Of course it disturbs how the unit works, huh I mean. Of course it disturbs how it works, because there are comings and goings, there's the police, there's the medical examiner. Of course it disturbs how the unit works. But we also responded to the residents who asked questions and wanted to know what was happening. We also answered that it was a resident who had chosen to pass away with Exit. We didn't publicize it in the home that they had passed away with Exit. But for people who asked the question directly, we answered it*" (3_D_director).

In terms of post-mortem rituals, the facilities treat assisted suicide in the same way as other deaths: in their eyes, this is very significant, representing an important moment that allows professionals to "close the circle" and to have the feeling that they have finished accompanying the person. In some institutions, accompanying a person ends with attending the funeral. When that is not possible following an assisted suicide (because the family did not want it), the care teams found it difficult.

4 Discussion

In Switzerland, professionals are not actually involved in the final act, since it is the person who ends themselves their life. Similarly, the substance is not provided by the professionals who work in long-term care facilities, but usually by an association for the Right to Die with Dignity. However, management and professionals are involved, in various ways, in the process from the initial request to the aftermath of death.

The description of the process experienced by management and professionals shows that a request for assisted suicide within a long-term care facility is not a trivial event: it generally gives rise to a large number of questions concerning the most appropriate way to respond and follow up as shown also in previous research (10, 46). Similarly to results reported in studies within palliative care, the core purpose of the institution was questioned (22–24). The process that led to the assisted suicide required a whole series of specific support steps for the requesting person and their family, and staff within the institution. In all the situations investigated, institutional life and daily operations were significantly impacted.

The normative context (presence or absence of a law or formal institutional procedure) did not seem to play a major role in the way directors and staff dealt with requests. This may be related to the fact that once assisted suicide has been introduced in the institution, it seems not sufficient to follow a formal or administrative procedure, as assisted suicide involves personal, collective, moral, ethical, and organizational issues that require discussion and elaboration specific to each situation. Our findings suggest that the style of management and the choices made in terms of communication and involvement of staff during the process or still the support provided, dynamically adapted, were critical. In institutions where management set out a clear framework for the way in which the request would be handled and provided sufficient and appropriate support for staff over time, disruptions were less important, not only in terms of operations, but also in terms of cohesion within teams and in relationships between care teams and management. The need of support is frequently mentioned in previous studies (22, 23, 25).

From an institutional point of view, major adjustments were required in procedures, daily operations, and information processing or communication within the institution, as well as in the allocation of resources. For example, additional resources had to be allocated on the day of assisted suicide in order to be able to accompany the person to the point of death as well as ensuring normal functioning and accompaniment of the other residents, or to assist with the medico-legal procedures that follow the death. Lack of resources was sometimes an additional difficulty or barrier in the process for institutions as mentioned in a previous study (46) and some directors raised questions related to equity.

Respondents who had a closer relationship with the person requesting assistance found it easier to endorse the request, in line with previous findings (11, 16).

Communication within the institution throughout the process was fundamental in enabling the various staff to find their bearings and make sense of the situation, as well as to prepare as serenely as possible. These results are in line with previous studies that point to communication as a major issue that can be both a source of difficulty and a support for professionals (16, 46, 47).

By informing staff from the various professions at different times and creating spaces for exchange, discussion and even emotional venting, the managers enabled staff to situate themselves and to be able to anticipate and even integrate the adjustments that assisted suicide introduces into end-of-life care and support within the institution. Staff appreciated the opportunity for interdisciplinary exchange. Interdisciplinarity is considered a facilitating factor in assisted dying situations (46). The amount of time the institution put into organizing the event and accompanying the person requesting assistance was also deemed very important. Situations in which professionals felt they had enough time to accompany the person concerned or prepare for their departure were those that had the fewest negative impacts at both personal and organizational levels.

As the process unfolded, a number of cross-cutting issues emerged: the first was the need to strike a balance between respecting the procedures laid down by law or the directives of professional associations, and the second, to find ways of responding that, while respecting formal procedures, opened up spaces for exchange, emotional management, and the construction of meaning and professional closure for the various people involved in the process. Other issues include the preparation and training of professionals, and the support provided throughout the process, as noted by other authors (8, 16, 22, 46–48). Indeed, some interviewees would have liked more support in the form of more regular exchange forums and prior training related to assisted suicide. The majority of the interviewees also hope that, in the future, assisted suicide will not simply become a matter of procedure and organization, but that discussions on the substance can take place within the teams (49) and the institution, so that both the motivation to care and the health of staff are preserved.

4.1 Strengths and limitations

For ethical reasons, institutions and professionals were recruited on a voluntary basis. Therefore, self-selection bias is likely to have occurred and the results, as in most qualitative studies, cannot be generalized. We have no means of knowing if institutions that did not participate in the study were faced with assisted suicide requests or if these situations unfolded differently from the process we described. In addition, the involvement of management in the internal distribution of the call for participation may have contributed to the selection bias, although in our sample, there are divergent opinions on both the acceptability of assisted suicide and the issues of its integration into the institution.

Finally, the variety of professional bodies interviewed and the specificity of the normative Swiss context (no federal law, active role of the Right-to-Die associations), where professionals do not administer the lethal substance and are not primarily in charge of the supervision of the final act, makes it even more difficult to generalize the results. Nevertheless, our results shed light not only on individual reactions and ways of coping with requests for suicide assistance, but also, in a unique way, on how such situations are dealt with collectively and organizationally. This may be of interest for institutions across countries faced with requests for assisted suicide, voluntary euthanasia, or medical aid in dying. Indeed, despite different legal provisions, the management of institutions is likely to face similar challenges such as adjusting internal organization and affairs, allocating specific and extra resources and dealing with employees who have contrasting views on assisted death. Our results are likely to foster new insights in a still understudied field in Switzerland and elsewhere, i.e., the management and collective implications and adjustments related to assisted dying within institutions. The results will enrich knowledge and are likely to guide training for professionals as well as organizational guidelines and management in a Western context where the number of assisted deaths is likely to increase, given demographic trends, population health issues, and evolving social representations about dying.

Future longitudinal research is necessary to investigate how the integration of assisted dying within long-term care facilities and other healthcare facilities impacts professionals' attitudes, health and social care standards and practices, and the kinds of organizational and professional adjustments that are necessary to provide appropriate care. Observational or even ethnographic research, capable of capturing different perspectives and interactions between various players simultaneously, would also be appropriate.

5 Conclusion

Long-term care facilities are not only a place of cure and care, where death occurs, but also a collective environment where living together or community life is as important as somatic care: various groups of people share a great deal of time and, at least to some extent, intention and purpose. According to the interviewees, assisted suicide is a variation of the end-of-life experience that requires major adjustments. Indeed, assisted suicide raises a number of personal, relational, and organizational issues. The scope and the organization of work, the routines and usual professional roles, and the modalities of interaction and communication at the end of life are likely to be disrupted. Our findings highlight some particularly important points when it comes to considering assisted suicide within the institution:

1. The institution should provide a clear and safe framework in which all parties involved can situate themselves in relation to the request for assisted suicide and throughout the process at various levels: ethical, professional, and

organizational. That goes beyond the adoption of standardized procedures.

2. Sufficient resources should be provided throughout the process: time and support for candidates and professionals, such as opportunities to vent emotions, discuss the situation from ethical, relational, professional and organizational perspectives, reflect on collaboration, adjust work schedules and routines, and meet with external professionals. Caregivers would be more comfortable and skilled in dealing with such situations, and they would in turn provide tailored support to the person concerned and their loved ones.
3. It is critical to pay proper attention to information and communication management with all parties involved in the process.
4. Specific and multi-faceted training should be consistently provided that goes beyond the provision of information. It should address multiple issues and provide opportunities to develop ethical, professional, and organizational skills (e.g., communication).

Although assisted suicide in institutions is still a controversial issue, and despite sometimes conflicting views on the matter, the perspectives of respondents show that management and professionals have had to develop a common way of responding to the request and a common modus operandi within the institution if they wish to ensure congruence and quality of care to the end of the requestor's life. Meaningful communication, attention to the needs of professionals, and opportunities for collaboration and mutual support among different professions are likely to facilitate the wellbeing of the staff involved and are critical to addressing the challenges associated with assisted suicide.

Data availability statement

As agreed with the ethic commission and research field partners, raw or deidentified data cannot be shared in any form. Requests to access the datasets should be directed to angela.castelli@hefr.ch.

Ethics statement

The studies involving humans were approved by Ethical commission (030/13-CER-FR). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

DC: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft. EP: Formal Analysis, Investigation, Methodology, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. HES-SO University of Applied Sciences and Arts Western Switzerland (grant number HES-SO 33509-RECSS 10-12) and the School of Social Work in Fribourg (HES-SO //FR) supported financially the study and the writing of the article.

Acknowledgments

The authors would like to thank the long-term care facilities and the professionals who participated in the study as well as Prof. Em. Sabine Voélin and Prof. Em. Michel Fontaine, members of the research team, for their contribution.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Generative AI was used for grammatical corrections concerning the paragraphs added or modified in the revised article. DeepL Pro, version 24.11.4.14424.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2025.1537038/full#supplementary-material

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 17 June 2025
DOI 10.3389/fpsyt.2025.1560719

OPEN ACCESS

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RECEIVED 14 January 2025
ACCEPTED 20 May 2025
PUBLISHED 17 June 2025

CITATION
Conejero I, Porras-Segovia A, Albarracín-García L, Barrigón ML, Lopez-Castroman J, Courtet P and Baca-Garcia E (2025) Depression subtypes, suicidality, and healthcare costs in older adults: results from a naturalistic study.
Front. Psychiatry 16:1560719.
doi: 10.3389/fpsyt.2025.1560719

Depression subtypes, suicidality, and healthcare costs in older adults: results from a naturalistic study

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Introduction: The burden of depression is increasing worldwide, particularly in older populations. While the impact of depressive disorders on suicide in later life has been clearly identified, less is known about the role of their subtypes and their costs in the elderly.

Objectives: We aimed to describe the sociodemographic and clinical characteristics associated with the depression subtypes and suicidality, and their related healthcare costs in older adults receiving mental healthcare.

Methodology: The study was carried out across four psychiatry departments in Madrid, Spain. Adults aged over 60 years were included if they attended the psychiatric inpatient or outpatient services and were diagnosed with Major Depressive Disorder (MDD), recurrent depressive disorder, bipolar depression, or dysthymia. Sociodemographic data and diagnoses according to the International Classification of Diseases, 10th edition were obtained from electronic health records. Lifetime suicidal history, suicidal ideation and suicide attempts in the previous month were identified using the Columbia Suicide Severity Rating Scale (CSSRS). Mean healthcare costs were calculated over one year.

Results: N=2868 patients were included in the analysis. Of these, 550 were assessed with the CSSR. The mean age of the sample was 70.05 years and 75.9% of the patients were women (N=2177). Of the patients assessed with the CSSRS (N=550), 83.2% (N=458) reported suicidal ideation, and 7.3% (N=40) had attempted suicide in the previous month. Psychiatric healthcare costs over the

follow-up differed between the depression subtypes (Eta-squared 0.003 CI [0.000 - 0.008]; p<0.001). They were significantly higher in patients diagnosed with bipolar depression, than in those diagnosed with dysthymia (p=0.026), but did not differ from those bearing MDD (p= 0.775) or recurrent depressive disorder (p= 0.129). Recent suicide attempters had a more frequent lifetime history of suicide attempt (OR= 8.434). Suicide attempts were more frequent in individuals aged 71-80 years (OR= 3.433) or over 80 years (OR= 3.322), and in patients with recurrent depressive disorders (OR= 3.529).

Conclusion: Psychiatric healthcare costs differed between depression subtypes, with a small effect. Furthermore, older age, a diagnosis of recurrent depression, and a history of suicide attempts increased the risk of suicide. Health policies should target these populations to improve mental health outcomes in the older adults.

KEYWORDS

older adults, depression, suicide, healthcare costs, suicidal ideation

Introduction

The burden of depression is increasing worldwide, particularly in older populations as a result of longer life expectancy (1). The global prevalence of major depressive disorder (MDD) in the elderly ranges from 13% to 31% (2, 3), with Europe showing the second highest rates after Australia (2). Globally, depressive disorders are placed among the three leading causes of disability, along with low back pain and headache disorders (4). In parallel, suicide risk increases with age (5). The global suicide rate for people aged 50-69 years, is 16 per 100 000, but rises to 27 per 100 000 among those aged 70 and over (6). Deaths by suicide increased among older people by 8.1 per cent in the 65+ age group between 2021 and 2022 (5). The situation is equally concerning in European countries, such as Spain, where the incidence of suicide attempts among older adults has been estimated at 35 per 100 000 (7).

A recent meta-analysis examined the sociodemographic and clinical factors associated with MDD in older adults. Key factors associated with higher rates of depression in this population included female gender, advanced age, social isolation, lack of social support, and chronic health issues (3). In addition, lower levels of social activity and repeated depressive episodes may increase the risk of depression in later life (7, 8). Suicidal behavior in older adults shares common risk factors with depression including bereavement, dependency and the experience of illness (6). However, less is known regarding the distribution of these factors across unipolar and bipolar depression subtypes and their specific role in suicidal ideation or attempts in patients with depressive disorders. While the impact of depressive disorders on suicide in late life has been clearly identified (6, 9), less is known about the role of the specific depression subtypes.

In addition, depressed or suicidal older people are frail and particularly at risk of poor mid- and long-term medical outcomes (10). Therefore, it is important to target this population, which is also more likely to need healthcare resources. To this end, examining the costs associated with clinical depression subtypes and suicidal behaviors in older patients should further help to identify unmet needs in this complex population. This may also provide information to better guide large-scale health policies in depressed older adults (11).

Hence, we aimed to describe and compare the sociodemographic characteristics and clinical features associated with depression subtypes and with suicidality in older adults aged over 60 years receiving mental healthcare in hospital psychiatric inpatient or outpatient settings. We also assessed mean total, psychiatric and medical healthcare costs during follow-up according to the depression subtypes and to the occurrence of recent suicidal ideation or attempts. We hypothesized that bipolar depression, and suicidal behavior would be associated with higher levels of psychiatric comorbidities and greater healthcare costs in older age. We also hypothesized that recent suicidal behaviors in old age would be associated with a lifetime history of suicide attempts.

Materials and methods

Study design and patient sample

Depressed older adults aged over 60 years were recruited between 2014 and 2020 in the Departments of Psychiatry of four hospitals of the Community of Madrid, Spain (University Hospital Fundación Jiménez Díaz, University Hospital Rey Juan Carlos,

General Hospital of Villalba, and University Hospital Infanta Elena).

The patients were included if they attended the psychiatric inpatient or outpatient facilities, and if they were diagnosed with MDD, recurrent depressive disorder, bipolar depression, or dysthymia. The diagnoses were coded according to the International Statistical Classification of Diseases and Related Health Problems 10th (ICD-10) criteria. In the ICD-10 classification, MDD relates with depressive episodes (F32.x) and include mild (F32.0), moderate (F32.1), severe (F32.2), or psychotic (F32.3) depressive episodes. Patients with unspecified depressive disorders (F32.9) were not included in the study. Recurrent depression (F33.x) corresponds to repeated episodes of current mild (F33.0), moderate (F33.1), severe (F33.2), or psychotic (F33.3) depressive episodes. Patients with recurrent depressive disorder unspecified (F33.9) were not included in the study. Dysthymia (F34.1) corresponds to a chronic depression of mood without criteria for diagnosing recurrent depression. Finally, bipolar depression corresponds to F31.3, F31.4 and F31.5 subcategories of bipolar affective disorders (F31.x). Regarding comorbidities, the category "organic mental disorders" (F00-F09) included Alzheimer's dementia, delirium and other dementia; the category "substance use disorders" (F10-F19) included all the mental and behavioral disorders due to psychoactive substance use; the category "psychotic disorders" (F20-F25, F28) included schizophrenia, delusional disorders and other nonorganic psychotic disorders; the category "anxiety disorders" (F40-F44) included anxiety and dissociative disorders; the category "personality disorders" (F60.x) included all the personality disorder subtypes.

Variables and measures

Information registered at first contact with the mental health services was drawn from structured fields in Electronic Health Record interface from the MEmind platform (12): sociodemographic data, coded medical and psychiatric diagnoses using ICD-10 classification. MEmind is a digital ecosystem based on an application installed on the patient's smartphone for behavioral monitoring including self-reports, caregiver or family reports and professional assessments. The application is freely available in Apple Store and Google Play, and has been described elsewhere (13–15). Lifetime history of suicidal ideation and suicide attempts in the month prior to first contact with our psychiatric services were identified using the Columbia Suicide Severity Rating Scale (CSSRS) registered in hospitals' Electronic Health Record (16). The CSSRS was added as a screening instrument in clinical routine from the last three years of recruitment. Data on psychiatric care costs, other medical care costs and overall healthcare costs were collected from recruitment to 31 December 2023. We used the EPICO study methodology to allocate direct costs to each care modality (including emergency room visits, hospitalization, routine laboratory testing, X Rays, computed axial tomography, magnetic nuclear resonance, psychology visits) for overall health care, psychiatric, or other medical healthcare (11). Indirect costs related to loss of productivity (cost for temporary and permanent work disability) were not computed. Each type of expense was computed over one year and expressed as mean/year (euros) per patient. Notably, psychiatric and other medical healthcare costs were calculated over different periods of time, not necessarily overlapping. Hence, each type of healthcare cost should be considered separately.

Electronic medical records were pseudoanonymized in compliance with Spanish laws on the Protection of Personal Data and guarantee of digital rights. The study was approved by the University Hospital Fundación Jiménez Díaz Ethics Committee and patients' information was handled as stated in Spanish and European regulations on data protection and patients' digital rights. All the participants provided written informed consent before entering the study and installing the MEmind application.

Availability of data

Data will be made available upon request.

Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 29. First, we offered descriptive statistics of the whole population and performed univariate analyses to compare the clinical characteristics, and healthcare costs between depression subtypes. We also compared patients who had reported suicidal ideation in the previous month with those who had not, and also compared patients who had attempted suicide with those who had not recently attempted suicide. The univariate analyses were performed using F-exact test, chi-square, ANOVA or Welch's ANOVA in case of variance inequalities assessed through Levene's test. Effect sizes and confidence intervals (Eta-squared, [CI]) were computed (17). If the results were significant, *post-hoc* comparison between groups were applied through Tukey's or Games-Howell's tests. For exploratory purposes, we performed a binary logistic regression to assess the clinical factors associated with suicidal ideation and attempts.

The significance level was set at $p < 0.05$, using 2-sided tests and 95% confidence intervals.

Results

Baseline characteristics of the sample

Of the 39,472 patients who received mental healthcare between 2014 and 2020, 2,868 met the inclusion criteria and were included in the analysis. Of these patients, 550 were assessed with the CSSRS at baseline, as this tool was available latter after the start of recruitment. Suicidal behavior was analyzed in this last subgroup. The study flow chart is provided in Figure 1.

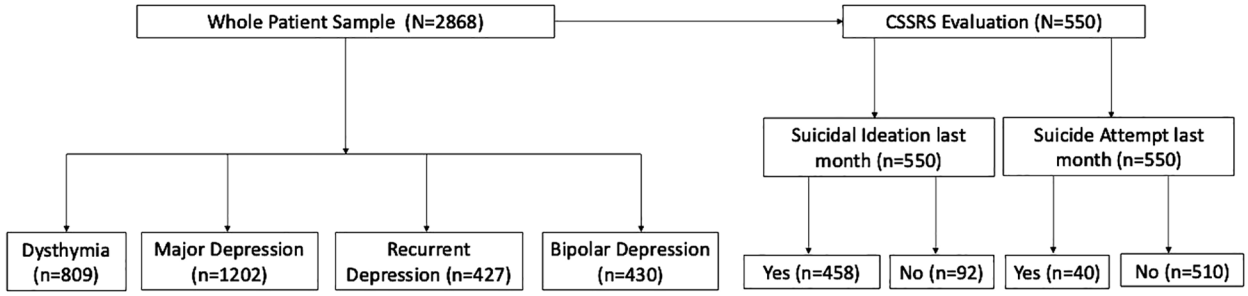

FIGURE 1
Study flow chart.

The clinical characteristics of the study population at baseline are reported in Table 1. The mean age of the sample was 70.05 [SD= 7.81] and 75.9% of the patients were women (N=2177). Age classes were distributed as following: 1,639 (57.1%) were aged between 60 and 70 years; 888 (31%) were aged between 71 and 80 years; and 341 (11.9%) were aged over 80 years. Regarding marital status, 8.8% (N=246) of the patients were single (never lived with a partner and never married), 35.7% (N=994) were separated or widowed, and 55.4% (N=1542) were living with a partner. Total health care costs per patient averaged 2,811.64 euros/ year [SD=22168.47].

In the whole sample, 28.2% (N=809) of patients were diagnosed with dysthymia, 41.9% (N=1202) with MDD, 14.9% (N=427) with recurrent depressive disorder, and 14.9% (N=430) with bipolar depression. Regarding psychiatric comorbidities, 5.6% (N=161) were diagnosed with an organic mental disorder, 4.4% (N=126) with a substance use disorder, 2.3% (N=66) with a psychotic disorder, 20.7% (N=594) with an anxiety disorder, and 8.9% (N=254) with a personality disorder. The distributions of the total, psychiatric and medical healthcare costs across the different comorbidity categories are shown in Supplementary Table 1.

Among patients assessed with the CSSRS (N=550), 83.2% (N=458) reported suicidal ideation, and 7.3% (N=40) had attempted suicide in the previous month. Those results are presented in the Table 2.

Association between depression subtypes, and patients' characteristics or healthcare costs over the follow-up

Age differed between depression subtypes (Eta-squared 0.007 CI [0.002 - 0.013]; p<0.001). Those diagnosed with MDD were older than those with dysthymia, recurrent depressive disorder or bipolar depression (Mean 70.80 [8.53] Vs. 69.57 [7.08] (p=0.002), 69.65 [7.27] (p=0.038), and 69.26 [7.37] (p=0.002), respectively). Particularly, 17% of the patients with MDD were aged over 80 years, while they were 8.3% in the group showing dysthymia, 8.7% in the group with recurrent depressive disorder, and 7.2% in the group with bipolar depression. In contrast, patients with bipolar depression were younger than the other groups, 61.9% of them being aged between 60 and 70 years old. Those diagnosed with dysthymia were more frequently females than those with MDD, recurrent depressive disorder or bipolar depression (91.9% vs. 68.6%, 79.1%, and 64.9%; p<0.001 respectively).

Patients with bipolar depression lived less frequently with a partner (50.1%) than other groups (56.4% for dysthymia, 54.3% for MDD and 62% for recurrent depressive disorder, p<0.001). They also had more frequent comorbidities with organic mental disorders (10%) and psychotic disorders (4.9%).

Those with recurrent depressive disorder had a higher comorbidity rate with substance use disorder (6.6%). Dysthymia was more frequently comorbid with anxiety disorder (30.8%) and personality disorder (15.7%).

Finally, psychiatric healthcare costs over the follow-up differed between the depression subtypes (Eta-squared 0.003 CI [0.000 - 0.008]; p<0.001). They were significantly higher in patients diagnosed with bipolar depression (Mean 3105.92 [SD=19045.60] euros/year), than in those diagnosed with dysthymia (Mean 293.61 [SD=620.04] euros/year, p=0.026), but did not differ from those bearing MDD (Mean 1903.14 [SD=25093.83] euros/year, p= 0.775) or recurrent depressive disorder (Mean 906.80 [SD=2685.71] euros/year, p= 0.129). The results are shown in Table 1 and in Figure 2.

Association between suicidal ideation, and patients' characteristics or healthcare costs over the follow-up

Patients who reported suicidal ideation in the previous month were more frequently diagnosed with dysthymia and MDD, and less frequently diagnosed with recurrent depressive disorder and bipolar depression compared with those without suicidal ideation (p<0.001). The individuals with suicidal ideation in the previous month had less frequent comorbid organic mental disorder (p=0.030) and more frequent anxiety disorders (p=0.002). They were also less likely to report a history of suicide attempts (p<0.001). Finally, total healthcare costs were reduced in patients with suicidal ideation in the previous month (p=0.017). The results are reported in Table 2.

TABLE 1 Clinical characteristics of old age patients and subsequent healthcare costs according to the clinical depression category[a].

Clinical characteristics	Whole sample (n=2868)	Dysthymia (n= 809)	Major Depressive Disorder (n=1202)	Recurrent Depressive Disorder (n=427)	Bipolar depression (n=430)	Significance (p-value)[b]
Age	70.05 [7.81]	69.57 [7.08]	70.80 [8.53]	69.65 [7.27]	69.26 [7.37]	< 0.001
60-70	1639 (57.1%)	476 (58.8%)	652 (54.2%)	245 (57.4%)	266 (61.9%)	< 0.001
71-80	888 (31%)	266 (32.9%)	344 (28.6%)	145 (34%)	133 (30.9%)	
> 80	341 (11.9%)	67 (8.3%)	206 (17.1%)	37 (8.7%)	31 (7.2%)	
Gender						
Male	681 (23.7%)	65 (8.1%)	376 (31.4%)	89 (20.9%)	151 (35.1%)	< 0.001
Female	2177 (75.9%)	742 (91.9%)	820 (68.6%)	336 (79.1%)	279 (64.9%)	
Missing	10	2	6	2	–	
Family status						
Single[c]	246 (8.8%)	60 (7.6%)	99 (8.5%)	31 (7.5%)	56 (13.5%)	< 0.001
Separated or widowed	994 (35.7%)	283 (36%)	433 (37.2%)	127 (30.5%)	151 (36.4%)	
Lives with a partner	1542 (55.4%)	443 (56.4%)	633 (54.3%)	258 (62%)	208 (50.1%)	
Missing	86	23	37	11	15	
Comorbidities						
Organic mental disorder (F0)	161 (5.6%)	18 (2.2%)	78 (6.5%)	22 (5.2%)	43 (10%)	< 0.001
Substance use disorder (F1)	126 (4.4%)	26 (3.2%)	58 (4.8%)	28 (6.6%)	14 (3.3%)	< 0.001
Psychotic disorder (F2)	66 (2.3%)	10 (1.2%)	27 (2.2%)	8 (1.9%)	21 (4.9%)	< 0.001
Anxiety disorders (F4)	594 (20.7%)	249 (30.8%)	229 (19.1%)	94 (22%)	22 (5.1%)	< 0.001
Personality disorders (F6)	254 (8.9%)	127 (15.7%)	74 (6.2%)	31 (7.3%)	22 (5.1%)	< 0.001
Missing	1667	379	736	244	308	
Mean healthcare costs/year (Euros) per patient						
Total Healthcare costs (missing= 259)	2811.64 [22168.47]	1911.82 [1841.47]	2277.67 [5303.97]	1998.25 [2921.64]	7200.83 [58245.74]	0.066
Psychiatric care costs (missing= 249)	1433.68 [17530.33]	293.61 [620.04]	1903.14 [25093.83]	906.80 [2685.71]	3105.92 [19045.60]	< 0.001
Medical Healthcare costs (missing= 220)	2082.78 [11483.89]	2126.87 [8638.93]	2393.20 [16323.71]	1564.49 [2360.61]	1670.56 [1955.25]	0.547

[a]Data are means [Standard Deviation], or number (%).
[b]The univariate analyses were performed using F-exact test, chi-square, or ANOVA.
[c]Single: never lived with a partner and never married.

Association between suicidal attempts in the last month, and patients' characteristics or healthcare costs over the follow-up

Patients who attempted suicide in the month prior to evaluation were older (p=0.001), more frequently diagnosed with MDD and recurrent depressive disorder, less frequently diagnosed with dysthymia and bipolar depression (p=0.025), and showed more frequent lifetime history of suicide attempts (p<0.001) than those who did not attempt suicide. No differences were found regarding the healthcare costs over the follow-up. The results are reported in Table 2 and Figure 3.

10.3389/fpsyt.2025.1560719

TABLE 2 Clinical characteristics of old age patients and subsequent healthcare costs according to the suicidal ideation and behaviors at baseline[a].

Clinical characteristics	Suicidal ideation (last month)			Suicide attempt (last month)		
	Yes (n= 458)	No (n=92)	Significance (p-value)[b]	Yes (n=40)	No (n= 510)	Significance (p-value)[b]
Age	68.74 [7.73]	69.63 [7.57]	0.311	72.62 [8.78]	68.59 [7.54]	0.001
60-70	296 (64.6%)	54 (58.7%)	0.550	15 (37.5%)	335 (65.7%)	0.002
71-80	113 (24.7%)	26 (28.3%)		18 (45%)	121 (23.7%)	
> 80	49 (10.7%)	12 (13%)		7 (17.5)	54 (10.6%)	
Gender						
Male	133 (29.2%)	23 (25%)	0.246	10 (25%)	146 (28.8%)	0.379
Female	322 (70.8%)	69 (75%)		30 (75%)	361 (71.2%)	
Missing	3	–		–	3	
Famlily status						
Single[c]	28 (6.2%)	7 (7.8%)	0.126	5 (12.5%)	30 (6%)	0.275
Separated or widowed	164 (36.5%)	42 (46.7%)		14 (35%)	192 (38.5%)	
Lives with a partner	257 (57.2%)	41 (45.6%)		21 (52.5%)	277 (55.5%)	
Missing	9	2		–	11	
Mood disorders						
Dysthymia	118 (25.8%)	19 (20.7%)	<0.001	5 (12.5%)	132 (25.9%)	0.025
Major depressive disorder	224 (48.9%)	36 (39.1%)		19 (47.5%)	241 (47.3%)	
Recurrent depression	85 (18.6%)	19 (20.7%)		14 (35%)	90 (17.6%)	
Bipolar depression	31 (6.8%)	18 (19.6%)		2 (5%)	47 (9.2%)	
Missing	–	–		–	–	
Comorbidities						
Organic mental disorder (F0)	19 (4.1%)	9 (9.8%)	0.030	4 (10%)	24 (4.7%)	0.138
Substance use disorder (F1)	36 (7.9%)	8 (8.7%)	0.461	2 (5%)	42 (8.2%)	0.360
Psychotic disorder (F2)	6 (1.3%)	4 (4.3%)	0.069	2 (5%)	8 (1.6%)	0.160
Anxiety disorders (F4)	139 (30.3%)	14 (15.2%)	0.002	12 (30%)	141 (27.6%)	0.437
Personality disorders (F6)	67 (14.6%)	17 (18.5%)	0.215	6 (15%)	78 (15.3%)	0.588
Missing	–	–		–	–	
Suicidal behavior lifetime						
No	335 (73.1%)	3 (3.3%)	<0.001	7 (17.5%)	331 (64.9%)	<0.001
Yes	123 (26.9%)	89 (96.7%)		33 (82.5%)	179 (35.1%)	
Mean healthcare costs / year (Euros) per patient						
Total Healthcare costs	2366.15 [3270.35]	3412.55 [5407.00]	0.017	3559.46 [3530.69]	2468.22 [3746.87]	0.091
Psychiatric care costs	2187.39 [23193.70]	1413.11 [4199.10]	0.755	4075.86 [9195.10]	1905.56 [21833.88]	0.554
Medical Healthcare costs	1921.42 [2714.51]	2545.63 [4557.53]	0.144	2037. 82 [1522.81]	2009.27 [3185.63]	0.959

[a]Data are means [Standard Deviation], or number (%).
[b]The univariate analyses were performed using F-exact test, chi-square, or ANOVA.
[c]Single: never lived with a partner and never married.

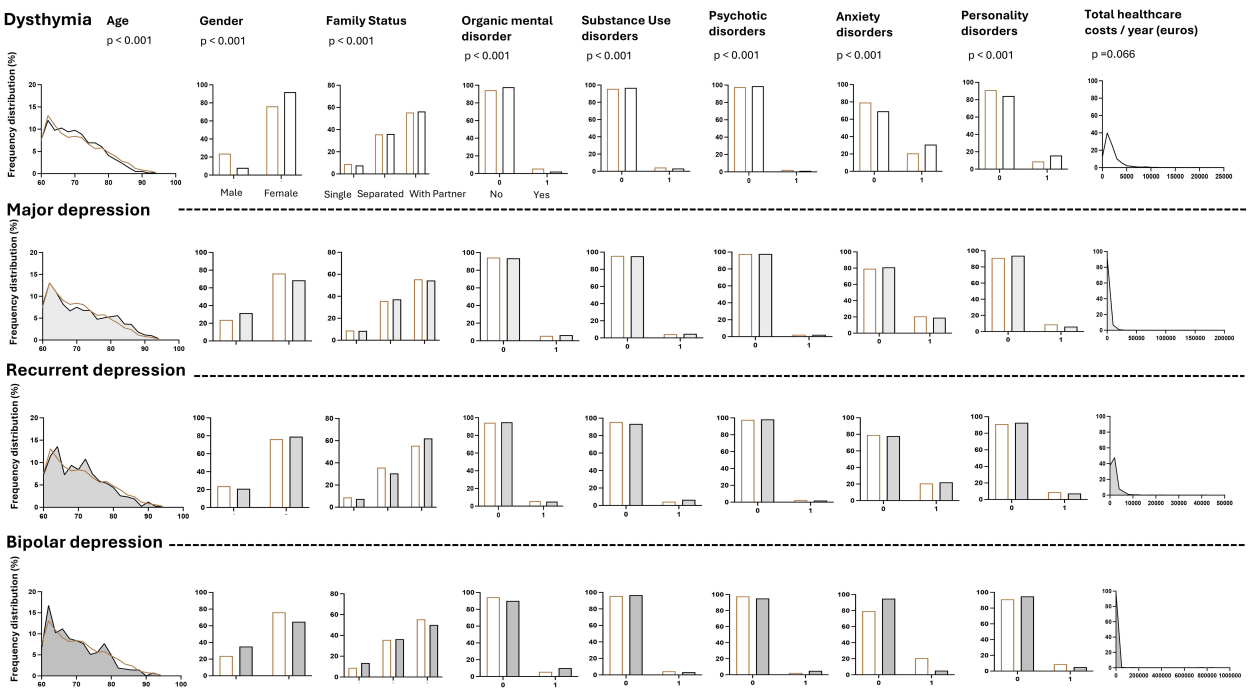

FIGURE 2
Clinical characteristics of old age patients and subsequent total healthcare costs/year (euros) according to the clinical depression category. The category "organic mental disorders" (F00-F09) includes Alzheimer's dementia, delirium and other dementia; the category "substance use disorders" (F10-F19) includes all the mental and behavioral disorders due to psychoactive substance use; the category "psychotic disorders" (F20-F25, F28) includes schizophrenia, delusional disorders and other nonorganic psychotic disorders; the category "anxiety disorders" (F40-F44) includes anxiety and dissociative disorders; the category "personality disorders" (F60.x) includes all the personality disorder subtypes. Single: never lived with a partner and never married.

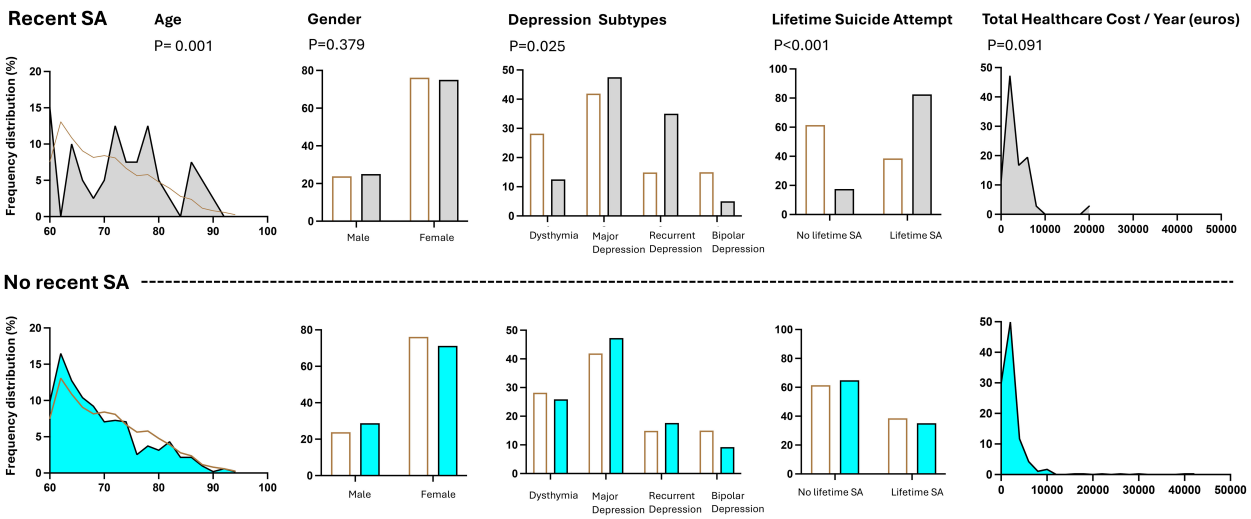

FIGURE 3
Clinical characteristics of old age patients and subsequent healthcare costs according to the suicidal ideation and behaviors at baseline.

Exploration of the factors associated with suicidal ideations and attempts using multivariate models

In the multivariate analysis, the frequency of suicidal ideation was increased in participants showing a comorbid anxiety disorder (OR = 2.113; CI-95% 1.027-4.346). In the contrary, suicidal ideation was less frequent in individuals reporting a lifetime history of suicide attempt (OR= 0.013; CI-95% 0.004-0.044). These latter results contrasted with what was found for suicide attempts. In fact, recent suicide attempters had a more frequent lifetime history of suicide attempt (OR= 8.434; CI-95% 3.491-20.372). Recent suicide attempts were also more frequent in age ranges between 71 and 80 years (OR= 3.433; CI-95% 1.476-7.988), and over 80 years (OR= 3.322; CI-95% 1.141-9.667) when compared to the individuals aged between 60 and 70 years. Suicide attempts in the previous month were also more frequent in patients diagnosed with recurrent depressive disorders (OR= 3.529; CI-95% 1.105-11.266). The results are shown in the Table 3.

Discussion

In this naturalistic cohort study, we found that the elderly with MDD were older than those with other clinical depression subtypes, whereas those with bipolar depression were younger, were more often socially isolated and showed more frequent mental organic disorders and psychotic comorbidities. Older adults with bipolar depression also required more psychiatric healthcare resources than those diagnosed with dysthymia, while the latter effect remains small.

We also found that older age, a diagnosis of recurrent depression and a lifetime history of suicide attempts increased the risk of attempting suicide. Suicidal ideation was more frequent in the participants showing comorbid anxiety disorder. In contrast, a lifetime history of suicidal behaviors was related with a lower risk of recent suicidal ideation. In our sample, suicidal ideators or attempters did not use higher healthcare resources than non-suicidal individuals.

Patients' profiles differ between clinical depression subtypes in old age

To our knowledge, no studies have previously compared patient characteristics between clinical subtypes of depression systematically in old age. However, our results are in line with some indirect findings in the literature. In particular, it has been reported that female gender and younger age may be associated with a higher risk of depression recurrence (18). Indeed, recurrent depression may be detected earlier as affected individuals experience multiple episodes in younger age (8). Similarly, in our study the individuals diagnosed with recurrent depressive disorders were more frequently females and were younger than those diagnosed with MDD, while age differences across depression subtypes were of small magnitude and showed limited clinical significance.

TABLE 3 Association between clinical characteristics and suicidal ideation or behaviors at baseline[a].

Clinical characteristics	Suicidal ideation			Suicide attempt (last month)		
	Estimated odds ratio (exp(b))	95% CI for Exp(b)	Significance (p-value)	Estimated odds ratio (exp(b))	95% CI for Exp(b)	Significance (p-value)
Age						
60-70						
71-80	0.878	0.447-1.728	0.707	3.433	1.476-7.988	0.004
> 80	0.833	0.326-2.130	0.703	3.322	1.141-9.667	0.028
Gender (female)	0.689	0.344-1.380	0.293	1.956	0.772-4.959	0.157
Mood disorders						
Dysthymia						
Major depressive disorder	1.238	0.556-2.753	0.601	2.452	0.785-7.658	0.123
Recurrent depression	1.094	0.459-2.611	0.839	3.529	1.105-11.266	0.033
Bipolar depression	0.570	0.210-1.549	0.271	0.362	0.038-3.479	0.379
Organic mental disorder (F0)	0.501	0.151-1.665	0.260	1.720	0.472-6.273	0.411
Anxiety disorders (F4)	2.113	1.027-4.346	0.042	1.776	0.766-4.119	0.181
Suicidal behavior lifetime	0.013	0.004-0.044	<0.001	8.434	3.491-20.372	<0.001
Total Healthcare costs / year per patient (> Median, Euros)	0.753	0.405-1.403	0.372	1.534	0.659-3.568	0.321

[a]A binary logistic regression was performed to assess the clinical factors associated with suicidal ideation and attempts.

Furthermore, younger age at onset has been reported in the elderly with bipolar depression compared with those showing unipolar MDD (19). Earlier onset of bipolar depression has also been reported in middle-aged populations (20, 21). In addition, late-onset bipolar disorder was more frequently of organic origin (22). Bipolar depression shows particularly high burden of comorbidities, whether psychiatric or organic (23). In line with the literature, we evidenced that the elderly showing bipolar depression were mostly younger, were most often socially isolated and were most frequently diagnosed with organic mental disorder and psychotic comorbidities.

Specificities of suicide attempter's profile

A recent review highlighted that despite a large amount of studies evaluating the effect of age, its role as a risk factor for suicide attempt was contrasted (24). In our sample, depressed elderly aged over 70 had an increased risk to attempt suicide compared with those aged between 60 and 70. In the same line, the risk was higher in those aged over 80 years compared to those aged between 60 and 70 years, while the effect was weaker. Furthermore, previous studies evidenced that the recurrence of depression was associated with a higher likelihood to attempt suicide (25). Our results support those findings as the diagnosis of recurrent depression was the only mood disorder increasing the risk to attempt suicide in the elderly. Conversely to the elevation of the risk to attempt suicide reported in the middle age population with bipolar disorder (26), bipolar depression in the older adults was not independently associated with such higher risks. In addition, we found that a history of suicidal behavior was the strongest risk factor for suicide attempts in later life, with an 8-fold increased risk. In their systematic review, Beghi et al. (2021) reported a moderate role of the lifetime history of suicidal behaviors in the elderly, with only 4 upon 9 studies showing significant results (24). In their meta-analyses grouping longitudinal studies performed in adolescents and adults, Ribeiro et al. (2016) found that self-injurious thoughts and behaviors were linked with an increased risk of attempting suicide (OR of 2.16), while a history of suicide attempt was specifically associated with increased odds of suicide attempt (OR 3.61) over the follow-up. The association did not differ between age groups (27). The latter results were partly obtained in general population samples. In our study, the data were collected in a clinical population seeking hospital mental care, and the suicidal vulnerability may have cumulated with the effect of current mood disorder at inclusion, thus increasing the likelihood of suicidal acts.

Surprisingly, we found that previous suicide attempts were associated with a lower risk of suicidal ideation in later life. Those results diverged from previous findings in the general population. In particular Ribeiro et al. (2016) reported a slight but significant positive association between the occurrence of suicide attempt and subsequent suicidal thoughts (OR 1.58) in their meta-analysis (27). Interestingly, a recent meta-analysis showed that while prior self-injurious thoughts and behaviors increased the risk for subsequent suicidal ideation in the general population, the association lost significance among veterans (28). Authors indicate that the relationship between risk factors and suicide related outcomes may weaken with age. This outlines the specificities and differences between the mechanisms underlying suicidal behaviors and ideation across the lifespan. The relationship between a preexisting vulnerability to suicide and subsequent suicidal ideation in older adults may vary from the one observed in younger individuals. However, further studies should be conducted to replicate these findings and confirm this hypothesis. In addition, comorbid anxiety was a risk factor for suicidal ideation in our study. These results are in line with prior study from Bendixen et al. (2018) conducted in aged individuals (29). This relationship seems stronger in elderly than in younger adults (30). This points the need toward treating such anxiety symptoms for preventing suicidal ideation in late life.

Finally, we did not evidence any relationship between gender and suicidal ideation nor with suicidal attempts. Similarly, absence of relationship was shown in a community sample of individuals bearing borderline personality disorders (31). However, in a population of patients with bipolar disorders, females were more likely to attempt suicide (32). In the older adults, rates of suicidal ideation and attempts differed between genders (33). Suicide deaths were found to be up to six time higher in males than in females (34). Hence, further studies should investigate and precise gender differences toward suicidality in the elderly population.

Healthcare associated costs

Previous Spanish real-world research evaluated the medical costs in retrospective observational studies involving depressed people, and showed that they ranged from a mean of 3,402 €/patient/year for non-TRD patients (11), to 3,846 €/patient/year (35). In our study sample, the mean total healthcare costs averaged 2811 €/patient/year. However, those costs were underestimated as we only calculated direct expenses. In fact, the studies conducted by Vieta (2021) and Perez-Sola (2021) also included indirect costs related to temporary and permanent disability. Annual psychiatric healthcare expenses in elderly patients diagnosed with bipolar depression exceeded those with dysthymia in our sample, but also out passed the total healthcare costs described in the above studies. These results are in line with previous reports showing that elderly with bipolar depression were four times more likely to use mental health services and four times more likely to require hospitalization (36). Nevertheless, interpretation should be cautious as measuring the likelihood to use healthcare resource is not strictly equivalent with the costs associated with healthcare. Furthermore, the large variability of the total healthcare costs in the patients with bipolar depression may have prevented us to evidence differences with other depression subtypes. Regarding the impact of suicidal behavior, although healthcare costs following a suicide attempt seemed more elevated, there was no significant difference compared with non-attempters.

Limitations and strengths of the study

Our study has some limitations. First, we were not able to distinguish between late-onset and early-onset depressive disorders in our elderly sample. In fact, reliable information regarding eventual past depressive episodes in middle or young age was not available. Furthermore, data on clinical factors classically associated with suicidal attempts were lacking, such as cigarette smoking or impulsivity traits (37). Data collection period overlapped with SARS-CoV-2 pandemic. This may limit the generalizability of the results. Moreover, while we assessed the presence of organic mental disorders including dementia, data collection did not involve recordings of cognitive measures. In fact, altered cognitive function may be associated with depression subtypes and suicidal behaviors. Regarding the calculation of medical expenses, mean total, medical, and psychiatric costs per year were computed over different time periods. Hence, each type of healthcare costs should be considered separately. Finally, the calculated costs did not include indirect social costs related with patient disability or premature mortality.

However, such knowledge may help guide healthcare policies for the prevention of depressive disorders in the elderly, and may help target clinical subgroups with particular needs. Notably, our research is a naturalistic real-world study involving one of the largest samples of depressed older adults to date. As we focused on a population receiving specific hospital psychiatric care, our findings may be generalized to frail older people, who tend to have the worst medical outcomes.

Clinical implications

Our findings have clinical implications. Early preventive measures should focus on detecting and treating comorbid anxiety in older adults in order to reduce the occurrence of suicidal ideation. In addition, tailored and specific treatments for recurrent depression should be provided early to help prevent suicidal behaviors. To this end, the use of innovative technologies for detecting and treating these conditions should be encouraged. For instance, smartphone-based tools and digital monitoring show promise for the care of older patients, particularly in populations with limited resources or those who are socially isolated (38).

Conclusions

Overall, we highlighted the phenotypes specifically associated with clinical depression subtypes across the depression spectrum in older age. We also examined the characteristics associated with suicidal behavior in older adults seeking mental healthcare in outpatients and inpatient hospital settings. Among the depression categories assessed, elderly individuals with bipolar depression were the youngest, most frequently socially isolated, and exhibited the highest rates of mental organic disorders and psychotic comorbidities. Psychiatric healthcare costs differed between depression subtypes, with a small effect. Early secondary and tertiary preventive measures should be set in order to mitigate the medical impacts of comorbidities. In parallel, being older, being diagnosed with recurrent depression, and showing a history of suicidal attempts increased suicide risk, while the latter factor was conversely associated with suicidal ideation. Clinicians should particularly assess eventual suicidal behaviors, preparation and plans in those patients for efficient prevention. To this end, the use of innovative technologies for detecting the behavioral markers of suicide in the elderly should be encouraged.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University Hospital Fundación Jiménez Díaz. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

IC: Data curation, Formal analysis, Writing – original draft, Writing – review & editing. AP: Conceptualization, Data curation, Writing – review & editing. LA: Conceptualization, Data curation, Writing – original draft. MB: Conceptualization, Data curation, Writing – review & editing. JL: Conceptualization, Data curation, Formal analysis, Supervision, Writing – original draft, Writing – review & editing. PC: Conceptualization, Data curation, Supervision, Writing – review & editing. EB-G: Conceptualization, Data curation, Formal analysis, Supervision, Writing – original draft, Writing – review & editing.

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Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was supported by CIBER -Consorcio Centro de Investigación

Biomédica en Red-(CB/07/09/0025), the Instituto de Salud Carlos III with the support of the European Regional Development Fund (ISCIII JR22/00011; ISCIII PI23/00614), by Ministerio de Ciencia e Innovación/a Agencia Estatal de Investigación MCIN/AEI/10.13039/501100011033 and "NextGenerationEU"/PRTR (TED2021-131120B-I00), by Fundació La Marató de TV3 (202226-31) and by CaixaResearch Health 2023 HR23-00421.

Acknowledgments

We are very grateful to Rosa Nunes for helping drafting and formatting the manuscript.

Conflict of interest

EB-G has been a consultant to or has received honoraria or grants from Janssen Cilag, Lundbeck, Otsuka, Pziffer, Servier and Sanoffi. EB-G is the founder of eB2. EB-G has designed the MEmind application.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2025.1560719/full#supplementary-material

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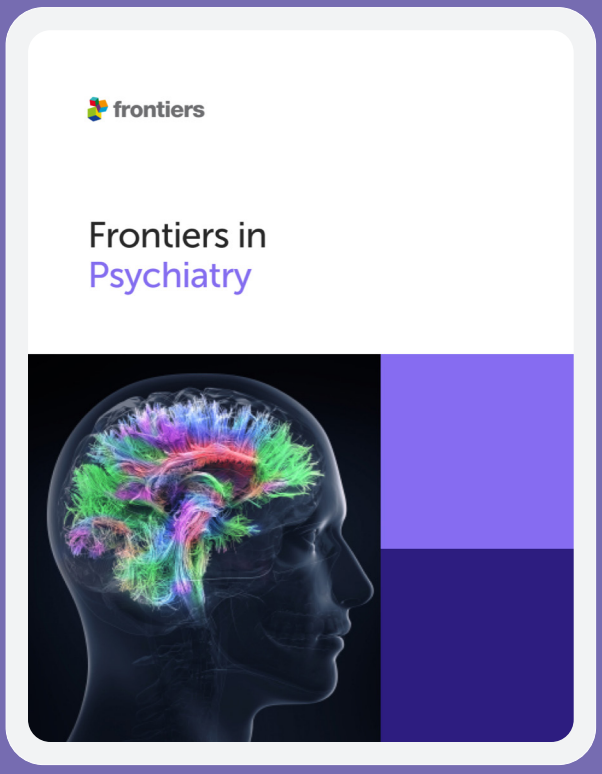

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