A CONCEPTUAL MODEL OF FRAILTY IN OLDER ADULTS: A LITERATURE REVIEW

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Abstract

This review employed several key procedures to synthesize the current evidence on frailty. An extensive literature search was conducted across major databases to identify relevant studies on frailty definitions, epidemiology, assessment tools, interventions, and conceptual models. The search results were analyzed using bibliometric techniques including thematic mapping with Biblioshiny and co-occurrence network visualization with VOSviewer. These bibliometric analyses identified core research themes, emerging topic clusters, and connections across the frailty literature. The main findings highlighted frailty's multidimensional nature spanning physical, cognitive, psychological, and social domains. While the frailty phenotype by Fried et al. (2) provided an initial operational definition, subsequent models increasingly encompassed a broader biopsychosocial frailty construct. Globally, over 10% of community-dwelling older adults were estimated to be frail, with rates exceeding 40% in those over 90 years old. Frailty was associated with numerous adverse outcomes like disability, falls, hospitalization and mortality. Current assessment approaches included the frailty phenotype, frailty index, and various clinical performance tests, though no single comprehensive tool existed. Evidence supported tailoring multimodal interventions combining physical, nutritional, cognitive, psychological and social strategies to individual risk profiles. The principal conclusion highlighted the critical need for a unified, holistic conceptual model elucidating the complex interplay of factors driving frailty's development and progression. By integrating the findings, a biopsychosocial framework was proposed that conceptualizes frailty as a multifactorial health state arising from the cumulative impact of interconnected physical, cognitive, psychological, social and environmental determinants over the life course. Such models are essential for advancing frailty science, shaping clinical practices, and informing policies to promote healthy, resilient aging amid rapidly aging populations worldwide.

Keywords: Aging, Conceptual Framework, Frailty, Older Adults

Introduction

Frailty is a common geriatric syndrome characterized by increased vulnerability to stressors due to age-related declines in physiological reserves (1). Over the years, various definitions and conceptualizations of frailty have emerged in medical literature, reflecting the complexity of this condition. The understanding of frailty has also evolved significantly, with the introduction of the frailty phenotype by Fried et al. (2) in 2001, marking a pivotal moment in frailty research. This review aims to explore the diverse definitions and concepts of frailty in older adults to provide a comprehensive understanding of this important geriatric syndrome.

Frailty has been defined in numerous ways, ranging from a physical phenotype to a multidimensional concept encompassing physical, psychological, and social domains (3). The Federal Council on Aging in the US initially described frailty in older adults as individuals over the age of 75 who require multiple health services due to multi-morbidity (4). Subsequent research has led to the development of

various operational definitions of frailty, culminating in the frailty phenotype proposed by Fried et al. (2). This phenotype includes criteria such as unintentional weight loss, weakness, exhaustion, slowness, and low physical activity, highlighting the multifaceted nature of frailty (2).

Frailty is a critical issue in geriatric care as it is associated with adverse health outcomes; including disability, hospitalization, institutionalization, and mortality. Studies have shown that frail older adults have a higher risk of poor outcomes compared to their non-frail counterparts (5-7). Recognizing and addressing frailty in older adults is essential for providing tailored care that addresses their specific needs and reduces the risk of adverse events.

Figure 1 illustrates the publication trends in frailty research, highlighting a steady increase over the past few decades, with a significant surge in the last 10-15 years. Starting from a single publication in 1989, the number rose to 17-19 publications annually in the early 2000s. This growth reflects the increasing recognition of frailty as a critical health issue in our aging population.

One major factor driving this trend is global population aging (8). The demographic shift towards an aging population worldwide has brought attention to the health challenges faced by older adults, including frailty. As life expectancy increases and birth rates decline, there is a pressing need to understand and address the unique healthcare requirements of older individuals. Consequently, this demographic trend has significantly fueled interest in frailty research as a crucial aspect of geriatric care (9).

In addition to demographic changes, there has been a growing recognition of the complexity of frailty. Frailty is now acknowledged as a multifaceted syndrome that extends beyond chronological age. It encompasses a combination of physical, cognitive, psychological, and social factors that contribute to increased vulnerability and adverse health outcomes in older adults (10). This broader understanding has driven in-depth exploration into the mechanisms, risk factors, and interventions associated with frailty.

Alongside this increased recognition, the demand for evidence-based interventions has also played a crucial role. With the rising prevalence of frail older adults and the accompanying healthcare challenges, there is an increasing demand for interventions and care strategies specifically designed to address frailty (11, 12). Researchers, clinicians, and policymakers, all recognize the importance of developing effective approaches to prevent, identify, and manage frailty to enhance the quality of life and reduce healthcare costs for this population.

Moreover, advancements in research methods have facilitated the growth of frailty research. The creation of standardized frailty assessment tools, such as the frailty phenotype and index, has provided consistent measures for identifying and categorizing frail individuals (13). Additionally, improvements in statistical modeling and epidemiological methods have enabled more comprehensive exploration of the complex interactions between frailty, aging, and health outcomes.

Finally, the interdisciplinary nature of frailty research has fostered significant collaboration and knowledge exchange across various fields. Frailty research inherently involves collaboration among geriatricians, primary care physicians, nurses, psychologists, social workers, and other healthcare professionals. This interdisciplinary approach has enriched the understanding of frailty and promoted the development of holistic care models that address the diverse needs of frail older adults.

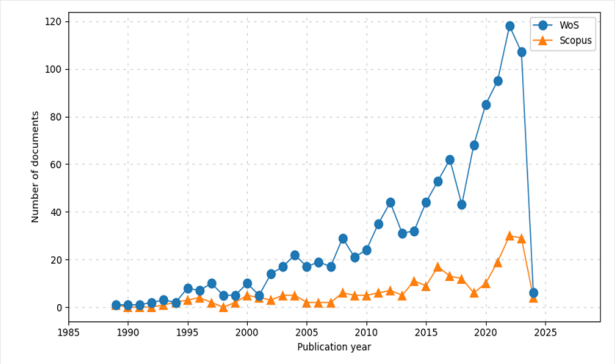

Figure 1: The publication trends between 1989- 2024

Prevalence and characteristics of frailty in older adults

A systematic review by Collard et al. (13) found frailty prevalence rates ranging from 4.0% to 59.1% in community-dwelling adults over 65 years old, with an overall weighted prevalence of 10.7%. Prevalence rises dramatically with advancing age, with some studies estimating rates as high as 27.3% for those 80-84 years old and 40.2% for those over 90 (14).

Key characteristics in frailty may include unintentional weight loss, exhaustion, muscle weakness, slow gait speed, and low physical activity (10). Development of frailty is associated with diverse physiological, medical, psychological, social, and environmental factors. Physiologically, frailty relates to sarcopenia, neuroendocrine dysregulation, immune dysfunction, oxidative stress, mitochondrial dysfunction, and cell senescence (15). Medically, multimorbidity strongly predicts frailty, with chronic diseases like cardiovascular disease, diabetes, chronic kidney disease, and COPD increases the risk of becoming frail (16). From a psychosocial perspective, depression, anxiety, loneliness, poor resilience, and lack of social support can also be contributing factors (16). Not only that, environmental influences such as inadequate nutrition, sedentary behavior, smoking, alcohol overuse, and socioeconomic disadvantages are proven associated risk factors (17). As such, a complex interplay of all these

factors is theorized to drive development and progression of frailty.

Health outcomes and impacts of frailty in older adults

Frailty in older adults is associated with a wide range of adverse health outcomes that significantly impact their quality of life and overall well-being. Understanding the health consequences of frailty is essential for healthcare providers to tailor interventions and support strategies to address the specific needs of frail individuals.

Frail older adults are more susceptible to functional decline and disability compared to their non-frail counterparts (18). The physical manifestations of frailty, such as muscle weakness and decreased physical activity, contribute to difficulties in performing activities of daily living independently, leading to a loss of functional independence.

In addition, frail individuals have been shown to have a higher risk of hospitalization due to acute illnesses, exacerbation of chronic conditions, and complications related to frailty itself (19). Hospitalizations can further exacerbate frailty by exposing older adults to the risks of hospital-acquired infections, functional decline, and iatrogenic complications.

Moreover, those population with frailty may have a higher mortality risk compared to non-frail individuals, with frailty serving as a strong predictor of mortality in this population. The presence of frailty is associated with a shorter life expectancy and a higher likelihood of experiencing adverse health events leading to death. Therefore, they often experience a diminished quality of life due to the physical, cognitive, and psychosocial challenges associated with frailty. The limitations imposed by frailty can impact social interactions, emotional well-being, and overall satisfaction with life.

Furthermore, frail individuals tend to utilize healthcare services more frequently and incur higher healthcare costs compared to non-frail older adults (20). The complex healthcare needs of frail individuals, including management of multiple chronic conditions and functional limitations, contribute to increased healthcare utilization and expenditures.

Assessment and measurement of frailty in older adults

Assessing and measuring frailty in older adults is essential for identifying individuals at risk, tailoring interventions, and monitoring outcomes over time. Various tools and approaches have been developed to assess frailty, each focusing on different aspects of the syndrome to provide a comprehensive evaluation of an individual's vulnerability and functional status.

The frailty phenotype, proposed by Fried et al. (2), is one of the most widely used models for assessing frailty in older adults. This model includes criteria such as unintentional weight loss, weakness, exhaustion, slowness, and low physical activity, with individuals meeting three or more criteria considered frail. The frailty phenotype provides a standardized and objective way to identify frail individuals based on physical characteristics.

The frailty index, which measures deficiencies in physical, cognitive, and psychosocial dimensions, is another popular frailty assessment tool (21). This index assigns a score based on the number of deficits present in an individual, with a higher score indicating greater frailty. The frailty index offers a comprehensive assessment of an individual's overall health status and functional capacity.

Also, various clinical assessment tools have been developed to evaluate specific aspects of frailty, such as gait speed, grip strength, balance, and cognitive function. These tools provide healthcare providers with objective measures to assess physical performance, muscle strength, and cognitive abilities, which are important components of frailty assessment.

Questionnaires and self-reported measures are also valuable tools for assessing frailty in older adults, as they capture subjective experiences and perceptions of health and well-being (22, 23). These measures often include questions related to activities of daily living, social support, mood, and quality of life, providing insights into the psychosocial aspects of frailty.

Given the multidimensional nature of frailty, a multifactorial assessment approach that combines various tools and measures is recommended for a comprehensive evaluation of frail older adults. This approach considers physical, cognitive, and psychosocial factors to capture the complexity of frailty and tailor interventions accordingly.

In addition to initial assessment, tools used to measure frailty should also be sensitive to change over time to monitor the progression or improvement of frailty in older adults. Regular reassessment allows healthcare providers to adjust interventions and support strategies based on changes in an individual's frailty status.

By utilizing a combination of assessment tools and approaches, healthcare providers can effectively evaluate and monitor frailty in older adults, leading to personalized care plans that address the specific needs of frail individuals. Ongoing research and development of innovative assessment methods will further enhance our ability to identify and manage frailty in the aging population.

Interventions and management strategies for frailty in older adults

Addressing frailty in older adults requires a multifaceted approach that encompasses various interventions and management strategies aimed at improving physical function, enhancing quality of life, and reducing adverse health outcomes. While there is no single universal intervention for frail individuals, a combination of

personalized strategies tailored to individual needs and preferences is essential for effective management of frailty.

Physical exercise, including resistance training, aerobic exercise, and balance exercises, has been shown to improve muscle strength, mobility, and overall physical function in frail older adults (24). Exercise programs tailored to individual capabilities and preferences can help counteract the muscle loss and physical decline associated with frailty, promoting independence and reducing the risk of falls and disability.

Adequate nutrition plays a crucial role in the management of frailty, as malnutrition and weight loss are common features of the syndrome (25). Nutritional interventions, such as dietary counseling, supplementation, and meal assistance, can help improve nutritional status, promote muscle health, and support overall well-being in frail older adults.

In addition, the comprehensive Geriatric Assessment (CGA) is a multidisciplinary approach that evaluates the medical, functional, cognitive, and psychosocial aspects of frail older adults to develop individualized care plans. CGA can identify specific needs, risks, and strengths of frail individuals, guiding interventions that address complex health issues and optimize outcomes.

Polypharmacy and inappropriate medication use are common concerns in frail older adults, leading to adverse drug reactions and functional decline (26). Regular medication reviews, deprescribing unnecessary medications, and optimizing drug regimens can reduce the risk of medication-related complications and improve overall health outcomes.

Cognitive impairment and mental health issues are also common in frail older adults and can impact overall functioning and quality of life. Interventions that provide cognitive stimulation, mental health support, and psychological interventions can help address cognitive decline, depression, and anxiety, improving overall well-being in frail individuals (27).

In conclusion, interventions and management strategies for frailty in older adults should be holistic, person-centered, and tailored to individual needs to address the complex and multidimensional nature of the syndrome. By implementing a comprehensive approach that combines physical, nutritional, psychosocial, and healthcare interventions, healthcare providers can improve outcomes, enhance quality of life, and promote independence in frail older adults. Ongoing research and innovation in frailty management will further advance our understanding and effectiveness of interventions for this vulnerable population.

Thematic and cluster trends for frailty in older adults

Figure 2 shows the thematic mapping from the bibliometric analysis, highlighting the various themes present in frailty research for older adults. The thematic map reveals niche, motor, emerging, and basic themes that provide insights into the research landscape and trends.

Centrally, "frailty" emerges as the predominant basic theme, anchoring the field and connecting various domains. This core concept highlights frailty as a complex, multidimensional syndrome requiring tailored interventions and management strategies.

Two major methodological themes drive advances in the field. "Shared frailty" is a significant motor theme fueling the development of innovative statistical models to explore shared risk factors and vulnerabilities contributing to frailty progression. The "frailty model" cluster represents a more specialized niche currently, with opportunities to transition it into a guiding theme by bridging modeling with practical care improvements.

Several emerging niche themes reflect growing specializations. The "Gamma" cluster signals interest in gamma distribution approaches for shared frailty modeling. Prominently clustered assessment tools like the frailty phenotype and index underscore their importance in clinically screening and measuring frailty. "Primary care" is also an escalating focus area, recognizing primary care's vital role in early frailty identification and management.

The core frailty themes have enabled the rise of multidimensional motor and niche topics spanning epidemiology, methodology, clinical practice, and policy domains. Continued integration and translation of these specialized areas into applied settings will be crucial for maturing the field comprehensively.

Moving forward, priorities should include using advanced modeling to optimize frailty risk assessment and care planning, validating robust assessment tools, and enhancing primary care capacity for frailty screening and intervention. Translating specialized research into holistic, evidence-based practices can foster resilience and mitigate frailty's multifaceted impacts on older adult populations.

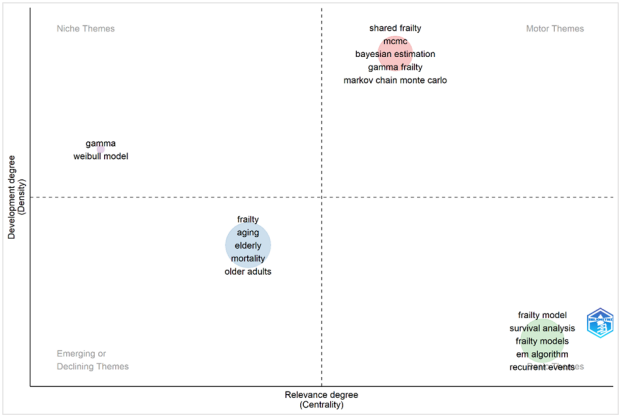

Figure 2: Thematic mapping (Source: Biblioshiny)

Figure 3 presents a VOSviewer network visualization of six clusters derived from author keywords related to frailty research in older adults. These clusters provide insights into the various dimensions and aspects of frailty that have been explored in the literature.

The first cluster focuses on frailty assessments and outcomes, encompassing studies on the validity and reliability of instruments like the Fried Frailty Phenotype and the Frailty Index. This cluster also investigates the impact of frailty on adverse outcomes such as falls, hospitalizations, cognitive impairment, and mortality, highlighting the importance of understanding these outcomes for developing targeted interventions and prevention strategies.

The second cluster delves into the conceptualization and assessment of frailty using various instruments and approaches. It reflects the ongoing efforts to refine the understanding of this complex syndrome and its underlying mechanisms. Studies in this cluster have explored different conceptual models, such as the frailty phenotype, the frailty index, and the multidimensional frailty model, contributing to the recognition of frailty as a distinct clinical entity. Additionally, this cluster may include research on the impact of COVID-19 on frail older adults, who are particularly vulnerable due to their compromised health status.

The third cluster focuses on frailty research in various healthcare settings, including primary care, geriatric medicine, public health, and surgical contexts. It also encompasses studies on screening approaches for identifying frail older adults. Previous research has emphasized the importance of screening for frailty in primary care settings, as early detection can facilitate timely interventions and improve patient outcomes. This cluster may also include research on frailty screening and management in surgical settings, where frailty is associated with increased risks of postoperative complications, prolonged hospital stays, and mortality.

The fourth cluster delves into the multidimensional aspects of frailty syndrome and its relationships with various chronic conditions and functional impairments. Previous studies have explored the concept of frailty as a distinct clinical syndrome characterized by a heightened vulnerability to stressors and a reduced ability to maintain homeostasis. Researchers have investigated the complex interplay between physical, cognitive, psychological, and social factors that contribute to the development and progression of frailty. This cluster likely includes research on the associations between frailty and specific chronic conditions, as well as the impact of frailty on activities of daily living (ADLs) and instrumental activities of daily living (IADLs).

The fifth cluster relates to the physical components of frailty and interventions targeting physical function, exercise, nutrition, and related factors. Previous research have focused on the role of sarcopenia, the age-related loss of muscle mass and strength, in the development of frailty (18-20). Exercise interventions, such as resistance training, aerobic exercise, and multicomponent programs, have been extensively studied for their effects on physical function, muscle strength, balance, and overall frailty status. Nutritional interventions have also been a focus, as malnutrition and micronutrient deficiencies are common contributors to frailty.

The sixth cluster focuses on the cognitive and psychological components of frailty, as well as the relationships between frailty and various mental health conditions. Previous studies have explored the concept of cognitive frailty, which refers to the coexistence of physical frailty and cognitive impairment (4, 10, 13). Researchers have investigated the underlying mechanisms and risk factors contributing to cognitive frailty, as well as its impact on functional outcomes and quality of life. The relationship between frailty and dementia has been extensively studied, with frailty being recognized as a risk factor for the development of dementia and as a predictor of more rapid cognitive decline.

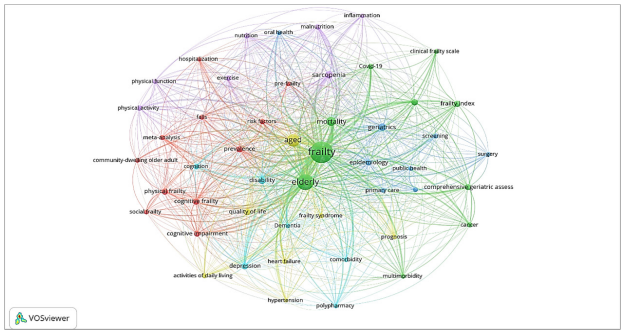

Figure 3: Network visualization of six clusters in frailty (Source: VOSviewer)

Conceptual considerations in understanding frailty in older adults

Advancing our understanding of frailty requires evaluating it through an integrated, multidimensional conceptual lens. Frailty manifests across interconnected physical, cognitive, psychological, social, and environmental domains as presented in Figure 4 (28).

Physically, frailty relates to sarcopenia, decreased muscle strength, nutritional deficiencies, and multimorbidity. However, cognitive and psychological dimensions are equally important. Frailty is associated with cognitive impairment and an increased risk of dementia. Psychologically, depression and anxiety are common and linked to worsened frailty outcomes (16).

Socially, lack of support networks and loneliness contribute to frailty development while exacerbating disability and dependence in daily activities (17). Environmentally, inadequate nutrition, sedentary lifestyles, poor housing, lack

of assistive devices, and reduced access to transportation and social services all enable frailty progression (19).

This complex interrelationship of factors must be considered when devising impactful solutions. Interventions likely need to be multimodal, combining physical activity/nutrition with social engagement and cognitive training, while also addressing unique individual and environmental risks.

More holistic frailty models are needed to drive systematic changes in healthcare policy and resource allocation for our aging population. Models emphasizing patient-centered care, multidisciplinary teams, care coordination, and enabling older adults to age successfully within their communities will be key to mitigating frailty's adverse impacts (29).

With growing societal aging, effectively addressing frailty requires an integrated biopsychosocial approach. This multidimensional lens will provide the understanding needed to develop systemic solutions that reduce risk, limit progression, and promote resilience and healthy aging across populations.

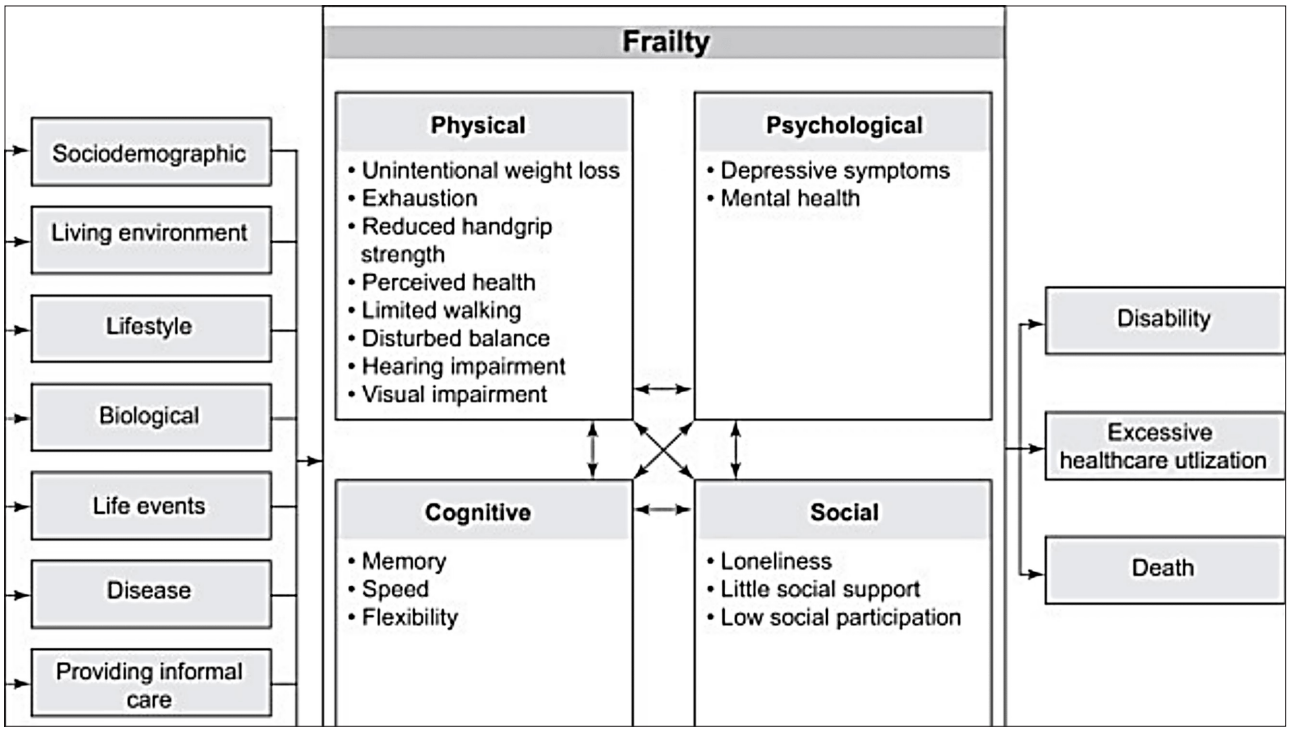

Figure 4: Conceptual model

Conclusion

This literature review synthesizes current knowledge on the complex geriatric syndrome of frailty. Key findings demonstrate frailty's high prevalence, multidimensional impacts, diverse risk factors, and limitations in assessment tools and interventions. These insights highlight the critical needs to advance frailty science. Conceptually, more holistic models are required to fully capture frailty's biopsychosocial nature and guide systemic solutions. Methodologically, pragmatic tools that integrate physical, cognitive, psychological, social, and environmental factors could enhance assessment accuracy. Regarding interventions, coordinated, multimodal approaches tailored to individual risks and needs show promise but require additional research.

Addressing frailty is an urgent priority given the rapidly aging populations worldwide. Frailty is associated with disability, morbidity, reduced quality of life, and escalating healthcare costs. However, evidence suggests it can be prevented and managed with appropriate screening, assessment, and timely interventions. Advancing frailty theory, measurement, and management will be essential to promoting healthy, resilient aging. This review aimed to synthesize literature and identify knowledge gaps to shape an integrated conceptual framework. The proposed model emphasizes frailty's multidimensionality while highlighting opportunities to advance research, clinical practice, and policy. With a more holistic understanding of frailty, we can develop targeted solutions to limit progression and mitigate adverse outcomes in our growing older adult demographic.

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Competing interests

The authors declare that they have no competing interests.

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