



## Preventive clinical approaches in active aging

Dario Martínez-Vázquez<sup>1</sup> , Dunia Vázquez-Martínez<sup>2</sup> , Nadina Travieso-Ramos<sup>3</sup> 

<sup>1</sup>University of Medical Sciences of Pinar del Río. Community Teaching Polyclinic "First of January". Consolación del Sur. Pinar del Río, Cuba.

<sup>2</sup>University of Medical Sciences of Pinar del Río. Community Teaching Polyclinic "5 de Septiembre". Consolación del Sur. Pinar del Río, Cuba.

<sup>3</sup>University of Medical Sciences of Pinar del Río. Pinar del Río, Cuba.

### ABSTRACT

**Introduction:** population aging is one of the most significant health challenges of the 21st century. Preventive medicine applied to active aging aims to extend disability-free life expectancy through evidence-based interventions.

**Objective:** to critically analyze current evidence on preventive clinical approaches to active aging, integrating classical perspectives on tiered prevention with emerging geroscience paradigms, and to provide a structured framework for their application in clinical practice.

**Methods:** a narrative literature review was conducted using the MEDLINE, Cochrane, and CINAHL databases. Articles published between 2020 and 2025, systematic reviews, clinical guidelines, and consensus documents from international organizations were included. The search strategy combined terms related to aging, primary, secondary, and tertiary prevention, and geroscience.

**Results:** the evidence is structured into three levels of prevention. Primary prevention includes vaccination (pneumococcal, influenza, and shingles), structured physical activity, and population-based screening. Secondary prevention incorporates blood biomarkers and early detection of chronic diseases. Tertiary prevention focuses on the optimal management of established diseases. The geroscience paradigm is emerging, proposing interventions targeting the biological mechanisms of aging, including senolytics, metformin, and GLP-1 agonists.

**Conclusions:** preventive approaches to active aging require stratification based on individual health profiles. The integration of lifestyle interventions, tailored screenings, and emerging geroscience strategies represents the most promising path to reducing morbidity and extending functional health in the older population.

**Keywords:** Healthy Aging; Aging; Preventive Medicine; Geroscience; Health Promotion.

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## INTRODUCTION

Population aging is one of the most significant demographic phenomena of the 21st century. It is estimated that by 2050, more than 2 billion people will be over 60 years old, representing an unprecedented challenge for global health systems.<sup>(1)</sup> This demographic shift entails a parallel increase in chronic non-communicable diseases—cardiovascular, neurodegenerative, metabolic, and neoplastic—whose incidence doubles every five years from the sixth decade of life onward.<sup>(2)</sup>

Traditionally, medical care for older adults has operated under a reactive paradigm, intervening only after disease has manifested clinically. However, this approach is insufficient and unsustainable. The contemporary understanding of aging as a modifiable biological process has driven the development of proactive preventive strategies that seek to extend not only life expectancy, but fundamentally "healthy lifespan".<sup>(3)</sup>

The concept of active aging, defined by the World Health Organization as "the process of optimizing opportunities for health, participation and security to enhance quality of life as people age," provides the conceptual framework for these interventions.<sup>(4)</sup> Within this framework, preventive clinical approaches acquire central relevance, classically structured in three levels: primary prevention (avoiding the onset of disease), secondary prevention (early detection and treatment in asymptomatic phases), and tertiary prevention (minimizing the impact and progression of already established diseases).<sup>(5)</sup>

Recently, the geroscience paradigm has emerged forcefully, proposing that, since aging is the main risk factor for most chronic diseases, intervening directly on its fundamental biological mechanisms could prevent or delay multiple pathologies simultaneously.<sup>(6)</sup> This approach transcends the traditional compartmentalization by diseases and aims to modify biological age - measured by epigenetics and other biomarkers instead of chronological age.<sup>(7)</sup>

In addition to biological determinants, active aging is influenced by social, economic, and environmental factors that affect people's opportunities to maintain their health and social participation. Preventive strategies must therefore address these social determinants of health, promoting environments that support healthy longevity.

The aim of this review is to critically analyze the current evidence on preventive clinical approaches in active aging, integrating classical perspectives of tiered prevention with emerging gerontological paradigms, and to provide a structured framework for their application in clinical practice.

## METHODS

A narrative literature review was conducted following the guidelines for narrative reviews. The bibliographic search was carried out in the databases MEDLINE (via PubMed), COCHRANE Library, CINAHL and PsycINFO, covering the period between January 2020 and December 2025. The inclusion of Scopus and Web of Science allowed the retrieval of high-impact literature in biomedical and social sciences; Embase provided additional coverage of pharmacology and clinical trials; LILACS ensured the inclusion of scientific production in Spanish and Portuguese from the Latin American region.

The search strategy combined MeSH terms and free words: ("healthy aging" OR "active aging" OR "healthspan") AND ("primary prevention" OR "secondary prevention" OR "tertiary prevention" OR "preventive medicine") AND ("older adults" OR "elderly" OR "geriatrics") AND ("lifestyle interventions" OR "geroscience" OR "screening").

Systematic reviews, meta-analyses, randomized controlled trials, clinical practice guidelines, and consensus documents from international organizations (WHO, USPSTF, scientific societies) were included. Letters to the editor, non-substantive editorials, and studies with small samples and no control group were excluded. Additionally, a manual search of the reference lists of the selected articles was conducted to identify relevant studies not captured in the initial search.

A total of 18 studies were included in the final analysis after screening titles, abstracts and full text, supplemented with reference documents and panoramic reviews on anti-aging strategies.

## DEVELOPMENT

The application of preventive medicine to older adults requires an adaptation of classical models, given the extreme heterogeneity of this population. Intervening in a healthy and independent older adult is not equivalent to intervening in a frail one with multiple comorbidities. Stratification according to health profile is therefore essential.<sup>(8)</sup>

Recently, Martinović et al.<sup>(9)</sup> proposed the concept of the "Longevity Pyramid" as a structured framework for understanding the progressive levels of intervention in longevity medicine. At the base of the pyramid is prevention, emphasizing early detection strategies and advanced diagnostics. The next level comprises lifestyle modifications and health-promoting behaviors. At the apex are personalized interventions, tailored to unique genetic predispositions and health profiles.

**Table 1.** Prevention levels according to the health profile of the elderly adult.

| Patient profile             | Priority preventive approach                         | Key interventions                                        |
|-----------------------------|------------------------------------------------------|----------------------------------------------------------|
| Healthy, independent        | Primary and secondary prevention                     | Vaccination, screenings, promotion of healthy lifestyles |
| Established chronic disease | Secondary and tertiary prevention                    | Therapeutic optimization, prevention of complications    |
| Fragile, dependent          | Prevention of accidents and iatrogenic complications | Home security, medication review, palliative care        |

**Fountain:** Prepared by the author based on American Geriatrics Society Expert Panel on Person-Centered Care<sup>(10)</sup>

## Primary prevention: key interventions

Primary prevention in older adults includes actions aimed at preventing the onset of diseases before pathological processes begin.

### *Vaccination*

Immunoprophylaxis is one of the most cost-effective preventive interventions. Recommended vaccines for most older adults include:

- Annual flu vaccine.
- Pneumococcal vaccine (according to sequential schedule).
- Zoster vaccine (two doses separated by 2-6 months).
- Respiratory syncytial virus (RSV) vaccine.
- Tetanus-diphtheria-pertussis (Tdap) booster once, and subsequently Td every 10 years.<sup>(11)</sup>

### *Physical Activity*

The evidence supporting physical activity as a preventive intervention in aging is overwhelming. Numerous high-quality studies have demonstrated its benefit on multiple outcomes relevant to maintaining functional independence.<sup>(12)</sup>

Aerobic exercise, particularly walking, improves cardiovascular endurance and reduces the risk of vascular events. Muscle-strengthening programs, especially progressive resistance training, counteract sarcopenia and increase bone mineral density, preventing falls and fractures. Interventions such as tai chi or dance provide additional benefits for balance and fall prevention. A recent meta-analysis that included 46 clinical trials concluded that multicomponent programs (aerobic + strength + balance) reduce the risk of falls by 23 % in adults over 70 years of age.<sup>(13)</sup>

### *Nutrition and Healthy Habits*

A healthy diet, preferably the Mediterranean pattern, is associated with a lower risk of chronic diseases and greater longevity. Caloric restriction and intermittent fasting have demonstrated the ability to extend lifespan in animal models and are being actively investigated in humans. Observational studies suggest that adherence to a high-quality diet (Healthy Eating Index) is associated with a 20–30 % reduction in all-cause mortality in people over 65 years of age.<sup>(14)</sup>

Smoking cessation maintains benefits even in advanced age, improving exercise capacity and reducing the risk of cardiovascular events and neoplasms. Regarding alcohol, it is recommended not to exceed one unit per day, given the altered metabolism in older adults and the increased risk of falls and accidents.<sup>(14)</sup>

## Secondary prevention: early detection and biomarkers

Secondary prevention seeks to identify diseases in asymptomatic phases in order to intervene early and modify their course.

### *Cancer screenings*

The indication for cancer screening in older adults should be carefully individualized, considering life expectancy and the risks of overdiagnosis and overtreatment. In patients with a life expectancy of less than 10 years, the benefits of screening are significantly reduced.

The screenings generally recommended include:

- Breast cancer: mammography (up to age 75, occasionally up to age 85)
- Colorectal cancer: fecal occult blood test or colonoscopy
- Cervical cancer: cytology (up to 65-70 years if previous screenings were normal)
- Prostate cancer: shared decision-making after informing about risks and benefits.<sup>(15)</sup>

#### *Cardiovascular and metabolic screenings*

Monitoring blood pressure, lipid profile, and blood glucose allows for the early identification of modifiable risk factors. Bone mineral density measurement using DXA detects osteoporosis before fractures occur. Annual frailty assessment using validated instruments (FRAIL scale, Fried phenotype) allows for the identification of patients at higher risk of adverse events and the targeting of preventive interventions.<sup>(16)</sup>

#### *Blood biomarkers and biological age*

Advances in omics technologies are enabling the development of aging biomarkers. Epigenetic clocks (based on DNA methylation patterns) and blood biomarkers (such as proteins related to cellular senescence) are emerging as tools for estimating biological age and predicting disease risk. Early detection of changes in these biomarkers could allow for personalized interventions before the clinical manifestation of disease. The use of inflammatory cytokine panels (IL-6, TNF- $\alpha$ ) and extracellular matrix proteins as predictors of functional decline has recently been proposed.<sup>(17)</sup>

### **Tertiary prevention: management of established diseases**

Tertiary prevention is aimed at patients with symptomatic chronic diseases, seeking to minimize functional decline, prevent complications and maintain the highest possible quality of life.

#### *Osteoarticular diseases*

Osteoarthritis affects approximately half of all people over 65, limiting mobility and increasing the risk of falls. Adapted exercise and adequate analgesia (avoiding non-steroidal anti-inflammatory drugs in at-risk patients) are fundamental pillars. Non-pharmacological interventions, including education and pain management programs, have demonstrated comparable efficacy to drugs in improving joint function.<sup>(18)</sup>

#### *Diabetes mellitus*

Glycemic control should be individualized according to the patient's profile. While an HbA1c <7 % is appropriate for healthy older adults with a life expectancy >10 years, more flexible targets (<8 % or <8,5 %) are suitable in patients with comorbidities or frailty, prioritizing the avoidance of hypoglycemia. Control of hypertension and dyslipidemia in these patients is particularly relevant. The use of drugs with a favorable cardiovascular safety profile, such as SGLT2 inhibitors or GLP-1 agonists, should be considered in patients with established atherosclerotic disease.<sup>(19)</sup>

#### *Cardiovascular disease*

Aggressive management of vascular risk factors (hypertension, smoking, diabetes, obesity, atrial fibrillation, dyslipidemia) in patients with established disease reduces the risk of new disabling events. Heart failure, with high morbidity and mortality in older adults, requires optimized treatment to reduce hospitalizations and functional decline. Anticoagulation in non-valvular atrial fibrillation should be individualized, using bleeding risk scales and taking into account renal and cognitive function.<sup>(20)</sup>

*COPD and smoking*

Smoking cessation, proper use of inhalers, and education in energy conservation techniques reduce exacerbations and hospitalizations. Multicomponent respiratory rehabilitation programs improve exercise capacity and quality of life in older adults with moderate-to-severe COPD.<sup>(21)</sup>

**The Geroscientific Paradigm: Interventions on the Mechanisms of Aging**

Geroscience proposes a paradigm shift: instead of treating each disease separately, intervening in the fundamental biological processes of aging could prevent or delay multiple pathologies simultaneously.

*Biological targets of aging*

The hallmarks of aging include genomic instability, telomere shortening, epigenetic alterations, loss of proteostasis, dysregulation of nutrient sensing, mitochondrial dysfunction, cellular senescence, stem cell depletion, and impaired intercellular communication. Each of these mechanisms constitutes a potential therapeutic target. Understanding these pathways has allowed the identification of pharmacological and lifestyle interventions that can modulate the rate of aging.<sup>(22)</sup>

*Emerging pharmacological agents*

Several drugs are being investigated for their potential to modulate aging:

- **Metformin:** This widely used antidiabetic drug may modulate multiple pathways related to aging. The TAME (Targeting Aging with Metformin) trial is specifically evaluating its ability to delay the onset of age-related diseases. Observational studies in people with diabetes suggest that those treated with metformin have lower mortality and incidence of cancer and dementia compared to other antidiabetic drugs.<sup>(23)</sup>
- **Senolytics:** Compounds that selectively eliminate senescent cells ("zombie cells") that accumulate with age and contribute to chronic inflammation and tissue damage. The combination of dasatinib and quercetin has shown promising results in preclinical models and small clinical trials in diseases such as pulmonary fibrosis, osteoarthritis, and renal dysfunction.<sup>(24)</sup>
- **GLP-1 agonists:** Drugs such as semaglutide, used for diabetes and obesity, may mimic some of the effects of caloric restriction associated with increased longevity. Recent trials have demonstrated a reduction in cardiovascular events and a delay in the progression of kidney disease, in addition to neuroprotective effects in preclinical studies.<sup>(25)</sup>
- **Telomerase activators:** Strategies to reactivate telomerase and counteract telomere shortening. Studies in animal models have shown reversal of signs of aging without increased cancer, although long-term safety in humans has yet to be established.<sup>(26)</sup>
- **Modulators of sirtuins and metabolic pathways:** Compounds such as resveratrol and nicotinamide riboside, among others, are being investigated for their ability to activate longevity pathways, although evidence in humans is still limited and heterogeneous.<sup>(27)</sup>

It is important to note that, to date, none of these agents have received regulatory approval (FDA or EMA) specifically for the treatment of aging as an indication, although multiple clinical trials are underway. Clinical translation of these findings will require phase III studies with functional health outcomes as the primary endpoint.

The effective implementation of preventive programs requires appropriate organizational models and multidisciplinary teams. Programs coordinated by specialized nurses, working alongside primary care physicians or geriatricians, have proven effective in coordinating protocol-based care and patient education. In the context of active aging, these programs have expanded to include the integrated management of frailty and multimorbidity. Group interventions for patients with the same chronic condition (e.g., diabetes) facilitate peer learning and improve outcomes such as glycemic control, adherence, and quality of life. Patient-centered care models supported by information technologies have been shown to improve continuity of care.

Effective preventive programs involve a diverse range of professionals: community and family nurses, kinesiologists, stress management experts, physical therapists, and, in complex cases, interdisciplinary geriatric teams. Collaboration between levels of care (primary, specialized, and community) is a key factor for success. Most preventive interventions are effectively implemented in primary care and community settings, rather than in hospitals. Annual visits to the primary care physician facilitate the timely implementation of preventive measures. Telehealth and mobile applications have emerged as complementary tools for monitoring and promoting healthy lifestyles in older adults, with promising results in adherence in other countries.<sup>(28)</sup>

## CONCLUSIONS

Preventive clinical approaches to active aging have evolved significantly, shifting from a reactive, disease-centered model to a proactive paradigm that seeks to maintain function and reduce morbidity in later life. Current evidence strongly supports the implementation of preventive interventions stratified according to the older adult's health profile. In healthy, independent individuals, primary prevention through vaccination, promotion of structured physical activity (especially walking and strength training), and healthy dietary patterns forms the basis of care. Cancer and cardiovascular screenings, tailored to individual life expectancy, allow for early detection in asymptomatic phases. In patients with established chronic diseases, tertiary prevention aimed at optimizing treatment, preventing complications, and maintaining functional capacity is a priority. Structured disease management programs and coordination between levels of care improve outcomes. The emerging gerontological paradigm offers promising perspectives by proposing interventions on the fundamental biological mechanisms of aging. Although senolytic agents, metformin, and other compounds are still in research phases and lack specific approval for this indication, preliminary results are encouraging, and ongoing clinical trials could transform the preventive approach in the next decade. Integrating traditional approaches (leveled prevention) with new gerontological strategies, within the framework of the "Longevity Pyramid" that prioritizes early detection, lifestyle modifications, and personalized interventions, represents the most promising path to extending the functional health of the growing older population. Healthcare systems must adapt to implement these models, forming multidisciplinary teams and strengthening primary and community care as cornerstones of prevention in active aging.

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## Conflict of interest

The authors declare that there is no conflict of interest.

### Authors' contributions

**DMV:** Conceptualization, formal analysis, project management, writing - original draft, writing - revision and editing.

**NTR, DVM and BNPP:** He was in charge of conceptualization, formal analysis, project management, writing - original draft, writing - revision and editing.

### Statement on the use of artificial intelligence

The authors declare that they did not use generative artificial intelligence technologies or AI-assisted tools during the research or writing of this article.

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