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The Role of Physical Activity in the Active Aging Process

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Abstract

Aging brings measurable losses in muscle mass, bone density, processing speed, and cardiovascular reserve. Physical activity is the most tractable behavioral factor for slowing these losses and preserving functional independence in adults over 65. This narrative review synthesizes evidence across four domains: musculoskeletal preservation, chronic disease management, cognitive retention, and psychological health, and evaluates the theoretical frameworks that explain why exercise adherence remains difficult despite well-documented benefits. Regular movement reduces sarcopenia risk, lowers cardiovascular disease incidence, increases hippocampal volume, and reduces depressive symptoms. These outcomes are not independent; they interact through shared biological mechanisms including BDNF upregulation, improved insulin sensitivity, and enhanced proprioceptive control. Adherence depends on self-efficacy, social environment, and infrastructure quality. Wearable sensor technologies and gamification strategies have emerged as candidate tools for sustaining long-term participation, though their efficacy in geriatric populations requires further controlled investigation. Integrating movement into community-based settings remains a critical public health priority for achieving a safe and sustainable active aging process.

Keywords: *Aging, Physical Activity, Sport, Healthy Aging, Aging Process.*

1. INTRODUCTION

Physical activity in geriatric populations covers all bodily movements produced by skeletal muscle contraction, including structured exercise modalities such as swimming or gymnastics as well as incidental movement through gardening, domestic maintenance, and active transport (Nelson et al., 2007; WHO, 2010). This breadth matters clinically because most older adults who meet activity guidelines do so through non-structured rather than formal exercise. Preserving functional independence is the primary objective; achieving it requires understanding how movement produces effects across musculoskeletal, cardiovascular, cognitive, and psychosocial systems in parallel, rather than treating each system as a separate case (Riebe et al., 2018; Gulgosteren et al., 2025).

Age-related sarcopenia and bone density attenuation begin in the fifth decade and accelerate after 70 (Daly et al., 2019). Physical activity substantially decelerates both processes. Improved muscular strength and balance reduce fall frequency, and fall prevention translates directly into fracture prevention, two of the most consequential disability pathways in geriatric medicine (Gillespie et al., 2012; Toros, 2025). These musculoskeletal gains, however, do not stand alone.

Regular exercise reduces the risk of hypertension, type 2 diabetes, and cardiovascular disease through mechanisms that include anti-inflammatory cytokine modulation and improved insulin sensitivity (Warburton & Bredin, 2017; Serin et al., 2025). Older adults who exercise regularly report lower rates of depression and anxiety, and they retain cognitive function and memory longer than sedentary peers, an effect mediated in part by exercise-induced increases in brain-derived neurotrophic factor (BDNF) and improved cerebrovascular perfusion (Mikkelsen et al., 2017; Erickson et al., 2011; Alkan et al., 2025). These psychological and cognitive benefits appear to share biological substrates with the physiological outcomes rather than arising through entirely separate pathways, which helps explain why single-domain interventions sometimes underperform expectations.

The aggregate of these effects constitutes what the literature designates "active aging": a condition in which individuals maintain independence, social engagement, and psychological well-being across later life (World Health Organization, 2015). Group-based activities reduce loneliness and reinforce this social dimension (Buman et al., 2010). The evidence that physical activity matters is no longer contested; long-standing consensus guidelines have definitively mapped specific exercise modalities to geriatric functional outcomes (Chodzko-Zajko et al., 2009). The more productive question is why adoption and sustained adherence remain low in the populations that stand to benefit most (Paterson & Warburton, 2010). Table 1 summarizes the major physiological effects of regular exercise and their clinical implications across five body systems, providing the mechanistic foundation on which the subsequent behavioral and theoretical analysis rests.

Table 1: Physiological effects of regular exercise and clinical implications by body system

System / Component	Physiological Effect (via Regular Exercise)	Clinical Benefit
Musculoskeletal	Increased muscle mass (hypertrophy) and bone mineral density.	Reduces sarcopenia and osteoporosis risk; prevents falls.
Cardiovascular	Increased maximum oxygen consumption (VO_2max) and stroke volume.	Regulates blood pressure; lowers cardiovascular disease risk.
Cognitive	Increased Brain-Derived Neurotrophic Factor (BDNF) and neural transmission speed.	Enhances memory; delays Alzheimer's and dementia onset.
Metabolic	Improved insulin sensitivity and maintenance of basal metabolic rate.	Manages type 2 diabetes risk; assists weight control.
Balance	Improved proprioception and neuromuscular control.	Increases mobility and independence in daily living.

Note. VO_2max = maximal oxygen uptake; BDNF = brain-derived neurotrophic factor. Adapted from Paterson & Warburton (2010) and Buman et al. (2010).

The following sections address adherence systematically: first by evaluating how the main theoretical frameworks account for behavioral adoption and lapse, then by reviewing what the accumulated evidence collectively supports and where significant gaps remain.

2. THEORETICAL FRAMEWORKS IN AGING

The theoretical literature on physical activity in older adulthood has produced several overlapping frameworks, each illuminating a different dimension of the problem. Rather than cataloguing them at equal depth, it is more analytically useful to evaluate each against a shared question: what testable prediction does the framework generate about exercise adherence, and does the geriatric evidence support that prediction?

2.1. Active Aging Theory

Active Aging Theory posits that health, participation, and security are three interdependent pillars of a successful later life (Walker, 2002). Physical activity supports all three: it preserves health by managing disease risk, supports participation by maintaining the mobility required for social engagement, and contributes to security by reducing injury risk through strength maintenance. The framework's practical implication is that interventions targeting only one pillar tend to be less durable than those designed across all three. An older adult who gains strength through resistance training but lacks transport to an exercise facility or a socially supportive exercise environment is likely to discontinue; the physiological prescription alone is insufficient. Table 2 maps these physical activity functions onto each pillar. This multi-pillar logic helps explain why community-based programs consistently outperform home-based individual interventions in long-term adherence studies.

Table 2: Active Aging Theory pillars and the role of physical activity within each

Pillar	Definition	Role of Physical Activity
Health	Maintenance of physical, mental, and social well-being.	Disease prevention, chronic pain management, and slowing cognitive decline.
Participation	Engagement in economic, cultural, and civic activities.	Mobility enables individuals to leave the home; group exercise fosters socialization.
Security	Provision of physical, social, and economic protection.	Strength maintenance reduces injury risk; preserved functional capacity ensures personal safety.

Note. Adapted from Walker (2002). Pillar definitions reflect the WHO active aging policy framework.

2.1. Successful Aging Theory

Successful Aging Theory, developed by Rowe and Kahn (1997), specifies that optimal aging combines low disease risk, high cognitive and physical functionality, and active life engagement. Physical activity contributes to all three components, but the framework generates a prediction that the evidence partially complicates: by foregrounding disease avoidance as the primary goal, it implies that health gains are most meaningful in those who remain disease-free. The literature suggests a more nuanced picture. Older adults who exercise regularly do maintain functional independence longer and lower their disease risks (Paterson & Warburton, 2010), but high physical and cognitive function can coexist with chronic conditions when those conditions are well managed. Physical activity may matter more for how effectively people live with disease than for whether disease develops at all.

3. SOCIAL COGNITIVE THEORY

Social Cognitive Theory, formulated by Bandura (1997), shifts the explanatory focus from the aging trajectory to the behavioral mechanism through which trajectories are shaped. The framework holds that behavior is determined by the interaction of personal factors, environmental influences, and the behavior itself. The critical personal factor is self-efficacy: individuals who perceive themselves as capable of exercising are more likely to begin and to persist, directly mitigating functional limitations in older adulthood. This generates a specific mediational prediction: social support and environmental access should affect adherence primarily through their effect on perceived capability rather than through direct enablement alone (McAuley et al., 2011). The evidence is broadly consistent with this prediction. Social support appears to sustain adherence not merely by providing practical assistance but by reinforcing the exercising person's sense of competence (Bandura, 1997; Stathi et al., 2004). This mechanism also explains why gamification frameworks and real-time physiological feedback have attracted attention as adherence tools, since they function, in Bandura's terms, as self-efficacy interventions delivered through technology (Algin, 2024; Pekgor et al., 2024b). Whether digital feedback tools replicate the efficacy of socially mediated self-efficacy in older adult populations specifically is a question the current evidence base does not yet answer.

4. LIFE SPAN DEVELOPMENT THEORY

Life Span Development Theory adds a temporal dimension that the other frameworks underweight (Baltes & Baltes, 1990; Pekgor et al., 2024c). Health behaviors form early; geriatric health outcomes partly reflect accumulated behavioral histories. Physical activity sustained across mid-life limits the physiological losses that would otherwise accelerate after age 70. The framework does not imply, however, that late-life initiation is futile: the evidence consistently shows that beginning activity at any age yields measurable gains, even if the magnitude is larger when activity is sustained across decades (Warburton & Bredin, 2017; Yıldız Öztürk et al., 2025). The clinical implication is that intervention timing matters. Primary prevention in younger cohorts and therapeutic intervention in older adults are justified on different but compatible grounds, and neither makes the other redundant.

5. THE BIOPSYCHOSOCIAL MODEL AND THEORY-BASED INTERVENTIONS

The Biopsychosocial Model does not generate unique behavioral predictions so much as it provides a rationale for multi-level program design. Sustaining exercise adherence in geriatric populations requires addressing physical health, psychological state, and social environment together rather than in sequence (Stathi et al., 2004). Theory-based exercise interventions that integrate goal-setting with self-efficacy supports consistently outperform those relying on physiological prescription alone, a finding documented across multiple behavioral domains by Rhodes et al. (2017) and grounded theoretically in the self-determination framework of Deci and Ryan (2000). Wearable sensor technologies offer one mechanism for implementing these principles at scale: real-time physiological monitoring allows exercise intensity to be calibrated non-invasively, maintaining safety while providing the performance feedback that supports perceived competence (Pekgor et al., 2024a). Monitoring systems similarly allow recovery protocols to be adjusted based on daily physiological state (Pekgor et al., 2025a). Table 3 positions all four frameworks against their core principles and evidential relationship to physical activity.

Table 3: Theoretical Frameworks for Physical Activity ın Aging: Core Principles, Behavioral Predictions, And Supporting Evidence

Theory	Core Principles	Relation to Physical Activity	Sources
Active Aging	Maximizing health, participation, and security.	Preserves functional capacity and social engagement across all three pillars.	Walker, 2002
Successful Aging	Low disease risk, high function, and social participation.	Reduces disease risk; supports physical and cognitive function, though function can remain high even with managed conditions.	Rowe & Kahn, 1997
Social Cognitive	Interaction between person, environment, and behavior.	Self-efficacy mediates the effect of social support and environment on adherence; gamification and feedback are self-efficacy interventions.	Bandura, 1997
Life Span Development	Habits form early; health is a cumulative result.	Limits physiological loss when sustained over decades; late-life initiation still yields measurable gains.	Baltes & Baltes, 1990

Note. Frameworks are evaluated against adherence predictions rather than descriptive categories alone.

6. RESEARCH SYNTHESIS: WHAT THE EVIDENCE COLLECTIVELY SUPPORTS

The preceding mechanistic and theoretical discussion sets up a more demanding analytical task: not listing what exercise does, but assessing what the evidence, taken together, reliably supports, where findings converge across study designs, where partial disagreements remain, and what questions the literature has not yet resolved.

6.1. Strong Convergence

Resistance exercise preserves muscle mass and delays the functional threshold at which sarcopenia produces disability; Cruz-Jentoft et al. (2019) document this effect with sufficient consistency across populations and study designs to treat it as established. Aerobic exercise at moderate to high intensity reduces the risk of hypertension and type 2 diabetes through improvements in cardiovascular function and insulin sensitivity (Warburton & Bredin, 2017; Pekgor et al., 2025b). These two lines of evidence represent the most replicated claims in the literature and carry the fewest methodological caveats. The cognitive evidence has strengthened considerably since Erickson et al. (2011) documented that aerobic exercise training increases hippocampal volume and improves memory performance. Subsequent work has reinforced the relationship between exercise and reduced dementia risk, with the BDNF pathway offering a plausible and increasingly well-characterized biological mechanism. The effect sizes in this literature are clinically meaningful, though most studies measuring hippocampal volume have used relatively healthy, community-dwelling samples; whether the effect magnitude holds in less healthy or institutionalized populations remains uncertain.

6.2. Partial Convergence

The mental health literature is broadly supportive: active older adults report lower depression and anxiety rates, and exercise increases life satisfaction across multiple study designs (Mikkelsen et al., 2017; Pekgor et al., 2025c). The mechanism is less well specified than in the musculoskeletal domain. Group-based exercise contributes to psychological benefit through social engagement, but isolating the social component from the physiological one is methodologically difficult; few studies are designed to do so. Buman et al. (2010) found that even light-intensity physical activity was associated with better self-rated health in older adults, suggesting that the threshold for psychological benefit may be lower than for cardiometabolic benefit. This distinction has practical relevance for frail or functionally limited populations who cannot sustain moderate-intensity aerobic exercise. Fall prevention evidence is strong for multicomponent interventions combining balance and resistance training (Sherrington et al., 2019; Pekgor et al., 2025d).). The evidence for aerobic exercise alone reducing fall frequency is weaker. This matters for clinical prescription: exercise type should be matched to the intended outcome. Treating all forms of physical activity as interchangeable for all purposes leads to programs that are difficult to evaluate and easy to misinterpret when they underperform.

6.3. Gaps and Open Questions

The literature is dominated by Western, high-income, relatively healthy samples. Whether the documented effects generalize to populations with lower baseline health, limited exercise infrastructure, or different cultural orientations toward organized physical activity is not yet established. Functional independence as an outcome is consistently supported (Paterson & Warburton, 2010), but evidence for contextual moderators of exercise efficacy remains thin. The physiological yields of physical activity do not occur in a vacuum; they are mediated by the atmospheric quality of the environment in which exercise takes place. Exposure to air pollution during exertion strains the aging cardiovascular and respiratory systems, partially offsetting the biological gains of the activity itself (WHO, 2020). That atmospheric quality is not fixed: it reflects the aggregate of corporate operational decisions made by organizations sharing the same industrial geography. Companies that adopt environmentally sensitive practices reduce ambient emissions as a structural consequence of those practices, improving the conditions under which nearby communities exercise, while those that do not create localized atmospheric burdens that fall disproportionately on the most physiologically vulnerable populations (Algin & Sarvan, 2024). Environmental quality is therefore a contextual variable for geriatric exercise program design that sits above the level of individual behavior, shaped by industrial governance decisions that public health planners rarely control but cannot ignore. Controlled intervention studies examining these macro-level moderating effects in geriatric exercise populations are lacking.

Similarly, wearable sensor technologies and monitoring systems offer practical mechanisms for real-time intensity calibration and recovery monitoring, but their capacity to improve adherence and health outcomes in older adults beyond what is achievable through social and behavioral supports alone has not yet been evaluated in randomized controlled trials. Both questions are tractable and represent the next productive line of investigation in this field. Taken together, the evidence supports three claims with high confidence: resistance exercise preserves musculoskeletal function; aerobic exercise reduces cardiometabolic disease risk; and both forms support cognitive health through overlapping neurobiological pathways. The behavioral literature adds a fourth: adherence depends on self-efficacy and social context more than on any single physiological variable. Program designs that address the body without addressing the behavioral determinants of participation systematically underperform.

CONCLUSION

Physical activity in older adulthood is central to individual health and psychosocial well-being, and the evidence base for this claim is now broad enough to guide clinical and public health practice with substantial confidence. Regular exercise mitigates sarcopenia and osteoporosis risks, and fall frequency is reduced through improved balance and proprioceptive control (Cruz-Jentoft et al., 2019; Gillespie et al., 2012). Hypertension and type 2 diabetes are managed more effectively in physically active older adults, and immune function is supported through anti-inflammatory mechanisms (Warburton & Bredin, 2017; WHO, 2020; Toros & Şekeroğlu, 2026). Memory retention is longer in aerobically active older adults, depressive symptoms are lower, and social isolation is reduced through group participation (Erickson et al., 2011; Mikkelsen et al., 2017; Buman et al., 2010).

The theoretical frameworks reviewed here converge on a shared implication: interventions that treat physical activity as a physiological prescription without addressing self-efficacy, social environment, and life-course behavioral context will produce smaller effects than those that integrate all three (Walker, 2002; Rowe & Kahn, 1997; Bandura, 1997; Baltes & Baltes, 1990).

Physical activity is, at its core, a behavioral intervention that produces physiological effects. When program design treats it as purely physiological prescription, adherence collapses and preventable chronic disease burden accumulates upstream of institutional care. That burden does not disappear; it transfers. Public hospital systems operating below technical efficiency thresholds absorb it with reduced capacity to do so, compounding resource strain that is already structurally embedded in healthcare delivery (Kaya & Algin, 2022). The case for behavioral precision in exercise program design is therefore not merely clinical but systemic: what fails in preventive care arrives, at greater cost, in curative care. What remains to be established is how precision feedback tools might intersect with sport psychology principles to sustain motivation in older adults specifically. Answering that question would move the field from establishing that activity matters to specifying the conditions under which it matters most. Integrating movement into community-based settings with systematic attention to both behavioral determinants and environmental context is the critical public health task for the decade ahead.

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