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Resistance Training as a Non-Pharmacological Strategy in Chronic Diseases

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Abstract

Introduction and purpose. Chronic non-communicable diseases (NCDs), such as cardiovascular disease and diabetes, are leading causes of global mortality. While pharmacological treatments remain standard, there is a shift toward lifestyle-based interventions. Historically, aerobic exercise was primarily recommended; however, contemporary evidence suggests that resistance training (RT) offers unique systemic benefits. This paper evaluates RT's efficacy as a non-pharmacological strategy and analyzes its underlying biological mechanisms.

Material and methods. A literature review was conducted using PubMed, Web of Science, and Google Scholar, focusing on meta-analyses and systematic reviews published between 2009 and 2025. A total of 31 academic sources were synthesized. Inclusion criteria focused on the impact of RT on metabolic, cardiovascular, musculoskeletal, and mental health in clinical populations.

Results. The analysis indicates that RT is a potent modulator of metabolic health, reducing HbA1c levels and enhancing insulin sensitivity via GLUT4 translocation. In cardiovascular health, RT is associated with significant reductions in blood pressure and improved endothelial function. Furthermore, RT serves as the most effective countermeasure against sarcopenia and osteoporosis by stimulating muscle protein synthesis and bone mineral density. Evidence also highlights the "muscle-brain axis," where RT-induced myokines alleviate symptoms of depression and anxiety. Under proper supervision, RT is safe and effective for patients with multiple comorbidities.

Conclusions. RT should be recognized as a cornerstone of chronic disease management, providing systemic benefits across metabolic and neurological health. Healthcare systems should integrate structured RT into standard clinical protocols. Addressing barriers such as lack of specialized medical training and patient accessibility remains essential for the successful implementation of this non-pharmacological strategy.

Keywords: resistance training, chronic disease, non-pharmacological strategy, metabolic health, exercise is medicine

1. Introduction

The global burden of chronic non-communicable diseases (NCDs) has reached unprecedented levels worldwide (World Health Organization, 2025). Conditions such as cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), obesity, and musculoskeletal disorders not only reduce life expectancy but also significantly impair quality of life and place a monumental strain on healthcare systems. While the development of pharmacological agents has revolutionized the management of these conditions, the rising prevalence of polypharmacy and its associated side effects has led researchers to look for integrative, non-pharmacological strategies.

The "Exercise is Medicine" initiative has long advocated for physical activity as a core component of medical treatment (Pedersen & Saltin, 2015). Historically, clinical guidelines leaned heavily toward aerobic exercise (e.g., walking, cycling) due to its well-documented effects on cardiorespiratory fitness. However, the last two decades have seen a paradigm shift. Resistance training (RT)—defined as physical conditioning involving the progressive use of resistive loads to elicit muscle contraction—has emerged as a vital therapeutic modality. Large-scale recent meta-analytic evidence indicates that engaging in muscle-strengthening activities is associated with a 10–17% lower risk of all-cause mortality and major non-communicable diseases (Momma et al., 2022).

The benefits of RT extend far beyond mere muscular hypertrophy or athletic performance. Skeletal muscle is now recognized as a secretory organ capable of producing signaling molecules known as myokines, which play key roles in metabolic regulation (Severinsen & Pedersen, 2020; Horváth et al., 2025). Resistance training has also been shown to reduce systemic inflammation and improve markers of insulin resistance and glycemic control in individuals with type 2 diabetes (J. Wang, Fan & Wang, 2025). Consequently, RT serves as a systemic intervention that addresses the root causes of metabolic and cardiovascular dysfunction.

This paper aims to synthesize current evidence regarding the application of RT as a non-pharmacological strategy in the management of chronic diseases, discussing its physiological foundations, clinical efficacy, and practical implementation.

2. Physiological Mechanisms of Resistance Training in Health and Disease

To understand why RT is effective in managing chronic illness, it is essential to examine the cellular and systemic adaptations it triggers. Unlike aerobic exercise, which primarily enhances oxidative capacity and cardiorespiratory fitness, RT induces specific neuromuscular and metabolic shifts that are uniquely beneficial for patients with non-communicable diseases (NCDs).

2.1. Skeletal Muscle as an Endocrine Organ

A major advancement in exercise physiology is the recognition of skeletal muscle as a sophisticated secretory organ. During resistance exercise, muscle fibers produce and release signaling molecules known as myokines—such as irisin, myostatin, and interleukin-6 (IL-6). While chronically elevated IL-6 is a marker of systemic inflammation, muscle-derived IL-6 released acutely during exercise acts as an anti-inflammatory signal that inhibits pro-inflammatory cytokines (Severinsen & Pedersen, 2020; Horváth et al., 2025). These myokines facilitate metabolic cross-talk between the muscles and other organs, including the liver, adipose tissue, and the brain. For instance, irisin promotes the browning of white adipose tissue, increasing energy expenditure and improving glucose homeostasis, which is particularly relevant for patients with obesity and T2DM (Boström et al., 2012).

2.2. Glycemic Control and Insulin Sensitivity

RT is one of the most effective non-pharmacological strategies for managing blood glucose. Skeletal muscle is the primary site for postprandial glucose disposal, accounting for approximately 80% of glucose uptake. RT increases the expression and translocation of glucose transporter type 4 (GLUT4) to the muscle cell membrane. Crucially, this process facilitates glucose uptake independent of insulin action, primarily through the activation of the adenosine monophosphate-activated protein kinase (AMPK) pathway (Kirwan, Sacks & Nieuwoudt, 2017). Furthermore, by stimulating muscle hypertrophy, RT creates a larger “metabolic sink” for glucose, which contributes to reversing the progression of pre-diabetes and improving long-term glycemic control.

2.3. Anti-inflammatory Effects

Chronic diseases are typically characterized by persistent low-grade systemic inflammation. Meta-analytic evidence indicates that regular resistance training can effectively reduce levels of pro-inflammatory markers such as C-reactive protein (CRP), although its effects on tumor necrosis factor-α (TNF-α) and circulating IL-6 remain more variable across different clinical populations (J. Wang et al., 2025). This shift toward an anti-inflammatory environment is essential for slowing the progression of atherosclerosis, preserving vascular function, and supporting overall cardiometabolic health.

3. Resistance Training in Cardiovascular Disease and Hypertension

For decades, patients with cardiovascular disease (CVD) were advised to avoid resistance training (RT) due to concerns that acute increases in intra-thoracic pressure and arterial blood pressure during lifting might trigger adverse cardiac events. However, contemporary clinical guidelines have undergone a radical shift. Evidence now suggests that RT is not only safe but provides unique cardioprotective benefits that complement aerobic exercise.

3.1. Hemodynamic Adaptations and Blood Pressure Regulation

Hypertension remains the leading modifiable risk factor for cardiovascular disease. Contemporary meta-analytic evidence indicates that structured RT significantly reduces resting blood pressure in individuals with hypertension.

Specifically, moderate-to-high intensity RT has been shown to lower systolic blood pressure (SBP) by approximately 6 mmHg and diastolic blood pressure (DBP) by approximately 4 mmHg (Polito et al., 2021; X. Wang et al., 2025).

These hypotensive effects are comparable to those achieved with some first-line antihypertensive medications. The primary mechanisms behind these changes include improved endothelial function, enhanced nitric oxide bioavailability, and modulation of the autonomic nervous system, such as increased heart rate variability and reduced sympathetic drive.

Through these adaptations, RT contributes to long-term cardiovascular health and serves as a safe and effective adjunct therapy for hypertensive patients.

3.2. Arterial Stiffness and Vascular Health

Arterial stiffness, commonly assessed by pulse wave velocity (PWV), is a key predictor of cardiovascular risk. Historically, concerns were raised that RT might increase vascular stiffness; however, recent clinical evidence suggests that long-term, structured RT does not adversely affect arterial compliance in clinical populations.

In some cases, RT may even lead to modest decreases in PWV (García-Mateo et al., 2020; Ceciliato et al., 2020). Meta-analytic findings indicate that the impact of RT on PWV is generally neutral or slightly positive, especially when compared to sedentary controls (Ceciliato et al., 2020).

While older studies noted that extremely high-intensity RT might transiently increase stiffness in young, healthy populations (Miyachi, 2013), moderate-intensity protocols used in clinical settings are considered safe and effective for maintaining vascular health. Overall, RT can be safely integrated into exercise programs without detrimental effects on arterial stiffness.

3.3. Cardiac Remodeling and Chronic Heart Failure (CHF)

In patients with chronic heart failure (CHF), RT has emerged as a crucial intervention for combating cardiac cachexia and improving functional outcomes. Meta-analytic evidence suggests that engaging in RT is associated with a significant reduction in all-cause and cardiovascular mortality (Saeidifard et al., 2019).

Beyond survival benefits, RT improves functional capacity, peak oxygen consumption (VO2peak), and muscular strength. Crucially, these improvements occur without inducing deleterious changes in left ventricular remodeling or ejection fraction.

Current guidelines for older adults and cardiac patients emphasize that when appropriately supervised and progressed, RT is a safe and indispensable component of comprehensive cardiac rehabilitation (Fragala et al., 2019). These recommendations support the inclusion of RT in rehabilitation programs to enhance the quality of life in CHF patients.

4. Resistance Training in Metabolic Disorders: Type 2 Diabetes and Obesity

The management of metabolic disorders has traditionally focused on caloric restriction and aerobic activity. However, the unique ability of resistance training (RT) to modulate skeletal muscle—the body's largest glucose-consuming tissue—makes it an indispensable non-pharmacological tool for metabolic health.

4.1. Glycemic Control and Glycated Hemoglobin (HbA1c)

For patients with type 2 diabetes mellitus (T2DM), stabilizing blood glucose levels is the primary clinical goal. Contemporary meta-analytic evidence indicates that structured RT significantly reduces HbA1c levels, with mean reductions ranging approximately from −0.33% to −0.50% compared with control conditions (Wan & Su, 2024; Bärg et al., 2025; Sun et al., 2025).

These reductions are clinically meaningful, as even a 1% decrease in HbA1c is associated with substantial reductions in the risk of microvascular complications. The therapeutic impact of RT is therefore comparable to that of certain oral hypoglycemic agents, highlighting its value as a co-therapy.

Mechanistically, RT increases the expression and translocation of glucose transporter type 4 (GLUT4) to muscle cell membranes. This process enhances glucose uptake independent of insulin action, which is vital for patients with high insulin resistance. Additionally, RT promotes glycogen synthase activity, facilitating the storage of glucose as glycogen within the muscle tissue.

Furthermore, by increasing total muscle mass through hypertrophy, RT creates a larger "metabolic sink" for glucose. This structural adaptation, combined with acute metabolic shifts, allows improvements in insulin sensitivity to persist for 24–48 hours post-exercise. Consequently, RT provides a sustained therapeutic window for glycemic control, even on non-training days.

4.2. Lipid Profile and Metabolic Syndrome

Resistance training exerts beneficial effects on the lipid profile. Regular RT is associated with improvements in low-density lipoprotein (LDL) cholesterol, triglycerides, and high-density

lipoprotein (HDL) cholesterol levels. These shifts are primarily driven by enhanced muscle metabolism and more efficient lipid clearance from the bloodstream.

In the context of metabolic syndrome—a cluster of conditions including abdominal obesity, hypertension, and dyslipidemia—RT serves as a powerful multi-target intervention. By addressing several clinical components simultaneously, RT supports overall metabolic stability more effectively than many single-target strategies.

Prospective evidence highlights the preventative value of this approach. Consistent engagement in muscle-strengthening activities is linked to a significantly lower risk of developing the core features of metabolic syndrome (Momma et al., 2022). This makes RT an essential component of long-term health management for at-risk populations.

4.3. Body Composition and Visceral Adiposity

The “sarcopenic obesity” phenotype—characterized by the co-occurrence of excess adiposity and depleted muscle mass—represents a significant challenge in chronic disease management. While weight loss achieved through caloric restriction alone often results in a concomitant loss of lean body mass, resistance training (RT) acts as a critical countermeasure by helping to preserve muscle tissue during weight reduction (Strasser & Schobersberger, 2011).

Importantly, RT is particularly effective at reducing visceral adipose tissue (VAT), the metabolically active fat surrounding internal organs. Since VAT is strongly linked to systemic inflammation and insulin resistance, its reduction is a key clinical priority for improving cardiometabolic health.

Furthermore, even in the absence of significant changes in total body weight, RT induces a favorable shift in body composition. This "recomposition"—increasing muscle mass while decreasing fat mass—contributes to improved metabolic rate and functional capacity.

This finding demonstrates that scale weight alone is an insufficient metric for assessing the efficacy of exercise interventions; rather, the focus should remain on the qualitative changes in tissue distribution.

5. Musculoskeletal Health: Sarcopenia and Osteoporosis

As the global population undergoes a demographic shift toward an aging society, the prevalence of musculoskeletal disorders has reached epidemic proportions. Resistance training (RT) stands as the most effective non-pharmacological intervention for preserving structural integrity and functional capacity throughout the lifespan.

5.1. Sarcopenia and the Selective Atrophy of Type II Fibers

Sarcopenia, defined as the progressive and generalized loss of skeletal muscle mass and strength, is a primary driver of disability in the elderly. A critical feature of age-related muscle loss is the selective atrophy of Type II (fast-twitch) muscle fibers. These fibers are responsible for power generation and rapid force production, which are essential for maintaining balance and preventing falls.

According to the National Strength and Conditioning Association (NSCA) position statement (Fragala et al., 2019), RT is uniquely capable of attenuating this degenerative process. High-intensity RT stimulates the recruitment of high-threshold motor units, promoting hypertrophy specifically within the Type II fiber population.

Furthermore, RT helps overcome "anabolic resistance"—the blunted muscle protein synthesis (MPS) response to protein ingestion commonly observed in older adults. It achieves this by upregulating the mTORC1 (mammalian target of rapamycin complex 1) signaling pathway, which is a master regulator of muscle growth (McLeod et al., 2019).

This molecular adaptation is essential for maintaining the "functional reserve" required for activities of daily living (ADLs), such as rising from a chair or climbing stairs. By preserving muscle quality and power, RT directly enhances independence and quality of life in the aging population.

5.2. Osteoporosis and the Mechanisms of Bone Mechanotransduction

Osteoporosis and the associated risk of fragility fractures represent a major public health concern, particularly in aging populations. Resistance training (RT) provides a potent osteogenic stimulus by exposing the skeletal system to mechanical loading of sufficient magnitude to induce adaptive remodeling. This process is consistent with Wolff’s Law, which

states that bone tissue adapts its structure and strength to the specific mechanical loads placed upon it.

At the cellular level, bone adaptation to mechanical loading occurs through a complex process known as mechanotransduction. Osteocytes, the primary mechanosensory cells within bone tissue, detect mechanical strain through their dendritic network and convert these physical forces into biochemical signals.

This signaling cascade regulates the balance between osteoblast (bone-forming) and osteoclast (bone-resorbing) activity. By promoting bone formation over resorption, RT helps maintain and enhance skeletal integrity in response to repeated loading stimuli (Hong & Kim, 2018).

Meta-analytic evidence indicates that RT significantly improves bone mineral density (BMD), particularly in clinically relevant regions such as the lumbar spine and femoral neck—the most common sites for osteoporotic fractures. These effects are especially pronounced when training is performed at moderate-to-high intensities, typically exceeding 70% of one-repetition maximum (1RM), and maintained consistently over time (Zhao et al., 2025).

By effectively increasing or preserving BMD, resistance training reduces the long-term risk of fractures and serves as a fundamental strategy for maintaining musculoskeletal health and independence in older adults.

5.3. The Frailty Syndrome and Fall Prevention

Frailty syndrome is a multidimensional clinical condition characterized by reduced physiological reserve and increased vulnerability to external stressors. It is strongly associated with dynapenia, defined as the age-related loss of muscle strength and power. Dynapenia is now recognized as a key predictor of falls, physical disability, and the subsequent loss of independence in the elderly.

Resistance training (RT) is one of the most effective interventions for addressing frailty, as it simultaneously improves muscle strength, neuromuscular coordination, and functional performance. These systemic adaptations significantly enhance postural control and reduce the cumulative risk of falls in older adults (Fragala et al., 2019).

Crucially, RT improves functional capacity by increasing the rate of force production (RFD) and enhancing motor unit recruitment. These neurological adaptations allow individuals to respond more rapidly and effectively to unexpected balance disturbances.

Evidence from major systematic reviews confirms that progressive resistance training improves physical function and mobility in older adults, directly contributing to fall prevention and the preservation of autonomy (Liu & Latham, 2009). By targeting multiple physiological systems, RT represents a comprehensive intervention that serves as a primary strategy to enhance the overall quality of life in increasingly frail populations.

6. Mental Health and Cognitive Function

While the somatic benefits of resistance training (RT) are well-established, its profound impact on the central nervous system (CNS) and psychological well-being has only recently gained significant clinical attention. RT is now recognized as a potent neuro-modulatory intervention capable of alleviating symptoms of common mental disorders and slowing neurodegenerative processes.

6.1. Depressive and Anxiety Symptoms: The JAMA Evidence

Depression is a leading cause of disability worldwide and frequently co-occurs with chronic medical conditions. A large meta-analysis of 33 randomized controlled trials involving 1,874 participants demonstrated that resistance training (RT) significantly reduces depressive symptoms across diverse populations (Gordon et al., 2018).

Importantly, these antidepressant effects were observed regardless of participants' baseline health status, training volume, or the magnitude of strength gains. This suggests that the psychological benefits of RT may be independent of the physical adaptations typically associated with training.

In addition to its antidepressant effects, meta-analytic evidence indicates that RT also significantly reduces anxiety symptoms in both healthy individuals and clinical populations (Gordon et al., 2017). These findings collectively support the role of RT as a robust, non-pharmacological intervention for improving mental health outcomes and psychological resilience.

6.2. The Muscle-Brain Axis and Neurotrophic Factors

The biological connection between skeletal muscle activity and brain function is mediated through the complex muscle–brain axis. During resistance training, contracting skeletal muscles act as an endocrine organ, releasing signaling molecules known as myokines. These molecules exert systemic effects that extend far beyond muscle tissue, influencing central nervous system function through systemic signaling pathways (McLeod et al., 2019; Pedersen, 2019).

Among the most significant exercise-induced signals is brain-derived neurotrophic factor (BDNF). Resistance training contributes to increased expression and circulating levels of BDNF, which serves as a key regulator of neurogenesis, synaptic plasticity, and neuronal survival. BDNF plays a central role in hippocampal function, thereby supporting critical cognitive domains such as learning, memory, and emotional regulation.

Furthermore, resistance training may influence neuroendocrine function by modulating stress-related pathways, including mechanisms associated with the hypothalamic–pituitary–adrenal (HPA) axis, and improving resilience to chronic psychological stress. Through these integrated molecular and endocrine mechanisms, RT supports long-term brain health and contributes significantly to improved psychological well-being and neuroprotection.

6.3. Cognitive Function and Neuroprotection

Resistance training is increasingly recognized as an essential strategy for preserving cognitive function in aging populations. Emerging evidence indicates that structured RT programs significantly improve executive function, attention, and memory, particularly in older adults at risk of cognitive decline.

One primary mechanism behind these benefits involves increased circulating levels of insulin-like growth factor-1 (IGF-1). This hormone plays a key role in neuroplasticity, angiogenesis, and neuronal survival, directly supporting the brain's ability to adapt and repair. Furthermore, RT has been shown to improve vascular function and cerebral perfusion, both of which are critical for maintaining brain health and metabolic efficiency (Maestroni et al., 2020).

Additionally, by optimizing cardiovascular health and reducing systemic inflammation, RT helps mitigate risk factors associated with vascular cognitive impairment. These multifaceted

adaptations support the role of RT as a potent neuroprotective intervention that promotes healthy cognitive aging and enhances resilience against neurodegenerative processes.

6.4. Psychosocial Mechanisms and Self-Efficacy

In addition to neurobiological effects, resistance training (RT) can positively influence mental health through psychosocial mechanisms, particulary by enhancing self-efficacy—the belief in one's ability to perform specific behaviors and manage challenges. Higher self-efficacy is associated with more positive affective responses to exercise and a greater intention to continue participation, both of which support long-term engagement and psychological well-being (Biscardi et al., 2024).

A recent longitudinal study of adults participating in a 16-week barbell-based RT program reported that self-efficacy and intrinsic motivation were positively associated with more positive affective responses and greater adherence over time (Martinez-Kercher et al., 2025). Participants experienced significant increases in positive affect following sessions and across the program's duration; those with greater self-efficacy tended to report stronger emotional benefits and a higher likelihood of sustained participation in RT.

Complementing these findings, observational research found that self-efficacy, effort, and perceived performance were significant predictors of positive psychological responses, including higher well-being and lower distress after RT sessions (Biscardi et al., 2024). This suggests that a person's belief in their capabilities can moderate the impact of resistance exercise on emotional outcomes.

Collectively, these results indicate that psychosocial adaptations—particularly enhanced self-efficacy and positive affective responses—are important pathways through which RT contributes to mental health. Interventions that foster mastery experiences, support intrinsic motivation, and reinforce self-efficacy may therefore enhance both adherence to RT and its psychological benefits in populations with chronic health conditions (Biscardi et al., 2024; Martinez-Kercher et al., 2025).

7. Programming and Safety in Clinical Populations

One of the primary barriers to implementing resistance training (RT) in clinical populations is concern regarding safety, particularly in individuals with cardiovascular disease, musculoskeletal disorders, or reduced functional capacity. However, current evidence-based guidelines indicate that RT is safe and well tolerated when appropriately prescribed and supervised (American College of Sports Medicine [ACSM], 2021; Fragala et al., 2019).

The risk of adverse events is low, especially when training programs follow principles of gradual progression and individualized programming. Importantly, RT has demonstrated significant therapeutic benefits in patients with chronic diseases, including improvements in muscle strength, functional capacity, metabolic health, and overall quality of life (ACSM, 2021).

Proper exercise prescription is essential to maximize these benefits while minimizing potential risks. Key variables such as frequency, intensity, type, volume, and progression should be tailored to the individual's medical condition, training experience, and functional status (ACSM, 2021; Fragala et al., 2019).

7.1. The FITT-VP Principle

The FITT-VP principle provides a structured framework for prescribing resistance training in clinical populations. This model includes frequency, intensity, time, type, volume, and progression, all of which should be individualized based on patient tolerance and clinical status (ACSM, 2021).

Frequency: Resistance training is generally recommended two to three times per week for most clinical populations. This frequency allows adequate recovery between sessions while promoting neuromuscular adaptations and functional improvements (ACSM, 2021; Fragala et al., 2019).

Intensity: Moderate-intensity resistance training, typically defined as 40–60% of one-repetition maximum (1RM), is recommended for beginners and individuals with chronic diseases. As tolerance improves, intensity may be progressively increased to 60–80% of 1RM to maximize gains in strength, muscle mass, and functional adaptations (ACSM, 2021; Fragala et al., 2019).

Time and Type: Resistance training sessions typically last between 30 and 60 minutes. Multi-joint exercises, such as leg press, chest press, and rowing movements, are prioritized because they engage larger muscle groups and promote greater improvements in functional performance and activities of daily living (ACSM, 2021; Fragala et al., 2019).

Volume and Progression: Training volume should begin conservatively, often with one to two sets per exercise, and increase gradually based on individual adaptation. Progressive overload is essential for continued improvement but must be implemented carefully to minimize injury risk and ensure long-term adherence (ACSM, 2021).

7.2. Safety Considerations

To minimize the risk of acute cardiovascular and hemodynamic complications during resistance training, patients should avoid the Valsalva maneuver, defined as breath-holding during exertion. This maneuver can significantly increase intrathoracic pressure and lead to transient but substantial elevations in arterial blood pressure, which may pose risks for individuals with cardiovascular disease, hypertension, or vascular abnormalities (ACSM, 2021; Fragala et al., 2019).

Instead, controlled breathing techniques—typically involving exhalation during the concentric phase and inhalation during the eccentric phase—are recommended to maintain hemodynamic stability and reduce cardiovascular strain (ACSM, 2021).

Additionally, monitoring exercise intensity using the Rate of Perceived Exertion (RPE) scale, particularly the 6–20 Borg scale, is strongly recommended in clinical populations. RPE provides a practical and reliable method for regulating exercise intensity, especially in patients taking medications such as beta-blockers that alter heart rate response. This approach enhances safety and allows for individualized intensity adjustment based on patient tolerance and clinical status (ACSM, 2021; Fragala et al., 2019).

8. Discussion: Barriers and Future Perspectives

Despite substantial scientific evidence supporting resistance training (RT) as an effective non-pharmacological intervention for the prevention and management of chronic diseases, its integration into routine clinical practice remains limited (American College of Sports Medicine, 2021; World Health Organization, 2020). Several important barriers contribute to this gap between evidence and implementation.

Clinical perception: Many physicians receive limited formal education in exercise prescription during medical training. As a result, exercise interventions, including RT, are often underutilized or not prescribed systematically, despite their well-documented therapeutic benefits. Increasing physician education in exercise medicine is essential to facilitate the integration of RT into standard clinical care (ACSM, 2021).

Accessibility: Limited access to appropriate facilities, equipment, and qualified supervision represents a significant barrier, particularly for older adults, individuals with disabilities, and patients living in rural or underserved areas. These structural limitations can reduce adherence and prevent patients from receiving the full therapeutic benefits of RT (WHO, 2020).

Psychological barriers: Fear of injury, symptom exacerbation, or physical discomfort may discourage patients from participating in resistance training programs. Misconceptions regarding the safety of RT, particularly among individuals with chronic diseases, can negatively affect motivation and long-term adherence. Patient education and supervised training programs play a crucial role in improving confidence and engagement (Fragala et al., 2019).

Future perspectives highlight the growing role of exercise as a formal component of medical treatment. The development of specialized Exercise Medicine clinics and the integration of RT into multidisciplinary care models may improve accessibility and clinical implementation. In addition, telerehabilitation and remote monitoring technologies, including wearable devices, offer promising opportunities to deliver safe and effective RT programs to broader patient populations (ACSM, 2021).

Advances in understanding muscle as an endocrine organ have further strengthened the clinical relevance of RT. The identification of myokines and muscle–organ cross-talk mechanisms provides new insights into how RT exerts systemic therapeutic effects. These discoveries may

contribute to the development of more targeted and individualized exercise interventions for specific chronic diseases in the future.

9. Conclusions

Resistance training has evolved from a supplemental fitness activity to a cornerstone of non-pharmacological medicine. The evidence synthesized in this paper demonstrates that resistance training is not only safe for clinical populations but also essential for addressing the root causes of chronic conditions, including metabolic and cardiovascular dysfunction, cognitive decline, and musculoskeletal frailty. By recognizing skeletal muscle as a secretory organ, clinicians can better appreciate the systemic effects of exercise-induced adaptations. Successful integration of resistance training into routine clinical practice requires a shift in medical education, alongside the implementation of supervised and individualized protocols. Ultimately, resistance training is a potent, cost-effective tool for preserving functional independence and enhancing quality of life in an aging global population.

Disclosure

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