**Revisión Narrativa**

**Is physical exercise a protective agent against the way we currently age? A narrative review.**

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**Abstract:** Aging is an inherent process to living beings that involves a deterioration of homeostatic regulation and functional reserve. Currently, the aging population has high levels of physical inactivity that aggravates muscle disuse, which in turn drastically affects functional capacity and quality of life. The aim of this narrative review is to present aging conditions and the protective role of physical exercise in functional reserve and capacity in relation to how we currently age. The regular practice of physical exercise provokes several favorable responses to the preservation of neuromuscular and cardiorespiratory function, which has a direct impact on physical capacity, even benefiting cognitive function. Physical exercise has been shown to have a protective effect on different systems, apart from contributing to the preservation of functionality and self-efficacy, which is why it is essential for healthy aging, since it favors a better resolution to stressful events such as falls and/or diseases. In conclusion, even though physical exercise does not prevent the deleterious conditions of aging, its effects are positively related to the maintenance of systemic functional reserve and capacity, which translates into greater autonomy, independence and quality of life related to health in the last stage of the life cycle.

**Keywords:** Aging; functional capacity; physical exercise; quality of life

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1. INTRODUCTION

Aging is a complex process of which even in our times there is no universal agreement in its definition (1). Despite the existence of an endless number of theories with scientific validity, none manages to fully address the understanding of this phenomenon by itself (2). A main aspect of aging consists of a deterioration and even loss of homeostatic regulatory mechanisms (3), beginning at some indeterminate moment when the individual's stage of development, growth and maturation ends (4). From this stage, a gradual decrease in physiological reserves begins, which directly affects the physical and functional capacity of the organism (5, 6). From the age of 65, these changes accelerate and affect to a greater extent the functional reserve of the neuromuscular and cardiorespiratory system, causing a loss of autonomy and independence (7). In addition, muscle disuse because of the drastic reduction in daily physical activity carried out by this population increases these effects to a greater degree, impairing quality of life and increasing the risk of morbidity and mortality (8). In recent decades, the proportion of older adults has increased dramatically, due to a longer life expectancy and a decrease in the fertility rate (9). This rapid demographic transition has led us to witness a phenomenon never described before in the history of humanity: the "aging of aging", which translates into a significant increase in eighty and even ninety-year-old individuals in the world population (10). Despite the increase in life expectancy and a greater protected environment, these last years are not fully lived, due to a reduction in functionality (11). Therefore, aging today must be addressed in terms of quality over the number of years completed, since a notable increase in chronic non-communicable diseases is expected in the coming decades, mainly attributed to musculoskeletal conditions (12). In this context, physical exercise could be an essential alternative for the treatment and prevention of the effects of aging, as it is low cost and without adverse effects (13). The main benefits of physical exercise in the elderly are related to the maintenance and / or improvement of functional capacity, physiological reserve, and quality of life (14, 15, 16). Although there is abundant scientific evidence on the deleterious effects of aging on the different functions and systems of the human being, it is not clear at present how influential physical inactivity is in this natural process and how the benefits of physical exercise could counteract the effects derived from both factors. Therefore, the present research aims to review the conditions of aging and physical inactivity on the body's physiological reserve, and the protective role that physical exercise could play against the way we age today.

2. EFFECTS OF AGING AND PHYSICAL INACTIVITY ON FUNCTIONAL RESERVE

Aging is a multifactorial process, but fundamentally biological and physiological, which induces changes that limit the adaptability of the organism in relation to the environment (17). These changes have consequently, a greater difficulty to carry out the basic and instrumental activities of daily life, regardless of the presence or absence of diseases and / or a sedentary lifestyle (18, 19). Added to this, 92% of older adults globally do not accomplish the physical activity recommendations proposed by the World Health Organization (WHO) (20). This represents between 60-70% (14-17 hours) of the day performing sedentary activities, and in relation to other age groups, older adults are the most inactive (21). Muscle disuse because of physical inactivity
causes a drastic decrease in the capacity of the cardiorespiratory and neuromuscular system to perform tasks with greater energy demand (7). This deficit of physical activity implies a deterioration of the functional reserve, understood as the difference between the minimum and maximum capacity that an organ or system has to perform its functions (22), which accelerates neurodegenerative and musculoskeletal processes that expose the individual to a loss of control of cardiorespiratory and metabolic diseases, added to an increased risk of falls and fractures that could directly affect their levels of autonomy, independence and quality of life (23). In addition, the suffering of chronic pain that is common in this population could trigger mental alterations, such as fear of moving and falling, causing voluntary confinement that paradoxically will further deteriorate their functional reserve (24).

2.1. Effects of aging and physical inactivity on the Neuromuscular System (NMS)

As a result of aging, the Central Nervous System (CNS) cells present certain conditions such as increased oxidative stress, accumulation of damage to proteins, lipids and nucleic acids, increased generation of reactive oxygen and nitrogen species, which involve cell damage due to mitochondrial dysfunction (25, 26). This degeneration causes a decrease in force levels and alteration of mechanisms such as reinnervation and denervation of motor neurons, delays in the process of stimulation and conduction of the nerve impulse towards muscle fibers, and alterations in muscle recruitment patterns (27). Regarding muscle tissue, a decrease in strength with age is observed, essentially due to a progressive loss of muscle mass (sarcopenia) and/or selective loss of type II fibers mainly, causing important changes in the qualitative characteristics of the same tissue (28). However, it seems that sarcopenia plays a relatively minor role in the mechanisms involved in force reduction (29), since deficits in the structure, function, and intrinsic force-generating properties of the NMS, is due to dynapenia (loss of strength) (30). Within these deficits, the changes associated with oxidative stress and inflammation generate damage, loss and failure in the innervation of α motor neurons, considerably affecting neuromuscular coordination (31). The first studies that demonstrated the loss of motor units over the years date from the 1970s (32). Adults older than ~ 75 years have less than 50% motor units in relation to younger individuals and even older people may have less than 10% of their remaining motor units (33) and the action potentials are mostly complex, so the stability of their transmission decreases (34). These alterations trigger an enlargement of the motor units as a compensatory mechanism for the loss of functional motor units, a phenomenon known as “sprouting” (35). This mechanism leads to an adaptive remodeling in which the remaining fast motor neurons seek the reinnervation of type I fibers but generating a motor unit of poor performance (36). These conditions will result in a significant reduction in muscle power that is reflected in a walking speed equal to or less than 0.8 m/s, which is related to a syndrome known as "muscle insufficiency", which is used as a clinical indicator to apply therapeutic interventions (37). Muscle mass and strength vary throughout the life cycle, decreasing considerably in advanced ages (38). After the age of 50, the loss of muscle mass in the lower limbs is 1-2% per year and in strength 1.5-5% per year (39). This decline in neuromuscular morphology and function considerably affects the regulation of the endocrine system and homeostatic mechanisms, characterized by multiple hormonal dysregulations with disruption in the secretion axes of insulin-like growth factors (IGF-1), testosterone and growth hormone mainly (40). Among the alterations involved in the structure of muscle tissue, we find anabolic resistance, which is the main moderator of atrophy of the musculoskeletal system, which will result in low-grade systemic inflammation, added to a reduction in the number and activity of satellite cell (41). At the same time, anabolic resistance is associated with malnutrition, regardless of whether this condition originates from a reduced caloric intake (42) and it has been proposed in recent studies that low muscle mass is part of a poor nutritional status (43). All these adverse changes that accumulate throughout life, added to the muscular disuse especially present in elderly people, cause a serious...
functional limitation at the time of long-term activities, which further encourages avoiding physical activity, generating a significant deterioration of the physiological reserve of the organism (44).

2.2. Effects of aging and physical inactivity on the Cardiovascular System (CVS)

Aging causes a decrease in cardiovascular capacity due to the decrease in maximum cardiac output (CO max), which results from the decrease in maximum stroke volume (SV) and maximum heart rate (HR max) (45). The gradual loss of contractile force in cardiomyocytes, caused to a great extent by a decrease in the activity of the myosin-ATPase enzyme and by the loss of elasticity of the walls of the heart, hinders an adequate and rapid ventricular filling, having therefore a decrease in CO (46). HRmax is similarly reduced between active and inactive people over the years (47). For example, people who are physically active have the same HRmax than long-distance runners when they are in their middle life (48). The decrease in HRmax can be attributed to morphological and electrophysiological changes in the cardiac conduction system, specifically in the sinoatrial node and the atrio-ventricular bundle, which would slow down cardiac conduction (49). In addition, dysregulation of β1-adrenergic receptors in the myocardium also reduces cardiac sensitivity to catecholaminergic stimulation (50). Over the years, systolic function does not deteriorate excessively, but diastolic function is significantly altered since rapid filling is considerably delayed by the age of 80 (51). The delay in ventricular filling is due to the increased stiffness of the hearth walls and an increase in the isovolumic relaxation time, due to the decrease in calcium in the sarcoplasmic reticulum of cardiac myocytes (52). This factor triggers a reduction in maximum SV in elderly people, due to increases in the end systolic volume (ESV) in the left ventricle and decrease in ejection fraction (EF) (53). These mechanisms are mainly altered by a decrease in end diastolic volume (EDV), the product of less peripheral venous return and slow relaxation of the ventricular wall (54). The increase in total peripheral resistance (TPR) with age increases cardiac afterload, causing the myocardium to work harder to bring blood to the periphery, which increases myocardial oxygen consumption for a given effort (55). Greater peripheral resistance also causes higher systolic blood pressures and is considered one of the most important factors that justify the decrease in stroke volume with age (56). In the blood vessels there is a progressive fragmentation and even a breakdown of the elastic components over the years (57). These ruptures are replaced by highly cross-linked collagen, which leads to hardening and stiffness of the aorta mainly (58). Furthermore, this stiffness is associated with a generalized increase in the intima-media thickness of the arteries, generating a very important underlying mechanism known as endothelial dysfunction, the product of high oxidative stress and low-grade inflammation (59, 60). Regarding blood, there is a decrease in blood and plasma volume, a reduction in the number of red blood cells, hemoglobin and their transport capacity, and consequently in hematocrit, regardless of the level of physical activity performed (61). White blood cells are almost unchanged, but the immune capacity of lymphocytes is reduced, exposing the individual to a higher risk of infections (62). In general, aging per se is a degenerative biological process that reduces the function of the CVS, but to a lesser extent than the physical deconditioning mediated by sedentary behavior highly present in this population (63).

2.3. Effects of aging and physical inactivity on the Respiratory System (RS)

Throughout the aging process there is a reduction in the physiological capacity of the RS and especially, of sedentary people (64). Regarding structural changes, a decrease in lung compliance, greater rigidity of the rib cage and a decrease in the curvature of the diaphragm can be seen, which are associated with a significant loss of strength and respiratory muscle mass (65). At the intrapulmonary level, there are alterations in the collagen fiber networks that lead to a dilation of the alveolar duct and consequently, an enlargement of the air spaces (66). Together, these changes cause alterations in ventilatory mechanics that are interrelated with other effects, such as decreased airway caliber, expiratory flows, and overall lung function (67). At the same time, alterations
associated with respiratory mechanics generate changes in lung volumes (68). For example, the residual volume increases by approximately 50% from 20 to 70 years, due to greater rigidity of the rib cage and consequently causing an occlusion of the airway (69). The strength of the diaphragm is considerably reduced at advanced ages, being up to 25% lower in relation to young people (20-30 years), which is mainly associated with changes in its intrinsic properties and decrease in its curvature (70, 71). The strength of the rest of the inspiratory and expiratory muscles also decreases gradually after the age of 65 in men and women (72). Regarding other respiratory parameters, it has been shown that older adults present a lower tidal volume, lower forced vital capacity, and higher respiratory frequency, having therefore, pulmonary oxygenation disorders and poor cardiorespiratory capacity (73, 74). Another important parameter that is impaired by a loss in elasticity in the various lung tissues is the forced expiratory volume in one second (FEV₁) (75). With advancing age, this parameter begins to decline steadily, generating a greater risk of suffering from cardiopulmonary diseases (76). Starting at age 30, FEV₁ decreases by approximately 30 ml each year and accelerates even more after age 65, greatly affecting expiratory flow volume (77, 78). All the lung conditions reviewed show even more drastic changes when aging with sedentary behavior, especially a limitation of expiratory flow when trying to perform physical exercise (79).

In addition, sedentary behavior added to tobacco consumption and/or exposure to environments with high levels of air pollution and respiratory irritants, further worsen lung structure and function, increasing the risk of developing serious respiratory diseases such as disease. chronic obstructive pulmonary disease (COPD), pulmonary hypertension, pulmonary emphysema, among others (80).

2.4. Effects of aging and physical inactivity on Functional Capacity (FC)

In contemporary societies, levels of voluntary physical activity begin to decline with advancing age, avoiding all kinds of activities that involve generating muscle tension (81). Physical inactivity leads to a deterioration in the capacity of the systems, especially the NMS, CVS and RS, which affects tolerance to strenuous effort, as a result of the decrease in Maximum Oxygen Consumption (VO₂max) (82). The VO₂max decreases gradually with age (83) and after the age of 20-30, it decreases approximately 10% per decade (84). This reduction is largely explained by a decrease in the capacity of the physiological determinants of VO₂max (COmax and maximum arterio-venous oxygen difference) (85). The main consequences of these changes in the elderly person, result in an accelerated decline in both power and cardiorespiratory capacity (86), which leads to reaching a functional threshold that will cause greater difficulty in performing their everyday life activities (44). This limitation and loss of function generates a decline in the ability to remain independent from the community, increasing the risk of frailty and mortality (87). Faced with this situation, basic actions such as getting up from a chair can be highly demanding for elderly people, which is an important risk factor for a possible diagnosis of frailty (88). Frailty is a biological syndrome associated with age characterized by a poor resolution of the organism to maintain homeostasis in situations of low stress or demand (89, 90). Older people diagnosed with this syndrome have reduced levels of mobility, muscle strength and physical-cognitive function in general, which is associated with a higher probability of falls and higher rates of hospitalization, increasing the risk of morbidity and mortality (91, 92). Within these conditions, the risk and number of falls are a frequent cause of unintentional injuries that can cause eventual disability (93). Approximately 30% of people aged ~ 65 and 50% of people ~ 80 years old fall at least once a year, and of those who fall, 50% fall again the same year (94, 95). The main causes of falls in the elderly are muscle weakness and deficiencies in gait and balance associated with age (96). A close relationship between gait speed (GS) and the probability of falling has been demonstrated, since a GS <0.7 m/s is associated with a higher risk of falls in any environment and with adverse outcomes (97). These limitations are the result of reduced levels of strength in the upper and lower extremities (40-70%), cardiorespiratory endurance (45%), flexibility (50%) and, to a greater extent, neuromuscular coordination (90%) in people aged ~ 75 years compared to 20-year-olds (98, 99). Finally, all these
conditions together generate a significant loss of function that leads to severe limitations on the autonomy of the elderly person, increasing their physical dependence on their family nucleus or some technical element that conditions their independence and quality of life (100, 101).

2.5. Effects of aging and physical inactivity on Quality of Life

All the degenerative processes associated with aging, added to muscle disuse, gradually reduce the functional reserve of the systems, leading to a significant risk of suffering adverse events that can condition autonomy and quality of life (102). Quality of life is closely related to physical health and the ability to remain independent, which in turn will have an impact on the personal satisfaction of each individual (103, 104). Studies on quality of life in older people have focused on factors such as emotional state, depression, stress, income, and functional level (105). Therefore, quality of life is a useful index to assess the physical functioning, well-being and health status of older people (106). Despite the importance of evaluating this index, current policies and public services promote aging at home rather than at institutionalized contexts, which seems to be positive due to the security that this environment represents, but which to some extent could threaten their quality of life (107), since aging at home could mean an excessively safe environment, having as a possible consequence a high prevalence of physical inactivity in this population due to various factors such as the presence of diseases, fear of injury and falls, lack of energy and motivation, added to the lack of companions that allow them to socialize (108). Older people who experience mobility restrictions have difficulties in improving their quality of life through physical activity, which could lead to a state of fragility (109). It has been shown in a cross-sectional study that frail older people report a much lower health-related quality of life compared to those who are not frail on all scales, especially the physical and mental component of the SF-36 questionnaire (110). On the other hand, in a recent longitudinal study, it has been shown that frailty is negatively associated with quality of life, especially in older people who suffered a hip fracture in the last year (111), due to because of this syndrome, the incidence of falls is higher in this population and therefore, early identification of frailty is essential for its treatment (112). There is a phenotypic diagnosis for frailty syndrome based on certain criteria (113). These criteria are involuntary weight loss, self-reported exhaustion, decreased grip strength, slow gait speed and low level of physical activity, considering an elderly person frail when they present 3 or more of these criteria (114). However, frailty is potentially preventable, even when it becomes a severe condition that could lead to death and therefore, it is essential to apply strategies to prevent and/or slow the progression of this syndrome (115). Within the criteria for the diagnosis of frailty, two of them are directly related to conditioning aspects of physical capacity and that in turn, can be improved with training, such as decreased grip strength and slow gait speed (116). Faced with all the conditions regarding aging in conjunction with muscle disuse, which severely deteriorate the physiological reserve, functional capacity and quality of life, it is imminent to review the benefits derived from the regular practice of physical activity on the way we age and the maintenance and/or improvement of the functional reserve of the organism, with the purpose of arguing and promoting an autonomous and independent aging of the community.

3. BENEFITS OF PHYSICAL EXERCISE ON FUNCTIONAL RESERVE

Even though it is quite common to relate the increase in age with the decrease in well-being and the increase in frailty (117), it is also true that two older people with the same chronological age can vary in their functional reserve and health status (118). Frailty syndrome and the decrease in functional reserve represent adverse factors that lead to possible disability, but which in turn, can be modifiable with different types of intervention and specific health strategies, which aim to prevent, maintain and even reverse these factors (119). In this sense, it has been shown that the regular practice of physical exercise causes a series of favorable responses that contribute to healthy
aging (120), because it causes improvements in many aspects of health such as physical-functional capacity (121), cognitive and mental function (122, 123), benefits in muscle (124) and cardiopulmonary function (125, 126). Therefore, physical exercise should be fully recommended in the elderly because it works as a protective agent against different adverse outcomes, which will improve their functionality and quality of life (127, 128). Next, the benefits of physical exercise on physiological reserve, functional capacity and quality of life will be reviewed.

3.1. Benefits of Physical Exercise on the Neuromuscular System

The aging process results in morphological and functional changes in brain tissue and its constituent components, affecting the volume, size, number of neurons, white and gray matter and synaptic connections (129). Evidence has shown the benefits of physical exercise on the neuromuscular system, even in advanced ages (130). In this sense, the main benefits are seen in increases in muscle mass and, more importantly, significant improvements in muscle strength and power (131, 132). Longitudinal studies in older people, date the relevance of muscle strength over structural components such as muscle mass (133), whose deterioration is two to five times greater, in strength levels than in the loss of muscle mass, according to annual follow-up records in this population (134). A condition that is accentuated in untrained people given the hypoexcitability of the motor cortex, compromising the ability to generate tension in a maximum voluntary contraction by 20% (135). Mechanical response, conditioned by the frequency of discharge and the recruitment of motor units, determining factors of the functionality of the skeletal muscle (136). In this sense, physical exercise plays a protective role in the preservation of motor units (137), which is a condition related to the contractile properties of skeletal muscle, which generates a preventive anti-inflammatory effect through the expression neurotrophic factors (138). In addition to having a local effect on active muscle tissue, it also favors the interaction of the musculoskeletal system with other organs through various anti-inflammatory myokines that promote a protective effect on the motor units themselves and other tissues (139). In turn, these anti-inflammatory mechanisms play an important role in neuronal plasticity and survival, dendritic branching and synaptic connections (140, 141), which favors processes related to memory, learning and cognitive functions (142).

Among the physical exercise modalities, strength training is considered an important tool to combat the effects of aging on the NMS (143). Programs of 8 to 12 weeks (144, 145) of progressive strength training, with moderate-high intensity, close to 70% of 1RM (146), have shown improvements between 25-30% of the levels of strength in lower extremities (147) and in upper extremities (148). The muscle deteriorates by the loss of neurological control, rather than the intrinsic ability to generate tension in the muscle fibers. Strength training and myofibrillar hypertrophy improve mechanical efficiency by reducing the demand for activation of motor units in the face of a specific movement (143). Remodeling in motor units (144) and reinnervation of denervated muscles (149) could explain the neuromuscular adaptations and the short-term benefits of strength training in older people (150). Novel and innovative methodologies have been used to optimize the benefits of strength and power training programs in older adults. Adapted plyometric training has proven to be a reliable and safe option for older people (151), demonstrating improvements in neuromotor control of functional tests such as: climbing stairs, contraction speed in repetitive jumps and in power and height of the vertical jump (152). Results that relate a higher speed of the stretch-shortening cycle product of the preservation of medium and large motor units, type Ila and IIX fibers and a greater amount of skeletal appendicular muscle mass (153). Not only the load is important for the maintenance of the neuromuscular function, but also the speed of execution. A 19-year follow-up (154) of (n: 2629) men and (n: 1249) women between 41 and 85 years of age, showing that in both sexes, the loss of muscle power levels was related to a greater incidence of mortality, while higher power levels were related to higher survival. Controlling the speed of execution and the overload used are fundamental aspects to be taken into consideration when designing training programs for older people. On the other hand, aerobic exercise has also shown benefits in
neuromuscular function with significant improvements in contractile capacity and maximum power, determined by the expression of the heavy head myosin isoforms I and II (155). Aerobic exercise and repetitive muscle contractions produce a large amount of reactive oxygen species (156), if not counteracted, these could accentuate the damage of tissues and constituent proteins, inflammation and subsequent cellular apoptosis, affecting excitability of CNS, favoring neurodegeneration and neuronal aging (157). Despite the above, there is no convincing evidence that prolonged and/or high-intensity aerobic exercise produces tissue damage and impaired neuromuscular function related to the production of reactive oxygen species (158). Contrary to the above and from a mechanical perspective, it is common to refer to neuromuscular limitations, which influence central parameters. A decrease in muscle efficiency, because of the increased coactivation of the antagonist muscles of the lower limb, contributes to the higher cost of oxygen during walking, both in sedentary and active older adults (159). Results that are determined by a series of factors such as: muscle morphology, elastic elements and joint mechanics in the efficient conversion of chemical energy into mechanical speed, a situation that translates into greater efficiency in the use of oxygen at a determined speed (160).

3.2. Benefits of Physical Exercise on the Cardiovascular System

Scientific evidence has widely shown that physical exercise can have an anti-aging effect on different systems (161), and that the benefits it may have outweigh the risks of practicing it in older adults (162). In this population, periods of physical inactivity of only 60 days can lead to a considerable loss of VO2max and maximum workload, however, intensive jump training can already be effective in counteracting cardiovascular deterioration (163). Exercise involves extra work on the cardiovascular system and myocardium, with the main cardiovascular responses being an increase in VO2max, CO and HR, as well as an early increase in SV, regardless of intensity level (164). Exercise has been considered as an effective complementary therapy in the treatment of hypertension (165) and its performance for life, in addition to increasing VO2max, can significantly reduce the risk of mortality because it preserves capillarization of skeletal muscle and aerobic enzymes (166), representing an important protective factor in advanced ages. Cardiovascular deterioration in the elderly is mainly due to structural changes including vascular stiffness (167), which can lead not only to cardiovascular events or heart attacks, but also to increased frailty and decreased functionality. Arterial dilation and compliance are yet unknown mechanisms that deteriorate with age and may be modified with exercise (168). Many authors have shown the need for physical exercise in older people for the prevention of CV diseases (169) and the improvement of quality of life. Resistance exercise has proven to have beneficial effects on cardiac function (170) and on the decrease in blood pressure by 5-7 mmHg after a training session, an effect that lasts up to 22 hours post-exercise, through neuro-humoral, vascular and structural adaptation mechanisms (171). In groups with impaired cardiovascular health after a heart attack, exercise has shown significant improvements in arterial compliance, resting systolic pressure, and distance in the 6-minute walk test (172). During exercise, blood flow to the metabolically inactive muscle and viscera decreases, which increases to the active muscle. Occlusion training, defined as blood flow restriction training, has also shown an increase in diastolic and systolic blood pressure, heart rate, stroke volume, and cardiac output in older women (173). Endothelium-dependent vasodilation of skeletal muscle, angiogenic markers, and capillarity also show a positive response to flexibility training (174), which is a good alternative in older populations. High intensity exercise can lead to greater improvements in aerobic capacity and cardioprotective effect (175), in addition to endothelial function and quality of life (176), from which it is inferred that the exercise intensity can have an impact on its protective effect at the cardiovascular level and can be an important factor in maintaining and/or improving the aerobic capacity of older adults.
3.3. Benefits of Physical Exercise on the Respiratory System

RS can also be benefited by the multisystemic effect of exercise in advanced ages. Studies show that respiratory capacity can be maintained over the years with regular physical activity (177), which presumably can improve the quality of life of older adults. Aerobic exercise at the ventilatory threshold can induce a significant improvement in maximal exercise capacity, respiratory muscle strength, and inspiratory muscle performance in obese subjects (178), which as in older adult populations, may decrease the sensation of dyspnea or shortness of breath. Likewise, an aerobic exercise program, combined with high-intensity training of the respiratory muscles, can significantly increase the maximum inspiratory and expiratory pressures (179), representative of the strength of the respiratory muscles and the maximum capacity to exercise. The improvement in exercise tolerance is correlated with the improvement in inspiratory vital capacity and even more so with the BODE index (180), a measurement that has been used as a predictor of mortality in older adults with COPD (181). Aging induces pulmonary alterations that may have implications in the response to exercise, which implies greater work of breathing during exertion due to greater elastic and expiratory resistive inspiratory work (182). Resistance exercise can help counteract this deterioration by having positive effects on ventilatory capacity and on the resistance of respiratory muscles to exertion (183), which can reduce pulmonary complications and improve the dyspnea scale during effort (184). On the other hand, aerobic exercise in combination with flexibility exercises of the respiratory muscles has been shown to improve the maximum inspiratory and expiratory pressures (179), representative of the strength of the respiratory muscles and the maximum capacity to exercise. The improvement in exercise tolerance is correlated with the improvement in inspiratory vital capacity and even more so with the BODE index (180), a measurement that has been used as a predictor of mortality in older adults with COPD (181). Aging induces pulmonary alterations that may have implications in the response to exercise, which implies greater work of breathing during exertion due to greater elastic and expiratory resistive inspiratory work (182). Resistance exercise can help counteract this deterioration by having positive effects on ventilatory capacity and on the resistance of respiratory muscles to exertion (183), which can reduce pulmonary complications and improve the dyspnea scale during effort (184). On the other hand, aerobic exercise in combination with flexibility exercises of the respiratory muscles has been shown to contribute to a greater efficiency of the respiratory muscles, by improving abdominal contribution and compartment volume, in addition to improving mobility and functional exercise capacity with decreased dyspnea (185). This improvement in the exertional dyspnea scale is mainly due to a reduced activation of the diaphragm, thus reducing changes in ventilation, respiratory rate and operating lung volumes (186), contributing to the improvement of the maximum inspiratory pressure (187). Calisthenic exercise in conjunction with breathing exercises has shown improvements in thoracoabdominal mobility, in addition to lower values on the dyspnea scale in the 6-minute walk test (188), which may induce improvements in its performance, used as a measure of functional capacity during exercise in older populations (189). Evidence suggests that a decrease in exercise capacity or physical activity level may be related to a decrease in maximum inspiratory pressure and exercise tolerance (190), so training programs are suggested to prevent respiratory diseases and improve lung functions in the elderly population (191), thus improving their long-term quality of life.

3.4. Benefits of Physical Exercise on Functional Capacity

Regular physical activity in older populations is essential for healthy aging and for the prevention of chronic diseases (192), being multicomponent exercise, which includes strength, resistance and balance training, the most recommended to improve the ability to walk and avoid falls in physically frail older adults (193), thus contributing to maintaining the functional capacity of this population. Improvements in physical fitness in terms of aerobic capacity, endurance, muscular strength and dynamic balance have been observed as a result of combined training in older adults (194), as well as in walking capacity, capacity of standing and sitting and functionality in general (195). Multimodal programs that include resistance and high-speed training, weight-bearing impact exercises, and challenging mobility and balance exercises appear to be the most effective in improving musculoskeletal function (196), by helping to slow down the loss of muscle mass and strength associated with aging. Resistance training interventions have resulted in significant improvements in muscle strength and functional results (16), due to the direct impact on the cross-sectional area of the muscle fiber, increasing not only the number of myofibrils, if not also muscle size and strength (123). Likewise, resistance training in this population can improve microvascular blood flow, blood vessel regulation, endothelial function, and muscle oxygen availability and extraction, resulting in better muscle oxidative capacity (197). Aquatic exercise programs have also shown benefits in older adults, improving the strength and flexibility of the upper and lower body,
functional mobility and balance (198), thus contributing to the improvement of physical and perceptual aspects, reducing the risk of falls in older adults with reduced physical capacity (199). The effect of exercise can partially reverse the physiological deterioration associated with aging, having a preventive role for sarcopenia, osteopenia, neurodegeneration and reducing the risk of CV mortality, by generating profound effects, related to a favorable physiological feedback cycle (200). Thus, training contributes to the maintenance and improvement of maximum strength, the 6-minute walk test and muscle strength and power (201), associated with an improved innate immune response and reduction risk of infection, inflammatory potential and disease (202). The gains in functional capacity and strength in response to training in older adults can be maintained for long periods of time, independent of the training load (203). However, regular and long-term participation in resistance training programs is necessary to maintain the muscle volume gained, as well as to maintain the protective effect of exercise against functional deterioration and disability (204), representing a valuable tool to combat frailty, falls and cognitive deterioration in the elderly (87).

3.5. Benefits of Physical Exercise on Quality of Life

The lack of physical activity in older populations has been shown to be one of the most common components of frailty (119), so the prescription of exercise, which must consider the state of health and functional capacity (192), will be vital to contribute to a better quality of life. Studies have shown that aerobic exercise, in conjunction with adequate sleep hygiene, can benefit the quality of sleep and mood, and quality of life of older adults (205). This close relationship between physical activity and quality of life could be explained by the improvement in the positive indexes of psychological health, such as self-esteem, and the decrease in the negative ones, such as symptoms of anxiety and depression (206). In sedentary older adults who begin an exercise program, a positive change has been observed in terms of pain reduction, better quality of life and greater self-efficacy (207), in addition to mental and social health benefits independently of the frequency of exercise (208), contributing to the independence and vitality of this population. In older adults, physical exercise has been shown to have positive effects on quality of life, even in those groups that suffer from certain conditions such as type 2 diabetes (209), arthritis (knee and hip) (210) and osteoporosis (211), among others; demonstrating even a high clinical relevance to improve the quality of life in breast cancer survivors (212), by demonstrating benefits in emotional, social and family well-being (213). In the elderly with depressive disorders, exercise programs have been shown to have a significant effect by reducing scores on the depression rating scales (214). The result of multimodal exercise programs is associated with significant changes in executive functioning and quality of life associated with health (215), like the effects of resistance exercise programs performed at least twice per week, which have been shown to improve quality of life and sense of coherence in older adults (216). Team training has also been implemented in older populations, showing benefits in physical function, psychological well-being, and quality of life (217), in addition to contributing to intrinsic motivation for the practice of physical activity. Other movement alternatives in the elderly, such as exercise programs at home or software games that enhance activities of daily life, can contribute to improving the physical and mental state in this population (218). Due to the high risk of falls in the elderly population and the consequence of burdens for both people and health system, a relationship is established between exercise programs to prevent falls and quality of life (219), Therefore, the daily practice of multimodal physical activity oriented to functionality is recommended to improve quality of life associated with health in this population (220).
4. Conclusions

In the present work, fundamental aspects of aging conditions added to muscle disuse and the benefits of physical exercise and its protective role in different systems, functional capacity and quality of life were reviewed. The general conclusions for each of the areas addressed in the review are presented below.

4.1 Neuromuscular System

The physiological and structural changes of the nervous and muscular system in the aging process are normal and can be accentuated to a greater extent with a sedentary behavior. This translates into lower levels of strength, power and muscle mass that are priority components in health care and autonomy. Physical exercise is essential for the preservation of neuromuscular function and other systems. Sustained muscle contraction over time is a mechanical tool that prevents deterioration due to disuse, causing a protective effect at a multisystemic level.

4.2 Cardiovascular System

Aging can deteriorate cardiovascular function, mainly due to a decrease in COmax and age-related endothelial dysfunction. Exercise can improve VO2max, CO and HR, in addition to showing improvements in arterial compliance, angiogenic markers, and capillarity, helping to lower blood pressure.

4.3 Respiratory System

Because of aging and unhealthy behaviors, there is a decrease in the capacity of the RS that causes alterations in ventilatory mechanics, respiratory flows, and compliance of the rib cage, which are associated with various respiratory pathologies. Physical exercise can preserve respiratory capacity, due to improvements in pulmonary pressures and functions, reducing the sensation of dyspnea and increasing tolerance to prolonged efforts.

4.4 Functional Capacity

Levels of physical activity tend to get lower and lower over the years, which affects VO2max and its physiological determinants. This condition will cause reaching a functional threshold that will limit the development of daily activities, increasing the risk of frailty and morbidity and mortality. Physical exercise improves the physical fitness of the elderly, having a preventive role against the various physiological deteriorations associated with aging and muscle disuse, due to increases in functional capacity that would ensure that this population is removed from the threshold of frailty.

4.5 Quality of Life

Quality of life can be negatively affected with aging, due to deterioration in physical health and functional capacity. Physical exercise contributes to improving the quality of life of older adults by improving psychological health, self-efficacy, and independence, reducing levels of depression.

In conclusion, the degenerative effect of aging at a multisystem level, added to muscle disuse, can reduce the functional capacity of older adults, limiting their daily life activities and negatively affecting their quality of life. This can lead to frailty syndrome and increased risk of contracting chronic diseases. However, physical exercise has been shown to have a protective effect on the different systems, in addition to contributing to the preservation of functionality and self-efficacy,
which is why it has been established as a fundamental tool for healthy aging and as a preventive measure against disease. Despite its potential benefits, physical exercise does not prevent the deleterious effects of aging. However, it plays an important role as a protective agent for both the reserve and the functional capacity of the different systems, delaying a possible frailty and physical disability, which is associated with higher levels of independence, autonomy, and quality of life in older adults.

5. Conflicts of interests.

The authors declare no conflict of interest.

6. References


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