RESISTANCE TRAINING IMPROVES CARDIOVASCULAR HEMODYNAMICS IN OLDER ADULTS: INVOLVING AUTONOMIC BALANCE AND THE IMMUNE SYSTEM

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Abstract

The study evaluated the effects of resistance training on cardiovascular and immune health in older adults. Sixty-nine participants were randomly divided into a control group and a training group, which performed resistance exercises three times a week for 12 weeks. Pre- and post-training assessments included measurements of heart rate, blood pressure, and hemodynamic analysis by impedance cardiography. Inflammatory biomarkers and functional capacity were also analyzed. The results showed that resistance training significantly improved several cardiovascular parameters, such as increased stroke volume, cardiac output, and heart rate variability, in addition to reducing systemic vascular resistance. There were also improvements in respiratory muscle strength and functional capacity, with an increase in the number of repetitions in the sit-to-stand test and elimination of oxygen desaturation during the test. In addition, training promoted positive effects on the immune system, reducing levels of interleukin 6 and tumor necrosis factor alpha, and increasing interleukin 10 and Klotho. It is concluded that resistance training can be an effective intervention to improve cardiovascular hemodynamics, autonomic balance, and immune response in older adults, in addition to improving muscle strength and functional capacity, thus promoting healthier aging.
Keywords: Older Adults; Elderly, Resistance Training; Cardiovascular Hemodynamics; Immune System

INTRODUCTION

Aging is a natural process that involves significant physiological changes in various systems of the human body. As age advances, functional changes occur that affect the body's ability to maintain homeostasis. Among these changes are a decrease in muscle strength, lean mass, and cardiovascular and cardiorespiratory health. Metabolic, hemodynamic, and body composition changes, such as loss of muscle and bone mass, negatively affect the quality of life of older adults, making them more prone to chronic noncommunicable diseases (CHEN et al., 2022).

The immune system also undergoes significant changes with aging, a process known as immunosenescence. This phenomenon includes a decrease in the effectiveness of innate and adaptive immune responses, resulting in a reduced ability to fight infections and a slower and less effective response to vaccines. In addition, aging is associated with a chronic state of inflammation, called “inflammaging”, which contributes to the progression of chronic and cardiovascular diseases in older adults (WEYH, C., KRÜGER, K., STRASSER, B., 2020).

In view of these changes, physical exercise, especially resistance training, has

proven to be an effective intervention to mitigate the deleterious effects of aging on the cardiovascular and immune systems. Therefore, investigating the impact of resistance training on cardiovascular hemodynamics, autonomic balance, and immune response in older adults is essential to develop strategies that promote healthy aging, prevent age-related complications, and increase the longevity of the elderly population.

MATERIALS AND METHODS

Sixty-nine elderly individuals were recruited through social media and the UniEVANGÉLICA project, Open University for the Elderly (UniAPI). After signing a free and informed consent form, they were randomly divided into two groups: a control group with 38 elderly individuals (mean age 69.46 ± 6.24 years) who did not receive specific interventions, and a training group with 31 elderly individuals (mean age 67.13 ± 5.11 years) who participated in a structured physical exercise program. This randomization was essential to ensure the impartiality of the results.

To preserve the integrity of the study and the safety of participants, those with neurological diseases that could interfere with the assessments or the training program were excluded. Inclusion in the study was restricted to older adults between 60 and 85 years of age who completed all assessments and maintained a minimum attendance rate of 75% in the training sessions, ensuring adherence and consistency throughout the study.

The study's resistance training protocol included seven exercises performed in 60-minute sessions, three times a week, for 12 weeks. The first week was dedicated to familiarizing participants with the movements, followed by exercises in 3 sets of 8 to 12 repetitions, with 1 to 2 minute intervals between sets. Loads were adjusted progressively, increasing by 2% to 10% weekly according to the participants' capacity, and intensity was monitored by signs of fatigue. Assessments were performed before the start and 24 hours after the completion of training to measure the effects on the physical and functional parameters of the volunteers.

Before and after the 3-month period, the volunteers underwent measurements of heart rate (HR), blood pressure (BP), cardiovascular hemodynamic analysis using impedance cardiography (Physioflow®, Bristol, USA), while functional capacity was assessed by the 1-minute Sit-to-Stand Test (STS) with monitoring of partial oxygen saturation (SpO2) and number of sit-to-stands performed in 1 minute. Inspiratory

pressures (PIMax) and expiratory pressures (PEMax) were assessed by manovacuometry, and muscle mass was assessed by bioimpedance.

The analysis of pulmonary fibrotic biomarkers was performed by measuring interleukin 6 (IL-6), interleukin 10 (IL-10), tumor necrosis factor alpha (TNF-α), and klotho in the participants' exhaled breath condensate, collected with an RT tube during 15 minutes of breathing at tidal volume. The samples were stored at -86 °C until analysis. Measurements were made with DuoSet ELISA kits, and concentrations were read with the Spectramax I3 microplate reader, ensuring accuracy in the results (Aquino-Santos et al., 2020).

Statistical analysis and graph construction were performed using GraphPad Prism 5.0 software. Paired t-tests were used to compare repeated measurements within the same group over time, while unpaired t-tests were applied to compare initial samples between different groups. The level of statistical significance was set at $p< 0.05$, indicating that values below this threshold would be considered statistically significant.

RESULTS

After 12 weeks of resistance training, several positive effects on the health of the elderly were observed. Cardiovascular hemodynamics showed significant improvements: increased stroke volume ($p < 0.0092$), increased cardiac output ($p < 0.0235$), reduced systemic vascular resistance ($p < 0.0424$), increased end-diastolic volume ($p < 0.0053$), and improved early diastolic function ($p < 0.0398$).

With regard to respiratory muscle strength, training resulted in increases in Maximum Inspiratory Pressure (MIP) ($p < 0.0034$) and Maximum Expiratory Pressure (MEP) ($p< 0.0036$). In functional capacity, the sit-to-stand test revealed an increase in the number of repetitions in 1' ($p < 0.0004$), while desaturation during the test was no longer observed in the training group after 12 weeks of the protocol ($p < 0.0230$).

With regard to the systemic humoral immune response, resistance training significantly reduced levels of Interleukin 6 (IL-6) ($p < 0.0001$), Tumor Necrosis Factor Alpha (TNF-α) ($p< 0.0430$), and increased levels of Interleukin 10 (IL-10) ($p< 0.0001$) and Klotho ($p< 0.0001$). These results indicate a positive effect of resistance training on multiple aspects of immune and cardiovascular health in older adults.

CONCLUSION

Therefore, it could be observed that the 12-week resistance training program improved cardiovascular hemodynamic parameters, autonomic balance, and systemic immune response. It also improved respiratory and peripheral muscle strength, as well as functional capacity in older adults.

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