EFFECTS OF A 12-WEEK SUPERVISED RESISTANCE TRAINING ON QUALITY OF LIFE AND PHYSICAL FITNESS IN OLDER ADULTS: A RANDOMIZED CONTROLLED TRIAL

Xuan Hu[1], Peiyou Chen[1], and Lovro Štefan[2]

[1]*School of Sports Science and Physical Education, Nanjing Normal University, Nanjing, Jiangsu, Peoples R China*
Faculty of Sports Studies, Brno, Czech Republic

Original scientific paper
DOI 10.26582/k.57.2.1

Abstract:

The main aim of the study was to examine the effects of a 12-week resistance training (RT) programme on HRQoL scores and physical fitness components. One hundred and fourteen older adults aged between 60 and 70 years were recruited (mean ± SD; age = 66.2 ± 3.0 years; 48.2% women) and randomly assigned to RT (n = 57; age = 66.0 ± 2.9 years; 48.5% women) or control (CON; n = 57; age = 66.4 ± 3.1 years; 47.9% women) groups. Baseline and follow-up data included Health-related Quality of Life (HRQoL) questionnaire, and Senior Fitness Test. No significant differences in outcome variables between the two groups were observed (p>.05). After a 12-week intervention, RT group improved physical (80.5%, ES = 4.7), psychological (60.2%, ES = 3.0), social (39.1%, ES = 1.5), and environmental (51.7%, ES = 3.9) components of HRQoL. Over the 12 weeks, RT group decreased body-mass index (-9.7%, ES = -0.4), fat mass percentage (-11.4%, ES = -0.6), and visceral fat (-17.2%, ES = -0.8) and increased muscle mass percentage (13.2%, ES = 1.0), muscular (20.9% and 12.4%, ES = 0.7 and 0.4) and cardiorespiratory fitness (7.2%, ES = 0.2), flexibility (62.5% and 34.6%, ES = 0.3), and agility (-14.8%, ES = -1.0). No significant time changes in the CON group were observed. A 12-week RT programme increases HRQoL and overall physical performance in older adults, making RT an effective intervention method for improving broad-spectrum HRQoL and physical fitness components.

Keywords: *geriatrics, intervention, physical performance, quality of life, strength training*

Introduction

Older adults have become one of the major social challenges in the 21st century (Lin, Chen, Tseng, Tsai & Tseng, 2020; Zhou, et al., 2025). Due to medical awareness, improved living standards, and implementing health policies to meet older adults' needs (Araujo de Carvalho, et al., 2017), estimates suggest that the global population of older adults will reach approximately 2 billion, accounting for 33.0% of the population by 2050 (The Lancet Regional Health—Europe, 2023). Because of a demographic shift towards older age and an increased life expectancy (Zhou, et al., 2025), projected socioeconomic patterns include taking advantages from medicine to keep older adults as healthy and active as possible, and to use health care services without restrictions (Iburg, et al., 2023). However, a burden of aging may impact economic growth and productivity of a working population, potentially leading to slower economic development (The Lancet Regional Health—Europe, 2023). Although independent living at older age is encouraging (Holm & Severinsson, 2013), many older adults are still facing major noncommunicable cardiovascular and mental diseases, compared to younger individuals (Le Couter & Thillainadesan, 2022).

Although health benefits of regular exercise to prevent or to control diseases have been well-documented (Langhammer, Bergland & Rydwik, , 2018), older adults with multimorbidity commonly experience poly-pharmacological therapies (Jungo, et al., 2022; Smith, Wallace, O'Dowd & Fortin, 2016). In older adults affected by noncommunicable diseases, the use of pharmacology may lead to acute improvements (Błeszyńska, Wierucki, Zdrojewski & Renke, 2020), yet a prolonged exposure to them may lead to adverse health outcomes, causing an unplanned hospitalization, drug abuse, and increased health care costs (Coleman & Pontefract, 2016). On the other hand, an everyday engagement in physical activity (PA) may naturally improve physical, mental and social health of an individual, directly affecting noncommunicable disease outcomes and well-being (Oliveira, et al., 2020; Saqib, et al., 2020). While being engaged in regular PA has positive impact on health, cognitive functioning, functional capacity and successful aging (Bangsbo, et al., 2019; Zhou, et al., 2025), the prevalence of physical inactivity is constantly rising, especially in people 60 years and older (Strain, et al., 2024). With an increasing age, older adults are at risk of having poor physical performance and higher incidence of falling, fractures and the rate of hospitalization (da Rosa Orssatto, de la Rocha Freitas, Shield, Silveira Pinto & Trajano, 2019).

Resistance training (RT) represents an effective avenue to improve muscle strength and muscle mass, and the components of physical and psychological constructs, and healthy life expectancy (Fragala, et al., 2019). In this type of exercise, muscles must contract against an external load repeatedly, with the implemented rest intervals between each set (Kraemer, et al., 2017). The application of RT has often been recommended for older adults, especially in terms of health-related quality of life (HRQoL) (Canuto Wanderley, et al., 2015; Chang & Chiu, 2020; Ericson, Skoog, Johansson & Wåhlin-Larsson, 2018; Ha & Sung, 2021; Kekäläinen, Kokko, Sipilä & Walker, 2018; Khodadad Kashi, Mirzazadeh, & Saatchian, 2023; Marcos-Pardo et al., 2019; Pirauá, et al., 2019; Ramirez-Campillo, et al., 2018) and physical performance (Lai, Tu, Wang, Huang & Chien , 2018; Makizako, et al., 2020; Vezzoli, et al., 2019; Weng, et al., 2022). However, most recent systematic reviews and meta-analyses have shown mixed findings, where the effects of RT on total score of HRQoL were only trivial-to-small and no significant improvements in strength of lower extremities have been observed (Lu, et al., 2021). Moreover, to our knowledge, little evidence has been provided regarding the effects of RT on HRQoL and physical performance being assessed as simultaneous constructs in older adults (Canuto Wanderley, et al., 2015; Marcos-Pardo, et al., 2019; Pirauá, et al., 2019; Ramirez-Campillo, et al., 2018). By observing such changes, one would expect that improvements in HRQoL may indirectly affect physical performance and *vice versa*; however, the hypothesis has yet to be established.

Therefore, we aimed to observe the effects of a 12-week RT programme on HRQoL and physical fitness parameters in older adults. It was hypothesized that the RT group would increase both HRQoL and physical fitness, opposed to the group without intervention.

Materials and methods

Study participants and trial design

In this randomized controlled study with a paralleled two-group design, we recruited community-dwelling older individuals from three neighborhoods through advertisement strategies in newspapers conducted between April and June 2024. At baseline, 145 volunteers (70 men and 75 women) approached testing to had examined their physical and psychological health status and got approval for further participation. Inclusion criteria included: (i) free-living older adults aged between 60 and 70 years, who were capable to perform everyday activities, (ii) being free of chronic communicable and non-communicable cardio-respiratory, metabolic or mental diseases (severe hypertension, ischemic heart disease, coronary heart disease, congenital heart disease, vein thrombosis or embolism, severe diabetes, neurological disorders, like Alzheimer's or Parkinson's disease, epilepsy, tumor, multiple sclerosis, etc.) that might preclude them from their participation in further exercise and testing, (iii) use of pharmacological drugs, which might have a contraindication effect on the exercise process, and (iv) not being under a supervised RT in the last 12 months, prior this study. Of the initial 145 participants, 31 did not satisfy the inclusion criteria and were removed from further analyses. The final sample is presented in Figure 1. A sensitivity analysis using the G*power calculator showed that by setting the p-value at <.5, statistical power of 1-β = 0.90, with the two groups measured at two time points and the total sample size of N = 114, the achieved effect would be $f = 0.15$. All procedures performed in this study were anonymous and were done in accordance with the Declaration of Helsinki.

Measures

To assess the quality of life, we used the World Health Organization Quality of Life (WHOQOL-BREF) (WHO, 1996), a 26-item questionnaire aiming to examine physical, psychological, social and environmental components of the quality of life. Each question is answered on a five Likert scale from 'not at all/very poor/very dissatisfied/never' to 'completely/very good/very satisfied/always' and is assigned to a certain component. Raw scores were then transformed on a scale from 0 to 20, where a higher score denotes better quality of life. WHOQOL-BREF has been assessed in various populations, and the psychometric properties have indicated acceptable reliability and validity properties (Skevington, et al., 2024). Specific, studies have shown that the reliability of the WHOQOL-BREF exceeds Cronbach's alpha of 0.80 and has acceptable agreement with moderate-strong correlations ($r = 0.26 – 0.73$) with overall quality of life and health satisfaction domains (Kalfoss, Reidunsdatter, Klöckner & NilsenM, 2021).

The level of physical fitness was assessed using the Senior Fitness Test, a simple, easy-to-use battery of tests designed to evaluate motor and functional abilities of older adults (Rikli & Jones, 2013). Tests were initially designed and validated for older

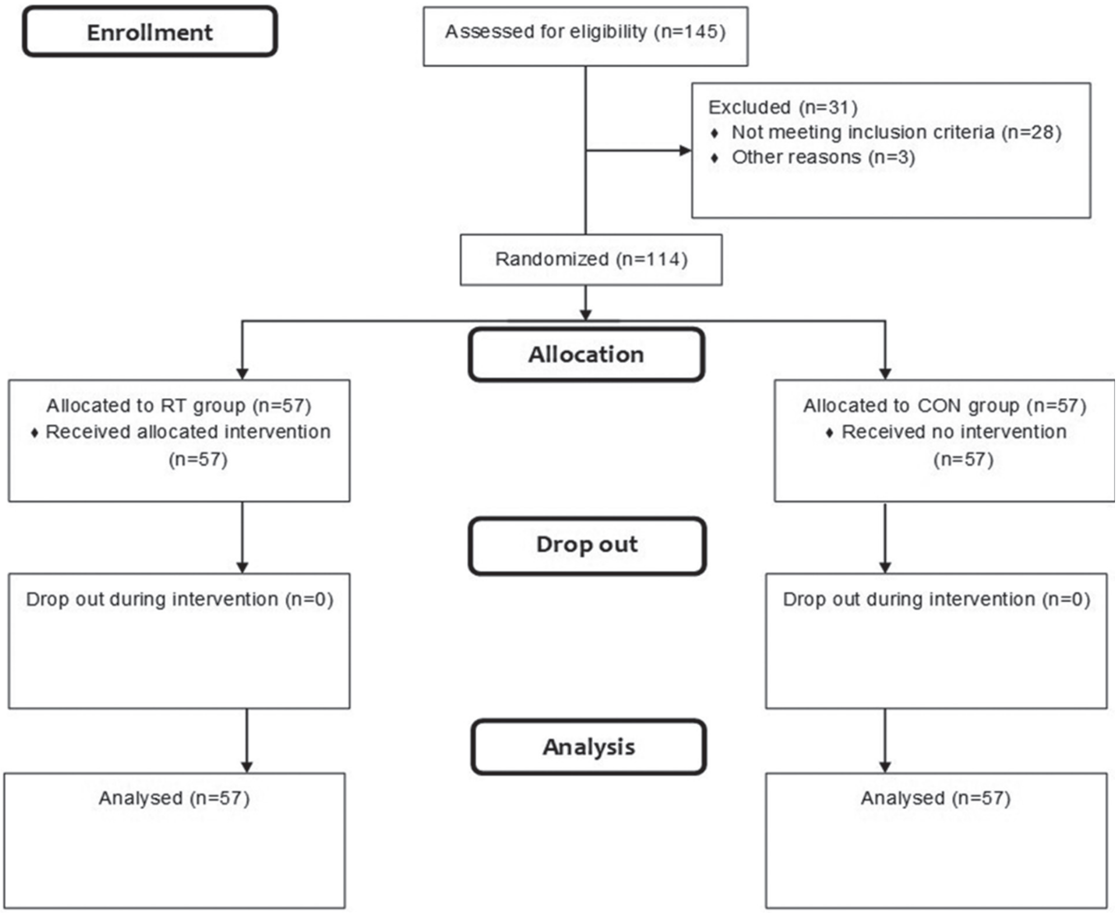

Figure 1. Flow chart diagram of participants' enrolment, randomization and final analysis.

adults at risk of losing movement functionality. As described by Rikli and Jones (2013), the evaluation consisted of seven items covering body size (body mass index), muscle strength of upper (30-second arm curl) and lower extremities (30-second chair stand), aerobic endurance (the 2-minute step test), lower (the chair sit-and-reach test) and upper body flexibility (the back scratch test), and agility and dynamic balance (the 8-foot up and go test). Reliability and validity properties of each test item, along with the testing procedures have been previously described in the Senior Fitness Test Manual (Rikli & Jones, 2013). In brief, Rikli and Jones (2013) stated that the overall reliability of physical fitness tests ranged between 0.93 and 0.98, while the validity properties ranged between 0.79 and 0.97. In addition to body mass index, we measured body composition using the principles of bioelectrical impedance analysis (Omron BF500 Body Composition Monitor, Omron Medizintechnik, Vernon Hills, IL, USA). After entering sex, age and body height, the participants stood barefoot on the metal pads while grasping a pair of electrodes in front of them and holding them for five seconds. Based on pre-programmed equations, the device gave the information regarding fat and muscle mass percentage, and visceral fat (Pietiläinen, et al., 2013).

Intervention group

Exercise training was designed based on the National Strength and Conditioning Association recommendations (Fragala, et al., 2019). This included providing the appropriate feedback for exercise technique and spotting for 2-3 exercises with 1-2 multi-joint exercises per major muscle group (chest, back, legs), and achieving gradual intensities between 70 to 85% of 1-repetition maximum, three times per week. Each exercise session lasted 60 minutes and consisted of a 10-min warm-up period that included both static and dynamic stretching, and exercises of low intensities, like walking on a treadmill or riding a bike on a cycle ergometer, followed by exercises for arms (curl and extension), chest (press), back (seated row and extension), trunk (flexion), and legs (flexion and extension in seated and lying position). During week 0, the participants assigned to the RT group were instructed about the proper lifting techniques of each exercise and were familiarized with the lifting machines by completing around 10 repetitions for a certain muscle group without the external load. During the same session, they were also tested for 1-repetition maximum, to adequately programme the appropriate weight during the intervention process. The 1-repetition maximum was performed three times with a 5-minute rest between the intervals. When the data were collected for all participants, a 12-week intervention was comprised of gradual increases of the percentage of the estimated 1-repetition maximum. Specifically, between weeks 1 and 3, participants completed 3 sets of 10 to 12 repetitions at 70%, followed by an increase at 75% (weeks 4 to 6), 80% (weeks 7 to 9) and at 85% (weeks 10 to 12) of the estimated 1-repetition maximum. They were instructed to avoid extended breath-holding during the repetitions to minimize an increase in blood pressure (Canuto Wanderley, et al., 2015). Approximately one trainer (seven in total) supervised eight participants for their lifting technique and gave feedback during the sessions. After every three weeks, the 1-repetition maximum was measured to ensure that the training stimulus was consistent throughout the following period.

Control group

Like the RT group, the participants assigned to this group were tested at baseline for HRQoL and physical fitness outcomes. During the intervention process of 12 weeks, this group did not participate in any kind of exercise programme and were instructed not to change their lifestyle behaviors (the level of PA, diet, sedentary behaviors, etc.). In the middle of the intervention (week 6), all participants were contacted by telephone to ensure their motivation for staying in the programme. Due to ethical considerations after the intervention period, they were invited to participate in a similar exercise programme designed for them.

Statistical analysis

Data calculations were performed using the Statistical Package for the Social Sciences ver. 26 (SPSS Inc., Chicago, IL, USA). Descriptive statistics [mean and standard deviation (SD)], Kolmogorov-Smirnov (normality of the distribution) and Levene's (homogeneity of variance) tests were calculated for both groups before inferential testing. Changes in HRQoL and physical fitness components following a 12-week intervention between (RT vs. CON group) and within each group (initial vs. final measurement) were tested using repeated measures analysis of variance (RMANOVA) with a two-factor (time x group) model and Bonferroni correction. Cohen *D* effect size (ES) was used to examine the magnitude of the group differences in HRQoL and physical fitness. Cohen's *D* was calculated by dividing the difference between the two group means by their pooled standard deviations as follows:

$$D = (x_1 – x_2)/SD\_pooled.$$

According to Hopkins, Marshall, Batterham & Hanin (2009), ES was classified as: (i) <0.2 (trivial), (ii) 0.2 - 0.6 (small), (iii) 0.6 - 1.2 (moderate), (iv) 1.2 - 2.0 (large), (v) 2.0 - 4.0 (large), and (vi) >4.0 (very large). The Kolmogorov-Smirnov and Leven's tests confirmed that the data were normally distributed and no violation of homogeneity of variance was observed. The significance was set at p<.05 and it was two-sided.

Results

No significant differences in basic sociodemographic characteristics between the groups were observed. Similar proportions of men and women were represented in both groups (Table 1). Higher proportion of men and women were highly educated in RT group and reported better self-rated health as opposed to CON group, although differences remained non-significant (p>.05). Most of the study participants did not meet the PA guidelines and were classified as being sedentary.

Tables 2 and 3 show changes and main effects (time and time x group) on HRQoL and physical fitness. After a 12-week intervention, the RT group improved physical (6.2 units or 80.5%, ES = 4.7), psychological (5.3 units or 60.2%, ES = 3.0), social (4.5 units or 39.1%, ES = 1.5) and environmental (4.4 units or 51.7%, ES = 3.9) components of HRQoL. Over the 12 weeks, the RT group decreased body-mass index (-2.6 kg/m2 or -9.7%, ES = -0.4), fat mass percentage (-3.3% of body fat or -11.4%, ES = -0.6) and visceral fat (-2.8 units or -17.2%, ES = -0.8) and increased muscle mass percentage (3.8% of muscle mass or 13.2%, ES = 1.0), muscular (3.1 and 2.2 repetitions or 20.9% and 12.4%, ES = 0.7 and 0.4) and cardiorespiratory fitness (6.8 repetitions or 7.2%, ES = 0.2), flexibility (2.5 cm and 0.5 cm or 62.5% and 34.6%, ES = 0.3) and agility (-0.9 sec or -14.8%, ES = -1.0). No significant time changes in the CON group were observed.

Discussion and conclusions

The main purpose of the study was to examine the effects of a 12-week RT programme on HRQoL and physical fitness parameters in older adults. As hypothesized, the findings showed significant improvements in HRQoL and physical fitness outcomes in the RT group as compared to the CON group. The largest magnitudes of change are observed for physical, psychological and environmental HRQoL, followed by agility, body composition and muscular fitness.

Findings of this study supported the RT intervention as an effective way of improving HRQoL (Canuto Wanderley, et al., 2015; Chang & Chiu, 2020; Ericson, Skoog, Johansson & Wåhlin-Larsson, 2018; Ha & Sung, 2021; Kekäläinen, Kokko, Sipilä & Walker, 2018; Khodadad Kashi, Mirzazadeh, & Saatchian, 2023; Marcos-Pardo, et al., 2019; Pirauá, et al., 2019; Ramirez-Campillo, et al., 2018). Moreover, it has been well-documented

Table 1. Basic descriptive statistics of the study participants

	Total sample (N = 114)	RT group (n = 57)	CON group (n = 57)	p- value
	Mean (SD) / N (%)	Mean (SD) / N (%)	Mean (SD) / N (%)	
Sex				
Men	59 (51.8)	29 (50.9)	30 (52.6)	
Women	55 (48.2)	28 (49.1)	27 (47.4)	.851
Age (yrs)	66.2 (3.0)	66.3 (3.1)	66.1 (3.0)	.669
Education level				
Primary school	2 (1.8)	0 (0.0)	2 (3.5)	
Secondary school	59 (51.8)	30 (52.6)	29 (50.9)	
Faculty (bachelor)	8 (7.0)	6 (10.5)	10 (17.5)	
Faculty (master's)	1 (0.9)	21 (36.8)	16 (28.1)	.297
Socioeconomic status				
Below average	1 (0.9)	0 (0.0)	1 (1.8)	
Average	105 (92.1)	53 (93.0)	52 (91.2)	
Above average	8 (7.0)	4 (7.0)	4 (7.0)	.604
Self-rated health				
Poor	7 (6.1)	3 (5.3)	4 (7.0)	
Average	96 (84.2)	45 (78.9)	51 (89.5)	
Good	11 (9.7)	9 (15.8)	2 (3.5)	.163
Meeting the PA guidelines				
Yes	24 (21.1)	14 (24.6)	10 (17.5)	
No	90 (78.9)	43 (75.4)	47 (82.5)	.358

Table 2. HRQoL and physical fitness components for the RT and CON groups before and after a 12-week supervised training intervention, mean (SD)

Study variables	RT group (n = 57)				CON group (n = 57)			
	Baseline	Final	Δ (%)	ES	Baseline	Final	Δ (%)	ES
HRQoL								
Physical component	7.7 (1.5)	13.9 (1.1)	80.5%	4.7	8.2 (1.1)	8.2 (1.5)	0.0%	0.0
Mental component	8.8 (1.9)	14.1 (1.6)	60.2%	3.0	9.1 (1.3)	8.8 (1.3)	-3.3%	-0.2
Social component	11.5 (3.3)	16.0 (2.9)	39.1%	1.5	11.7 (1.4)	12.1 (1.4)	3.4%	0.3
Environmental component	8.7 (1.1)	13.2 (1.2)	51.7%	3.9	8.8 (1.2)	8.9 (1.3)	1.1%	0.1
Body composition								
BMI (kg/m^2)	26.9 (4.6)	24.3 (7.3)	-9.7%	-0.4	26.3 (4.3)	26.0 (4.3)	-1.1%	0.1
Fat mass (%)	28.9 (5.3)	25.6 (5.2)	-11.4%	-0.6	28.0 (5.4)	28.1 (5.6)	0.4%	0.0
Fat-free mass (%)	29.5 (3.1)	33.4 (4.8)	13.2%	1.0	30.1 (3.0)	30.6 (3.2)	0.3%	0.2
Visceral fat (score)	16.9 (3.5)	14.0 (3.6)	-17.2%	-0.8	16.2 (3.4)	15.5 (3.3)	-4.3%	0.2
Muscular fitness								
Chair-stand test in 30 s (#)	14.8 (4.8)	17.9 (4.7)	20.9%	0.7	14.5 (3.3)	14.4 (3.5)	0.7%	0.0
Arm curl test in 30 s (#)	17.8 (5.5)	20.0 (4.7)	12.4%	0.4	17.0 (3.7)	16.1 (3.5)	-5.3%	-0.2
Cardiorespiratory fitness								
2-min step test (#)	95.9 (32.5)	102.8 (34.9)	7.2%	0.2	96.1 (32.2)	94.2 (32.0)	-2.0%	-0.1
Flexibility								
Chair sit-and-reach test (cm)	4.0 (9.5)	6.5 (8.9)	62.5%	0.3	4.3 (7.7)	3.6 (7.8)	-16.3%	-0.1
Back scratch test (cm)	-1.3 (8.1)	-0.85 (7.8)	34.6%	0.3	-1.6 (8.8)	-1.5 (9.0)	6.3%	0.0
Agility								
8-foot up and go test (s)	6.1 (0.9)	5.2 (0.9)	-14.8%	-1.0	6.2 (1.1)	6.3 (1.0)	1.6%	0.1

Table 3. Main effects of a 12-week intervention for HRQoL and physical fitness

Study variables	Main effects					
	Time			Time * group		
	F - value	P - value	ES	F - value	P - value	ES
HRQoL						
Physical component	3188.10	< 0.001	0.97	3184.50	< 0.001	0.97
Mental component	1480.41	< 0.001	0.93	1864.40	< 0.001	0.94
Social component	511.17	< 0.001	0.82	342.93	< 0.001	0.75
Environmental component	2326.64	< 0.001	0.95	2214.45	< 0.001	0.93
Body composition						
BMI (kg/m^2)	14.19	< 0.001	0.11	9.562	0.003	0.08
Fat mass (%)	253.85	< 0.001	0.69	289.66	< 0.001	0.72
Fat-free mass (%)	58.05	< 0.001	0.34	32.17	< 0.001	0.22
Visceral fat (score)	588.24	< 0.001	0.84	239.58	< 0.001	0.68
Muscular fitness						
Chair-stand test in 30 s (#)	877.54	< 0.001	0.89	1005.03	< 0.001	0.90
Arm curl test in 30 s (#)	17.52	< 0.001	0.14	85.20	< 0.001	0.43
Cardiorespiratory fitness						
2-min step test (#)	4.66	0.033	0.04	14.30	< 0.001	0.11
Flexibility						
Chair sit-and-reach test (cm)	2504.81	< 0.001	0.96	9718.97	< 0.001	0.99
Back scratch test (cm)	23.39	< 0.001	0.17	22.30	< 0.001	0.17
Agility						
8-foot up and go test (s)	7275.10	< 0.001	0.99	14168.19	< 0.001	0.99

that physical exercise is more strongly associated with physical and psychological HRQoL (Khodadad Kashi, Mirzazadeh, & Saatchian, 2023; Pucci, Neves, Santana, Neves & Saavedra, 2021; Weng, et al., 2022), which is in line with our results. The nature of RT plays an important role in enhancing physical and psychological capacities, indicating that regular participation in PA may have positive effects on engaging in everyday activities without accumulating fatigue and improving self-esteem and body image (Khodadad Kashi, Mirzazadeh, & Saatchian, 2023). Although we found significant increases in all four components of HRQoL, a study by Socha, Frączak, Jonak & Sobiech (2016) showed no changes in environmental component after a 16-week RT intervention programme. This component reflects the possibility of easily assessing and participating in PA, often during leisure time. However, it has been postulated that these concepts may be interrelated to improved functional capacity in physical component of HRQoL (WHO, 1996). Although we observed a strong ES of physical and environmental components, a correlation analysis revealed no significant relation between the two components ($r = 0.04$), indicating different measures of HRQoL. On the other hand, changes in social components of HRQoL due to RT were only moderate, compared to other components. Social determinant of health is described as a stable and enduring construct that changes relatively slowly during a follow-up period (Socha, Frączak, Jonak & Sobiech, 2016). Similar observations have been displayed previously, where changes in social HRQoL are more pronounced during the first three months of RT intervention, after which a decreasing trend towards a 9-month period is observed (Socha, Frączak, Jonak & Sobiech, 2016). In general, continuous participation in an RT programme improves general health, mental health, and social functioning and reduces bodily pain (Hart & Buck, 2019; Khodadad Kashi, Mirzazadeh, & Saatchian, 2023). Potential mechanisms of the RT and HRQoL include physiological changes in neurotransmitters of the brain, which are directly related to mental health constructs (Marquez, et al., 2020). On the other hand, being self-efficient and having more energy after undertaking exercise is linked with greater well-being/life satisfaction and personality traits (Artese, Ehley, Sutin & Terracciano , 2017).

This study also suggested that a 12-week RT intervention beneficially impacted various physical fitness components. RT increases muscle mass, muscle strength and functional capacity, while decreases fat mass in older adults (Canuto Wanderley, et al., 2015; Lai, Tu, Wang, Huang & Chien, 2018; Weng, et al., 2022). A few studies have reported that a progressive RT improves physical function in the chair stand and timed up-and-go performances in community-dwelling older adults with pre-sarcopenia or sarcopenia (Makizako, et al., 2020). Indeed, biological changes related to older age indicate an annual reduction of muscle mass at a rate of 0.9% in men and 0.7% in women and muscle strength at a rate 3%-4% in men and 2.5%-3% in women, respectively (Trombetti, et al., 2016). Although loss of muscle mass is inevitable, an increase of muscle strength may be more important for preservation of functional mobility and physical function (Canuto Wanderley, et al., 2015; Lu, et al., 2021). In the present study, the largest ESs were observed for agility and muscular fitness assessed by the 8-foot up-and-go and chair-stand in 30 s tests, which is in line with previous studies (Canuto Wanderley, et al., 2015; Lu, et al., 2021; Makizako, et al., 2020). Although effort has been made to examine the effects of RT on cardiorespiratory fitness, the data suggest mixed findings, where peak oxygen uptake and the 6-min walk test can be improved, but only in intervention periods shorter than 24 weeks (Smart, et al., 2022). On the other hand, to observe the changes in the 2-min step test can be difficult due to the relatively long performance time and the large range of values an individual can achieve, which can statistically affect the increase of the SD and the reduction of the effect of the intervention. However, previous studies have used the 6-min walk test, which correlates well with the 2-min step test (Poncumhak, Amput, Sangkarit, Promsrisuk, & Srithawong , 2023) and have found that RT tends to improve cardiorespiratory fitness (Canuto Wanderley, et al., 2015; Smart, et al., 2022).

This study is not without limitations. First, we recruited apparently healthy local community-dwelling older individuals aged between 60 and 70 years; therefore, findings might not be generalizable to their medically ill peers of this age or older. Second, more objective methods to assess the level of cardiorespiratory and muscular fitness, and body composition should have been applied. Although the reliability and validity properties of Senior Fitness Tests have been confirmed (Rikli & Jones, 2013), mostly moderate correlations with objective methods might have led to a potential measurement error. Third, we failed to collect blood samples to analyze potential biological changes following the RT.

In summary, the present study showed improvements with large ESs in HRQoL, especially for physical, psychological and environmental components involving RT regime. The RT group also largely decreased fat mass % and increased muscular fitness, agility and flexibility (chair sit-and-reach test), while small-to-moderate ESs were observed for cardiorespiratory fitness, muscle mass % and flexibility assessed by the back scratch test. Thus, the findings provide clear evidence that a 12-week supervised RT programme may be beneficial for overall health outcomes with the largest effects on HRQoL.

References

Araujo de Carvalho, I., Epping-Jordan, J., Pot, A.M., Kelley, E., Toro, N., Thiyagarajan, J.A., & Beard, J.R. (2017). Organizing integrated health-care services to meet older people's needs. *Bulletin of the World Health Organization*, *95*(11), 756-763. https://doi.org/10.2471/BLT.16.187617

Artese, A., Ehley, D., Sutin, A.R., & Terracciano, A. (2017). Personality and actigraphy-measured physical activity in older adults. *Psychology and Aging*, *32*(2), 131-138. https://doi.org/10.1037/pag0000158

Bangsbo, J., Blackwell, J., Boraxbekk, C.J., Caserotti, P., Dela, F., Evans, A.B., …, & Viña, J. (2019). Copenhagen Consensus statement 2019: Physical activity and ageing. *British Journal of Sports Medicine*, *53*(14), 856-858. https://doi.org/10.1136/bjsports-2018-100451

Błeszyńska, E., Wierucki, Ł., Zdrojewski, T., & Renke, M. (2020). Pharmacological interactions in the elderly. *Medicina (Kaunas, Lithuania)*, *56*(7), 320. https://doi.org/10.3390/medicina56070320

Canuto Wanderley, F.A., Oliveira, N.L., Marques, E., Moreira, P., Oliveira, J., & Carvalho, J. (2015). Aerobic versus resistance training effects on health-related quality of life, body composition, and function of older adults. *Journal of Applied Gerontology*, *34*(3), NP143-NP165. https://doi.org/10.1177/0733464812468502

Chang, S.F., & Chiu, S.C. (2020). Effect of resistance training on quality of life in older people with sarcopenic obesity living in long-term care institutions: A quasi-experimental study. *Journal of Clinical Nursing*, *29*(13-14), 2544-2556. https://doi.org/10.1111/jocn.15277

Coleman, J.J., & Pontefract, S.K. (2016). Adverse drug reactions. *Clinical Medicine (London, England)*, *16*(5), 481-485. https://doi.org/10.7861/clinmedicine.16-5-481

da Rosa Orssatto, L.B., de la Rocha Freitas, C., Shield, A.J., Silveira Pinto, R., & Trajano, G.S. (2019). Effects of resistance training concentric velocity on older adults' functional capacity: A systematic review and meta-analysis of randomised trials. *Experimental Gerontology*, *127*, 110731. https://doi.org/10.1016/j.exger.2019.110731

Ericson, H., Skoog, T., Johansson, M., & Wåhlin-Larsson, B. (2018). Resistance training is linked to heightened positive motivational state and lower negative affect among healthy women aged 65-70. *Journal of Women and Aging*, *30*(5), 366-381. https://doi.org/10.1080/08952841.2017.1301720

Fragala, M.S., Cadore, E.L., Dorgo, S., Izquierdo, M., Kraemer, W.J., Peterson, M.D., & Ryan, E.D. (2019). Resistance training for older adults: Position statement from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research*, *33*(8), 2019-2052. https://doi.org/10.1519/JSC.0000000000003230

Ha, S.Y., & Sung, Y.H. (2021). The effect of scapular strengthening exercise using elastic band on balance and quality of life in the old people. *Journal of Exercise Rehabilitation*, *17*(3), 214-219. https://doi.org/10.12965/jer.2142222.111

Hart, P.D., & Buck, D.J. (2019). The effect of resistance training on health-related quality of life in older adults: Systematic review and meta-analysis. *Health Promotion Perspectives*, *9*(1), 1-12. https://doi.org/10.15171/hpp.2019.01

Holm, A.L., & Severinsson, E. (2013). A qualitative systematic review of older persons' perceptions of health, ill health, and their community health care needs. *Nursing Research and Practice*, *2013*, 672702. https://doi.org/10.1155/2013/672702

Hopkins, W.G., Marshall, S.W., Batterham, A.M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, *41*(1), 3-13. https://doi.org/10.1249/MSS.0b013e31818cb278

Iburg, K.M., Charalampous, P., Allebeck, P., Stenberg, E.J., O'Caoimh, R., Monasta, L., Peñalvo, J.L., Pereira, D.M., Wyper, G.M.A., Niranjan, V., Devleesschauwer, B., & Haagsma, J. (2023). Burden of disease among older adults in Europe—Trends in mortality and disability, 1990-2019. *European Journal of Public Health*, *33*(1), 121-126. https://doi.org/10.1093/eurpub/ckac160

Jungo, K.T., Cheval, B., Sieber, S., Antonia van der Linden, B.W., Ihle, A., Carmeli, C., Chiolero, A., Streit, S., & Cullati, S. (2022). Life-course socioeconomic conditions, multimorbidity and polypharmacy in older adults: A retrospective cohort study. *PloS One*, *17*(8), e0271298. https://doi.org/10.1371/journal.pone.0271298

Kalfoss, M.H., Reidunsdatter, R.J., Klöckner, C.A., & Nilsen, M. (2021). Validation of the WHOQOL-Bref: Psychometric properties and normative data for the Norwegian general population. *Health and Quality of Life Outcomes*, *19*(1), 13. https://doi.org/10.1186/s12955-020-01656-x

Kekäläinen, T., Kokko, K., Sipilä, S., & Walker, S. (2018). Effects of a 9-month resistance training intervention on quality of life, sense of coherence, and depressive symptoms in older adults: Randomized controlled trial. *Quality of Life Research*, *27*(2), 455-465. https://doi.org/10.1007/s11136-017-1733-z

Khodadad Kashi, S., Mirzazadeh, Z.S., & Saatchian, V. (2023). A systematic review and meta-analysis of resistance training on quality of life, depression, muscle strength, and functional exercise capacity in older adults aged 60 years or more. *Biological Research for Nursing*, *25*(1), 88-106. https://doi.org/10.1177/10998004221120945

Kraemer, W.J., Ratamess, N.A., Flanagan, S.D., Shurley, J.P., Todd, J.S., & Todd, T.C. (2017). Understanding the science of resistance training: An evolutionary perspective. *Sports Medicine (Auckland, N.Z.)*, *47*(12), 2415-2435. https://doi.org/10.1007/s40279-017-0779-y

Lai, C.C., Tu, Y.K., Wang, T.G., Huang, Y.T., & Chien, K.L. (2018). Effects of resistance training, endurance training and whole-body vibration on lean body mass, muscle strength and physical performance in older people: A systematic review and network meta-analysis. *Age and Ageing*, *47*(3), 367-373. https://doi.org/10.1093/ageing/afy009

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, *4*, 863. https://doi.org/10.3389/fpsyg.2013.00863

Langhammer, B., Bergland, A., & Rydwik, E. (2018). The importance of physical activity exercise among older people. *BioMed Research International*, *2018*, 7856823. https://doi.org/10.1155/2018/7856823

Le Couteur, D.G., & Thillainadesan, J. (2022). What is an aging-related disease? An epidemiological perspective. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *77*(11), 2168-2174. https://doi.org/10.1093/gerona/glac039

Lin, Y.H., Chen, Y.C., Tseng, Y.C., Tsai, S.T., & Tseng, Y.H. (2020). Physical activity and successful aging among middle-aged and older adults: A systematic review and meta-analysis of cohort studies. *Aging*, *12*(9), 7704-7716. https://doi.org/10.18632/aging.103057

Lu, L., Mao, L., Feng, Y., Ainsworth, B.E., Liu, Y., & Chen, N. (2021). Effects of different exercise training modes on muscle strength and physical performance in older people with sarcopenia: A systematic review and meta-analysis. *BMC Geriatrics*, *21*(1), 708. https://doi.org/10.1186/s12877-021-02642-8

Makizako, H., Nakai, Y., Tomioka, K., Taniguchi, Y., Sato, N., Wada, A., Kiyama, R., Tsutsumimoto, K., Ohishi, M., Kiuchi, Y., Kubozono, T., & Takenaka, T. (2020). Effects of a multicomponent exercise program in physical function and muscle mass in sarcopenic/pre-sarcopenic adults. *Journal of Clinical Medicine*, *9*(5), 1386. https://doi.org/10.3390/jcm9051386

Marcos-Pardo, P.J., Orquin-Castrillón, F.J., Gea-García, G.M., Menayo-Antúnez, R., González-Gálvez, N., Vale, R.G.S., & Martínez-Rodríguez, A. (2019). Effects of a moderate-to-high intensity resistance circuit training on fat mass, functional capacity, muscular strength, and quality of life in elderly: A randomized controlled trial. *Scientific Reports*, *9*(1), 7830. https://doi.org/10.1038/s41598-019-44329-6

Marquez, D.X., Aguiñaga, S., Vásquez, P.M., Conroy, D.E., Erickson, K.I., Hillman, C., Stillman, C.M., Ballard, R.M., Sheppard, B.B., Petruzzello, S.J., King, A.C., & Powell, K.E. (2020). A systematic review of physical activity and quality of life and well-being. *Translational Behavioral Medicine*, *10*(5), 1098-1109. https://doi.org/10.1093/tbm/ibz198

Oliveira, J.S., Pinheiro, M.B., Fairhall, N., Walsh, S., Chesterfield Franks, T., Kwok, W., Bauman, A., & Sherrington, C. (2020). Evidence on physical activity and the prevention of frailty and sarcopenia among older people: A systematic review to inform the World Health Organization Physical Activity Guidelines. *Journal of Physical Activity and Health*, *17*(12), 1247-1258. https://doi.org/10.1123/jpah.2020-0323

Pietiläinen, K.H., Kaye, S., Karmi, A., Suojanen, L., Rissanen, A., & Virtanen, K.A. (2013). Agreement of bioelectrical impedance with dual-energy X-ray absorptiometry and MRI to estimate changes in body fat, skeletal muscle and visceral fat during a 12-month weight loss intervention. *The British Journal of Nutrition*, *109*(10), 1910-1916. https://doi.org/10.1017/S0007114512003698

Pirauá, A.L.T., Cavalcante, B.R., de Oliveira, V.M.A., Beltrão, N.B., de Amorim Batista, G., Pitangui, A.C.R., Behm, D., & de Araújo, R.C. (2019). Effect of 24-week strength training on unstable surfaces on mobility, balance, and concern about falling in older adults. *Scandinavian Journal of Medicine and Science in Sports*, *29*(11), 1805-1812. https://doi.org/10.1111/sms.13510

Poncumhak, P., Amput, P., Sangkarit, N., Promsrisuk, T., & Srithawong, A. (2023). Predictive ability of the 2-minute step test for functional fitness in older individuals with hypertension. *Annals of Geriatric Medicine and Research*, *27*(3), 228-234. https://doi.org/10.4235/agmr.23.0070

Pucci, G.C.M.F., Neves, E.B., Santana, F.S.D., Neves, D.D.A., & Saavedra, F.J.F. (2021). Effect of resistance training and pilates on the quality of life of elderly women: A randomized clinical trial. *Revista Brasileira de Geriatria e Gerontologia*, *23*, e200283.

Ramirez-Campillo, R., Alvarez, C., Garcìa-Hermoso, A., Celis-Morales, C., Ramirez-Velez, R., Gentil, P., & Izquierdo, M. (2018). High-speed resistance training in elderly women: Effects of cluster training sets on functional performance and quality of life. *Experimental Gerontology*, *110*, 216-222. https://doi.org/10.1016/j.exger.2018.06.014

Rikli, R.E., & Jones, C.J. (2013). *Senior fitness test manual*. Human Kinetics.

Saqib, Z.A., Dai, J., Menhas, R., Mahmood, S., Karim, M., Sang, X., & Weng, Y. (2020). Physical activity is a medicine for non-communicable diseases: A survey study regarding the perception of physical activity impact on health wellbeing. *Risk Management and Healthcare Policy*, *13*, 2949-2962. https://doi.org/10.2147/RMHP.S280339

Skevington, S.M., Lotfy, M., O'Connell, K.A., & WHOQOL Group. (2004). The World Health Organization's WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial. A report from the WHOQOL group. *Quality of Life Research*, *13*(2), 299-310. https://doi.org/10.1023/B:QURE.0000018486.91360.00

Smart, T.F.F., Doleman, B., Hatt, J., Paul, M., Toft, S., Lund, J.N., & Phillips, B.E. (2022). The role of resistance exercise training for improving cardiorespiratory fitness in healthy older adults: A systematic review and meta-analysis. *Age and Ageing*, *51*(6), afac143. https://doi.org/10.1093/ageing/afac143

Smith, S.M., Wallace, E., O'Dowd, T., & Fortin, M. (2016). Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *The Cochrane Database of Systematic Reviews*, *3*(3), CD006560. https://doi.org/10.1002/14651858.CD006560.pub3

Socha, M., Frączak, P., Jonak, W., & Sobiech, K.A. (2016). Effect of resistance training with elements of stretching on body composition and quality of life in postmenopausal women. *Przeglad Menopauzalny=Menopause Rreview*, *15*(1), 26-31. https://doi.org/10.5114/pm.2016.58770

Strain, T., Flaxman, S., Guthold, R., Semenova, E., Cowan, M., Riley, L.M., Bull, F.C., Stevens, G.A., & Country Data Author Group. (2024). National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: A pooled analysis of 507 population-based surveys with 5.7 million participants. *The Lancet. Global health*, *12*(8), e1232-e1243. https://doi.org/10.1016/S2214-109X(24)00150-5

The Lancet Regional Health—Europe. (2023). Securing the future of Europe's ageing population by 2050. (Editorial) *The Lancet Regional Health—Europe*, *35*, 100807. https://doi.org/10.1016/j.lanepe.2023.100807

Trombetti, A., Reid, K.F., Hars, M., Herrmann, F.R., Pasha, E., Phillips, E.M., & Fielding, R.A. (2016). Age-associated declines in muscle mass, strength, power, and physical performance: Impact on fear of falling and quality of life. *Osteoporosis International*, *27*(2), 463-471. https://doi.org/10.1007/s00198-015-3236-5

Vezzoli, A., Mrakic-Sposta, S., Montorsi, M., Porcelli, S., Vago, P., Cereda, F., Longo, S., Maggio, M., & Narici, M. (2019). Moderate intensity resistive training reduces oxidative stress and improves muscle mass and function in older individuals. *Antioxidants (Basel, Switzerland)*, *8*(10), 431. https://doi.org/10.3390/antiox8100431

Weng, W.H., Cheng, Y.H., Yang, T.H., Lee, S.J., Yang, Y.R., & Wang, R.Y. (2022). Effects of strength exercises combined with other training on physical performance in frail older adults: A systematic review and meta-analysis. *Archives of Gerontology and Geriatrics*, *102*, 104757. https://doi.org/10.1016/j.archger.2022.104757

WHO—World Health Organization. (1996). *WHOQOL-BREF: Introduction, administration, scoring and generic version of the assessment: Field trial version, December 1996 (No. WHOQOL-BREF).* World Health Organization.

Zhou, Y., Sun, Y., Pan, Y., Dai, Y., Xiao, Y., & Yu, Y. (2025). Prevalence of successful aging in older adults: A systematic review and meta-analysis. *Archives of Gerontology and Geriatrics*, *128*, 105604. https://doi.org/10.1016/j.archger.2024.105604

Submitted: ????????????, 2025
Accepted: ????????????, 2025
Published Online First: October 20, 2025

Correspondence to:
Lovro Štefan, Ph.D.
Faculty of Sports Studies
625 00 Brno
Czech Republic
Tel.: 00385-98-9177-060
E mail: lovro.stefan1510@gmail.com