Block strength training improves functional autonomy and quality of life in community-dwelling older women

El entrenamiento de fuerza en bloques mejora la autonomía funcional y la calidad de vida en mujeres mayores que viven en la comunidad

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Abstract

Introduction: Block strength training has been proposed as a useful and practical strategy to reverse the effects of aging in community-dwelling older adults. However, the effects of block strength training based on the nature of exertion on functional autonomy and life quality of older women living in the community are unknown.
Objective: To determine the effects of a Block Strength Training program based on the level of effort on functional autonomy and self-perceived life quality in community-dwelling older women.
Methodology: Eighteen older women (71.1 ± 8.01 years) residing in the community volunteered for the study. The study had a pre-experimental design with pre- and post-tests. The block strength training is 12 weeks and divided into three blocks of 4 weeks each. The study variables were functional autonomy, assessed with the GDLAM protocol, and self-perceived life quality, assessed with WHOQOL-BREF. Differences between pre- and post-intervention were performed using t-tests and Wilcoxon tests, both for related samples ($p < 0.05$).
Results: After applying the 12-week block strength training, 4 of the five tests of the GDLAM protocol showed significant improvements ($p < 0.05$). Likewise, 2 of the four dimensions of the WHOQOL-Bref showed significant improvements ($p < 0.05$).
Conclusions: A Block Strength Training program based on the level of effort significantly improves functional autonomy and self-perceived life quality in older women community residents. Consequently, this methodology is effective and practical for promoting healthy aging in the community.

Keywords

Aging; strength training; gerontology; life quality; old age.

Resumen

Introducción: El entrenamiento de fuerza en bloques se ha propuesto como una estrategia útil y práctica para revertir los efectos del envejecimiento en personas mayores que viven en la comunidad. Sin embargo, se desconocen sus efectos sobre la autonomía funcional y calidad de vida de mujeres mayores que viven en la comunidad.
Objetivo: Determinar los efectos de un programa de un entrenamiento de fuerza en bloques basado en el carácter del esfuerzo sobre la autonomía funcional y la calidad de vida autopercibida en mujeres mayores que viven en la comunidad.
Metodología: Dieciocho mujeres mayores (71,1 ± 8,01 años) residentes en la comunidad se presentaron voluntarias para el estudio. El estudio tuvo un diseño preexperimental con prueba y post prueba. El entrenamiento de fuerza en bloques fue de 12 semanas y se dividió en tres bloques de 4 semanas cada uno. Las variables del estudio fueron la autonomía funcional, evaluada con el protocolo GDLAM, y la calidad de vida autopercibida, evaluada con WHOQOL-BREF. Las diferencias entre antes y después de la intervención se realizaron mediante pruebas t y pruebas de Wilcoxon, ambas para muestras relacionadas.
Resultados: Tras aplicar el entrenamiento de fuerza en bloques de 12 semanas, 4 de las cinco pruebas del protocolo GDLAM mostraron mejoras significativas. Asimismo, 2 de las cuatro dimensiones del WHOQOL-Bref mostraron mejoras significativas.
Conclusiones: El entrenamiento de fuerza en bloques basado en el carácter del esfuerzo mejora significativamente la autonomía funcional y la calidad de vida autopercibida en mujeres mayores residentes de la comunidad. En consecuencia, esta metodología es eficaz para promover el envejecimiento saludable en la comunidad.

Palabras clave

Calidad de vida; entrenamiento de fuerza; envejecimiento; gerontología; vejez.

Introduction

The increase in the population's longevity is a phenomenon that encompasses all countries in the world, and in most communities, people are reaching 80 years of age or older (Amuthavalli et al., 2022). In this context, aging causes a series of challenges, including controlling the progressive loss of muscle mass and strength (sarcopenia) experienced by older people. In fact, increasing and maintaining muscle strength is one of the most relevant physical challenges for professionals working with older people (Hunter et al., 2019). In this regard, there is evidence that loss of muscle strength increases the risk of falling (Carrillo et al., 2024) as frailty, triggering an increase in dependency (Srivastava et al., 2024) and a decrease in the life quality (LQ) of older people (Beaudart et al., 2023). Likewise, from a gender perspective, differences in health status between men and women have been observed (Gallardo-Peralta et al., 2018). Specifically, at the same age, older women (OW) have been reported to have a higher prevalence of disease and physical dependence than men (Grijalva et al., 2024), negatively affecting performance in daily life activities (DLA), functional autonomy (FA), and LQ in this population segment (Bouaziz et al., 2016; Fragala et al., 2019).

The optimal development of DLA is conditioned to older people's physical, mental, and social independence (Romero Ayuso, 2007). The FA is a crucial factor in determining the LQ of older people (Boechat et al., 2007). Indeed, LQ is a broad and complex concept, influenced by the individual's physical health, psychological state, level of independence, social relations, and interaction with the environment (Bautista-Rodríguez, 2017). Therefore, maintaining and improving these aspects is essential for the general well-being of older people. In the face of this, physical exercise acts as an inhibitor of the degenerations associated with aging, allowing the maintenance of the FA (Cortez et al., 2023; Diaz et al., 2019) and improved performance in DLA (Gomes De Souza & Rodrigues, 2014), positively impacting the LQ of older people (Gómez-Rossel & Merellano-Navarro, 2024).

Research has shown that strength training benefits overall health throughout life (Forte et al., 2024). Specifically, in older people, strength training delays the effects of sarcopenia, such as loss of muscle strength, power, and endurance (Zhang et al., 2024), decreasing physiological vulnerability and mitigating its debilitating consequences on physical performance (Fragala et al., 2019). In addition, strength training has been shown to positively affect life quality and healthy life expectancy of this group of people (Khodadad et al., 2022). Despite abundant evidence of the benefits of these programs on older people, participation in them is low, even in developed countries (Cigarroa et al., 2022). This scenario is not very different from what is happening in Chile since, according to the national health survey, more than 87.6% of the population is sedentary (Fernández-Verdejo & Suárez-Reyez, 2021), which may further aggravate the aging process and increase the functional dependence of this population (Benito et al., 2022). This situation could mean that older people cannot conduct prolonged training sessions, mainly due to their reduced FA and physical performance (Papa et al., 2017). However, evidence has shown that physical exercise programs can be developed for the entire population, including community-dwelling older people, regardless of age and physical condition (Fernández-Revelles et al., 2023). For example, resistance training has been shown to produce changes in muscle architecture, including maximal isometric strength, pennation angle, fascicle length, thickness, and muscle activation (de Souza Cordeiro et al., 2023). Block strength training (BST) based on the level of effort, which represents the difference between the repetitions performed and those that could be performed with a given load (Pérez-Bilbao et al., 2021), is favorable for increasing strength and FA in this population (Jofré-Saldía et al., 2023). In fact, Jofré-Saldía et al. (2021) proposed a progressive multicomponent training program to increase functional autonomy through phases and training blocks oriented from the development of strength, aerobic endurance, flexibility, and balance according to the program phase. The sessions of the strength phase were based on the level of effort, obtaining favorable results in isolated tests of functionality and physical performance (Jofré-Saldía et al., 2021).

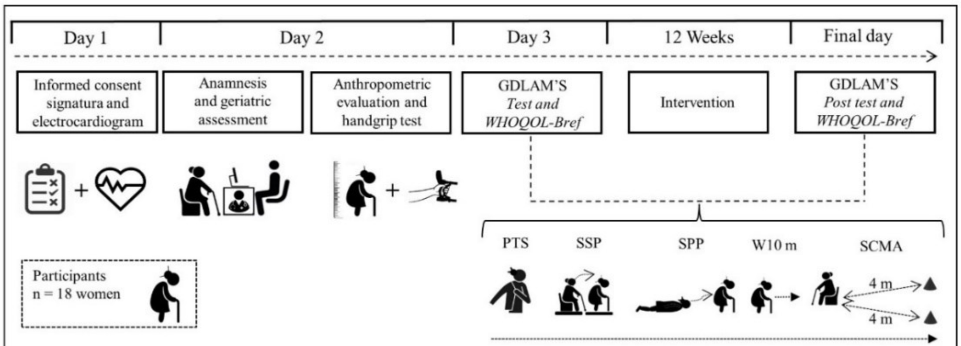
Specifically, a BST based on the level of effort could progressively improve the FA of older people, improving neuromuscular coordination, power, and muscular endurance without the need to fatigue the person. Likewise, this methodology could avoid muscle exhaustion and discomfort during exercise. However, to our knowledge, the effects of strength training based on the level of effort on FA and LQ have not been investigated. Therefore, the objective of the present investigation was to determine the effects of a Block Strenght Training program based on the level of effort on functional autonomy and self-perceived life quality in community-dwelling older women.

Method

Design

The present research considered a pre-experimental design, with pre- and post-test for a single group (Ato et al., 2013). The intervention sequence is detailed in Figure 1.

Figure 1. Research design



GDLAM'S Protocol, Latin-American Development to the Maturity Group; W10 m, walk 10 meters; SSP, stand up from sitting position; SPP, standing up from the prone position; SCMA, to sit and get up from the chair and move around the house; PTS, to put on and take off a T-shirt; WHOQOL-Bref, Quality of Life Questionaire World Health Organization.

Participants

25 OW residents of the commune of Valparaíso, Chile, volunteered to participate in this study. However, five of the 25 OWs enrolled were excluded for medical reasons, and 2 had less than 80% attendance, leaving a final number of 18 participants (71.1 ± 8.01 years). Inclusion criteria were female, over 60.0 years of age, and autonomy to consent and move around. Exclusion criteria were presenting a terminal illness, pre-existing cardiovascular diseases or diseases detected during the electrocardiographic evaluation (ECG), severe pulmonary conditions, fractures in the last three months, neurodegenerative diseases, severe dementia, physical impossibility to perform some of the proposed tests or a negative response to sign the informed consent. All OWs enrolled to participate in the study read and signed the informed consent. The research and the informed consent were approved by the ethical-scientific committee of the Universidad de Playa Ancha (registry 006-2022). Finally, all procedures respected the Declaration of Helsinki (updated in 2013) and the ethical standards for exercise and sports sciences (Harriss et al., 2019).

Procedure

Geriatric assessment

Before applying the BST program, blood pressure (BP) was measured according to the guidelines proposed by Tagle (2018) to rule out arterial hypertension. Also, a cardiovascular evaluation was performed through an ECG. These results, plus the Abbreviated Comprehensive Geriatric Assessment questionnaire conducted by a geriatric physician, allowed OWs to be safely included in the BST program.

Anthropometric measurements

Body mass was determined using a Tanita Inner Scan BC-554® digital scale. Height was assessed using a stadiometer from the feet to the vertex (Frankfurt plane). Body mass index (BMI) was calculated by dividing weight (kg) by squared height (m^2).

Functional Autonomy Assessment

The evaluation of FA was assessed through the Latin American Group for Maturity (GDLAM) protocol. The GDLAM protocol has demonstrated high reliability for evaluating FA in OW (Huerta Ojeda et al., 2024). This protocol considers the following tests (Dantas & de Souza Vale, 2004; Dantas et al., 2014): 1) To put on and take off a T-shirt (PTS), b) Standing up from sitting position (SSP), c) Standing up from the prone position (SPP), d) Walking 10 meters (W10 m), and e) To sit, get up from the chair, and move around the house (SCMA). Each of them performed against time and evaluated in seconds (sec):

PTS: This test assesses the individual's functional autonomy in dressing in daily life. The test determines how long an individual puts on and off a T-shirt. The individual must be standing, with arms at the body's sides and an extra-large size (XL) T-shirt held in the dominant hand. On signal, the participant should put on the T-shirt and immediately remove it, returning to the starting position. The unit of measurement for this test was timed in sec.

SSP: The purpose of the test is to evaluate the functional capacity of the lower extremity and consists of determining the time in sec it takes an individual to stand up and sit down five consecutive times, starting from a seated position on a chair, without armrests, with the seat at 50 cm from the floor.

SPP: This test evaluates the individual's ability to stand up from the ground. It consists of determining the time in sec it takes the individual to stand up. To do this, the individual must start from the initial position in a prone position, with arms along the body. At the "now" signal, the individual must stand up as quickly as possible.

W10 m: This test evaluates the time in sec an individual takes to cover 10 meters without running.

SCMA: This test assesses older people's agility and balance in life situations. With a chair fixed to the floor, two cones should be marked diagonally to the chair, four meters to the back, and three meters to the right and left sides, respectively. The person starts the test sitting on the chair with feet raised off the floor and, at the signal "go," stands up, moves to the right, turns around the cone, returns to the chair, sits down, and removes both feet from the floor, immediately, performs the same movement to the left. This is repeated twice, and emphasis is given to performing it as soon as possible. The unit of measurement for this test was timed in sec.

The results from the five timed tests, measured in sec, facilitated the calculation of the Functional Autonomy Index (GI). The following formula was applied for this purpose (Dantas et al., 2014): $GI = [(PTS + SSP + SPP + W10\ m) \times 2 + SCMA]/4$. For the interpretation of the GI, it should be considered that the lower the score, the higher the FA (Dantas et al., 2014; Marcos-Pardo et al., 2020).

Self-perceived life quality assessment

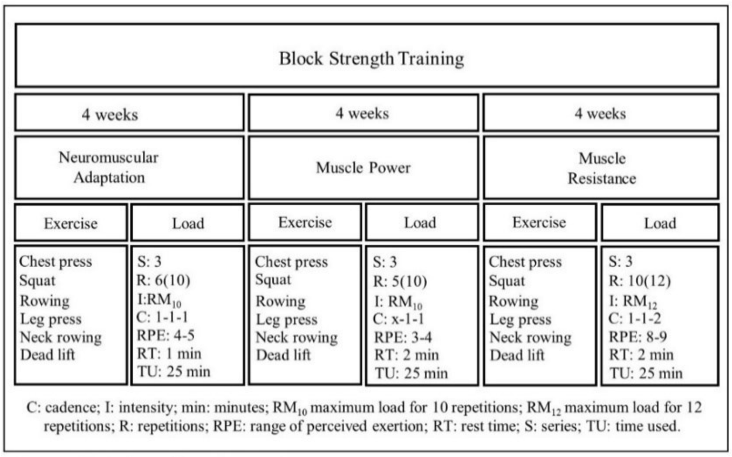
Self-perceived LQ was assessed by using the WHOQOL-BREF (Castro et al., 2014). This questionnaire was created by the World Health Organization's Quality of Life Study Group and consists of 26 questions: two general questions on LQ and satisfaction with health status and 24 questions grouped into four domains: Physical Health, Psychological Health, Social Relations, and Environment (Espinoza et al., 2011). During the questionnaire application, each participant must answer the questions with a Likert scale (between 1 and 5 points). The scores of the domains are then converted according to a score correction table due to the inequality in the number of items, having the possibility to be converted in a range from 0 to 100 or from 4 to 20 (Urzúa M & Caqueo-Urízar, 2013). Higher scores indicate better LQ for assessing self-perceived LQ (Espinoza et al., 2011).

Block strength program

The BST program was based on the multicomponent program proposal by progressive phases of Jofré-Saldía et al. (2021). These blocks were designed according to the functional consequence model for age-related sarcopenia proposed by Hunter et al. (2019), addressing the decrease in strength, power, and muscular endurance. Each block used a maximum repetition number (nRM) percentage to target effects based on potential load volume (Festa et al., 2023; Jofré-Saldía et al., 2022). This evaluation process made adjusting the load individually for each proposed exercise possible. In practice, participants were asked to perform the highest number of repetitions in each proposed exercise at the beginning of each block. The objective was to adjust the weight so that participants could complete a maximum of 10 repetitions (RM_{10}) for blocks 1 and 2 and 12 repetitions (RM_{12}) for block 3. Then, the loading of the different blocks was programmed according to the weight each participant reached in RM_{10} and RM_{12}, respectively, as well as the previously established sets and repetitions (Hernández-Belmonte et al., 2022; Rodríguez-Rosell et al., 2020). This program had a total duration of 12 weeks, divided into three blocks of 4 weeks each. The first block was for neuromuscular adaptation, and its objective was to educate the participants in correctly executing the exercises and methodology. The second block was aimed at developing explosive strength of the upper and lower extremities. Finally, the third block aimed to improve the overall muscular endurance of the participant's upper and lower extremities (Figure 2).

Concerning the intensity of traditional multi-joint exercises, both upper and lower limbs, it has been observed that, to achieve between 10 and 20 repetitions, exercises should be performed between 65 and 75% of 1RM. Consequently, blocks 1 and 2 for this study considered RM_{10}, while block 3 considered RM_{12} (Hernández-Belmonte et al., 2022; Rodríguez-Rosell et al., 2020). In parallel, to adjust the level of effort (LoE) from low to high during the program, both the perceived exertion scale (RPE) of 0-10 (i.e., ≤ 7 and 8-9) and the repetition percentage of each block (i.e., 60, 50 and 83%, respectively) were applied. Finally, the running cadence and tempo for all repetitions were monitored using a metronome. Before implementing the program, the entire intervention team was trained to ensure the correct implementation of each stage. The training sessions were conducted twice a week, in non-consecutive morning sessions and two groups of 10 participants. Each session lasted 60 minutes and was divided into 15 minutes of warm-up, 35 minutes of strength exercises, and 10 minutes of return to calm. The standardized 15-minute warm-up consisted of three sets of exercises: two for joint mobility and one for muscle activation, each lasting 5 minutes. After the warm-up, the OWs began the 35-minute main session, which included 25 minutes of strength exercises and a 10-minute cool-down with active flexibility exercises. Details of the program in terms of exercises and training load are shown in Figure 2.

Figure 2. Block Strength Training Loads.



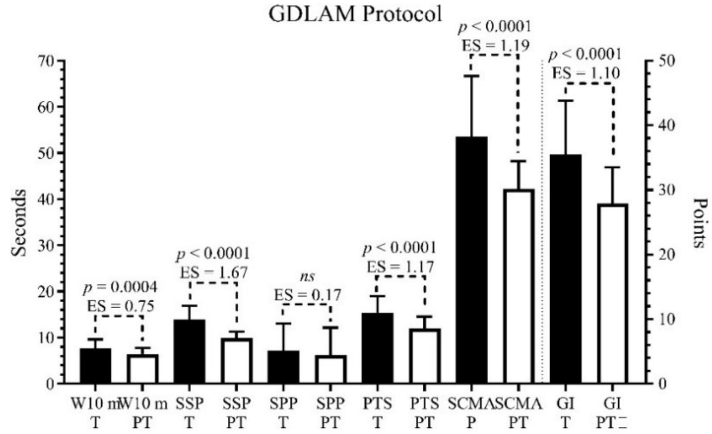
Data analysis

All parameters referred to anthropometry, GDLAM protocol, and WHO-QOL BREF were ordered in a spreadsheet designed for the study. Descriptive data are presented as means and standard deviations. The Shapiro-Wilks test confirmed the data's normal distribution ($p > 0.05$). Differences between the test and post-test were analyzed using the t-test for related samples, while the effect size (ES) was calculated using Cohen's d test. This analysis considered the following values: trivial ($d < 0.2$), small ($d = 0.2$-0.6), moderate ($d = 0.6$-1.2), large ($d = 1.2$-2.0), or very large ($d > 2.0$). The significance level for all statistical analyses was ($p < 0.05$). The data analysis was performed using Prism® version 10.2.0 for Windows®.

Results

The 18 women who completed the BST program had the following characteristics: 71.1 ± 8.01 years old, body mass = 74.3 ± 13.37 kg, height = 1.51 ± 0.07 meters and BMI = 32.6 ± 5.76 kg/m^2.
Concerning the FA results obtained, four of the five tests of the GDLAM protocol and the GI showed significant improvements after the intervention with the BST program ($p < 0.05$). The times and points for the five e GI tests of the GDLAM protocol, respectively, are shown in Figure 3.

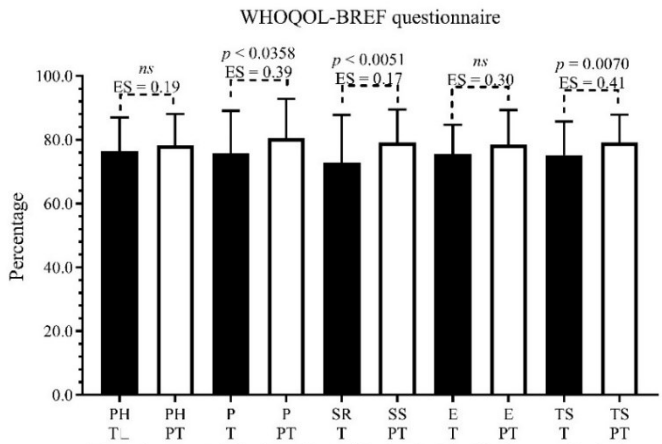
Figure 3. Functional autonomy before and after the implementation of a BST program.



ES: effect size; GDLAM protocol: Latin American Group for Maturity protocol; GI: GDLAM autonomy index; *ns*: non-significative; *p*: *p*-value; BST: Block Strength Training; PTS: to put on and take off a T-shirt; SCMA: sit, get up from the chair, and move around the house; SPP: stand up from the prone position; SSP: stand up from the sitting position; T: test; PT: post-test; W10 m: walk 10 meters.

Concerning the LQ scores obtained, two of the four dimensions and the total score of the WHOQOL-BREF questionnaire showed significant improvements after the intervention with the BST program ($p < 0.05$). Figure 4 shows the percentages of the four dimensions and the total score.

Figure 4. Quality of life before and after the implementation of a BST program.



E: environment; ES: size effect; FH: physical health; P: psycological; SR: social relationships; TS: total score; *ns*: non-significative; *p*: *p*-value; BST: Block Strength Training; T: test; PT: post-test; W10 m: walk 10 meters.

Discussion

The present study aimed to determine the effects of 12 weeks of a BST program based on the level of effort on the FA and LQ of community-dwelling OWs. The main results demonstrate that 12 weeks of 3-block training significantly improves self-perceived LQ and FA in this population.

Strength training and functional autonomy

Concerning strength training and FA, recent studies have reported improvements in FA using overloaded exercises. These methodologies have used machines to generate neuromuscular adaptations (Labata-Lezaun et al., 2023; Moradell et al., 2023). Regarding strength training and FA, recent studies have reported improvements in FA using overloaded exercises. These methodologies have been based on using machines to generate neuromuscular adaptations. Similarly, Concha-Cisternas et al. (2020) determined the effects of a multicomponent physical training program on the LQ of older people. At the end of the six-week intervention, participants reported statistically significant changes in the overall LQ ($p = 0.007$, ES = 0.65) (Concha-Cisternas et al., 2020). Another essential factor to consider is the load's progression during the application of the BST program. In this sense, it is a fact that the loads applied to older people must be goal-directed, individualized, and progressive (González, 2023). Indeed, this load progression in older people allows a gradual development of the FA and maintains the neuromotor capacities, enabling better performance in more complex sessions applied later (Bruderer-Hofstetter et al., 2018).

Concerning the intensity and volume used in the BST program, the resistance of the elastic band, the weight of the implements, and the variation of the program volume were adjusted individually, block by block, respecting the principle of individuality (Izquierdo et al., 2021). In this sense, other research has also carried out a progression of the load (Sadjapong et al., 2020; Vargas Vitoria et al., 2021). Specifically, Vargas Vitoria et al. (2021) adjusted the intensity of the load by changing the resistance of the elastic bands without modifying the training volume. At the end of the 12 weeks of training, the researchers observed increased physical fitness in the older people involved ($p < 0.05$) (Vargas Vitoria et al., 2021). Likewise, Sadjapong et al. (2020) adjusted the intensity of the load by changing the resistance of the elastic bands from 65% of 1RM to 90% of 1RM (they used red, green, blue, and black bands [1-8 kg]). However, the researchers also adjusted the volume of training: Month 1, reps: 8 × 2 set; Month 2, reps: 10 × 3 set; and Month 3, reps: 12 × 3 set, significantly improving physical performance and markers of frailty in older people ($p < 0.05$) (Sadjapong et al., 2020). In this context, the BST program applied in the present study considered a low-effort level (75% de 1RM) and a progression in volume for each block: block 1, reps: 6(10); block 2, reps: 5(10); and block 3: reps: 10(12). In this line, the low effort level and the low number of repetitions that characterized the BST program favored a high adherence to the training sessions. In fact, the OWs who completed the program had 89% attendance to the training sessions. Consequently, this high adherence to the BST program generated significant increases in the FA of the OW living in the community.

Specifically, of the different tests of the GDLAM protocol, the SPP test was the only one in which no statistically significant differences were found ($p > 0.05$). Some tests relate cardiorespiratory fitness to the ability to get off the ground (Borse et al., 2024). Although the third training block was intended to increase muscular endurance levels, it may not have generated changes in cardiorespiratory capacity that could be included in the SPP test performance. However, the relationship of these variables needs further exploration.

Strength training and life quality

Self-perceived LQ was assessed using the WHOQOL-BREF questionnaire, estimating older people's opinions (Castro et al., 2014). The results showed a significant increase in both the total score and the psychological and social relations dimensions in the intervened OWs. These results take on greater relevance if one considers that, at the same age, men present more favorable aging in terms of physical health, mental health, and economic security compared to women. However, women obtain better results in the subjective aspects or satisfaction with the different domains of life quality (Gallardo-Peralta et al., 2018).

From the perspective of the BST program applied and considering the individualization and autonomy in the execution of the exercises, there is evidence to suggest that this type of methodology does not favor social relations, mainly because it limits social interaction during its execution (Verdugo et al., 2021). However, our results showed a significant increase in the social relations dimension ($p < 0.05$). Our hypothesis in this regard is that these increases in the dimension of social relations are mainly due to the group development of the training sessions. Indeed, we tried to make the loads individualized but to make the training sessions group-based. However, the verification of this hypothesis requires further exploration.

Concerning the psychological dimension, it has been shown that physical exercise has beneficial effects on mood (Bonet et al., 2017). In fact, Villarreal-Angeles et al. (2021)reported significant increases ($p < 0.05$) in the psychological dimension after applying a 12-week physical conditioning program based on the Pilates method in older people. In this sense, our results evidenced significant increases in the psychological dimension in the 18 older people who completed the BST program ($p < 0.05$), demonstrating similarity to existing scientific evidence.

In parallel, the environment and physical health showed non-significant increases after applying the BST program ($p > 0.05$). In this context, scientific evidence has shown that multicomponent training can be an appropriate strategy to increase the FA of older people. However, more evidence is still needed to determine the true impact of these trainings on self-perceived physical health (Canto et al., 2022). We understand that psychosocial factors contribute to the adherence and practice of healthy physical exercise for active aging (Marcos Pardo et al., 2001). However, we believe that the low level of effort used in the BST program may have caused participants to underestimate their perception of physical health, mainly due to the belief that more intense exercise is better for health (Marcos Pardo et al., 2001). Finally, concerning the environmental dimension, the evidence shows that physical exercise programs increase their valuation in older people (Ibáñez Pérez et al., 2023). However, our results did not show significant changes in this dimension ($p > 0.05$). Eventually, the socioeconomic and educational stratum may condition this older people dimension (Ibáñez Pérez et al., 2023), but more studies are needed.

Limitations

Although the results presented are encouraging, the sample size limits their generalizability. In addition, the study does not present a control group, which reduces the reliability of the results.

Conclusions

At the end of the study, it was determined that block strength training based on the level of effort significantly improves self-perceived functional autonomy and life quality in community-dwelling older women. Consequently, this methodology could effectively promote healthy aging in the community.

Practical Applications

Although the present study showed increased functional autonomy and life quality in older women, it is suggested that before applying this type of training, a preventive medical check-up should be considered to rule out heart disease, cerebrovascular accidents (CVA), or any other event of these characteristics. Also, to avoid injuries or accidents such as falls, it is essential to maintain adequate and constant supervision of the training sessions. As a complement to the block strength training program, it is suggested that aerobic training be included to increase the cardiorespiratory capacity of older people.

Future lines of research

This research shows that a BST program improves both FA and LQ of community-dwelling older people. Hence, future research should try new and alternative strategies with this training methodology by adjusting the intensity, volume, or lasting of the training loads. Besides, it is essential that, within the study, variables of biochemical markers of cellular oxidative stress, muscular damage, and physical performance are included, such as strength, muscle quality, and even direct oxygen consumption.

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