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Multicomponent elastic training improves short-term body composition and balance in older women

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ABSTRACT

Multicomponent training is an effective modality to prevent and/or counteract certain physical, physiological, cognitive and emotional alterations of aging. Meanwhile, it is still unknown which specific methodological aspects of the training are more effective to achieve a better practical application. Objective: to assess the short-term effects of multicomponent training including some elastic exercises on body composition and balance in healthy older women. Methodology: In two sessions/week for 12 weeks, 24 women performed 4 blocks of exercise in 2 experimental conditions: a) Control Group; b) Multicomponent Training Group (EMC). The following were assessed: % of body fat, static balance in tandem position, static balance raising one leg with eyes open/closed, dynamic balance through the 4 m maximum speed walk test without running. An independent samples t-test was used to determine at the between-group level the effects of the intervention over time on the dependent variables, and a related-samples t-test was subsequently performed to detect possible differences over time. intragroup level. Results: there were significant inter-group differences ($p < .05$) in the variables of balance in tandem, with eyes open/closed and dynamic. Likewise, there were significant intra-group differences with respect to the EMC group in the variables of % body fat and balance with eyes open/closed and dynamic. Conclusion: The multicomponent training protocol including exercises with elastics performed at progressive intensity and volume over time is effective in improving body composition and balance in healthy older women.

Keywords: Physical conditioning, Elastic bands, Quality of life, Physical training.

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INTRODUCTION

There are numerous theories about why and how we age. Spirduso (2005) pointed out that "*aging*" refers to the changes that occur throughout the life of an organism, despite the fact that the rate at which they occur varies considerably between people. Currently, four premises have defined the course of aging according to Strehler (1985): a) Universal: each event linked to aging must take place to a certain extent in all people; b) Intrinsic: the reasons that lead to aging must be endogenous; c) Deleterious: the phenomena linked to the aging process are harmful; d) Progressive: the changes that lead to aging are generated gradually throughout life. Spain has one of the lowest fertility rates on the planet and considerable life expectancy at birth. These facts cause the so-called "*aging of aging*" (Limón & Ortega, 2011). The causes of the increase in life expectancy are education, the work of public health, advances in health care, the substantial decrease in fertility and the entry into old age of the generation of the "*baby boom*" (Murphy, 2017).

Regarding the physiological effects of aging on the musculoskeletal system, it is known that in sedentary people there is a pronounced decrease in muscle strength after 50 years of age, and it deepens after 60 years (Goodpaster et al ., 2001). However, the event through which people lose strength and muscle mass linked to age is called sarcopenia. Throughout life, several factors occur that facilitate its appearance: a) loss of lean mass; b) decrease in type II fibres; c) reduced blood flow; d) infiltration of connective and adipose tissue in the skeletal muscle; e) reduction of motor units; f) myofibril mismatch (Cruz-Jentoft & Sayer, 2019). On the other hand, aging leads to a decrease in bone mass and leads to skeletal weakening in older adults. With age, there is a demineralization of the bone tissue that leads to the distortion of the length of the bones of the lower limbs, as well as the narrowing of the vertebrae (Burr, 2019). Osteoporosis is a condition that arises after a disturbance in the remodelling of bone tissue, caused by the mismatch between bone resorption and bone formation. This materializes in the emergence of micro-structural disorders and especially in a decrease in bone mineral density (Kanis et al., 2019). This weakening of the bones caused by osteoporosis, added to the decrease in muscle mass and strength, leads to loss of balance during walking and increases the risk of falls (Bautista, 2008). High fall rates lead to an increase in the number of injuries, causing morbidity and mortality factors to also increase in the elderly population (Hochberg, 2008). Regarding adipose tissue, the course of aging leads to changes in the % of body fat due to multifactorial causes generated by changes in lifestyle and in the inflammatory system, genetic factors and hormonal changes (Lima et al., 2019) . It should be noted that the reduction in energy expenditure as a result of the decrease in physical activity, together with the deceleration of the basal metabolism, generates an increase in fat mass and weight throughout aging, which means that with the passage of time in a trouble doing physical activity (Cobos, 2017).

Currently, physical activity is essential for good health, in addition to being considered one of the most advantageous factors of lifestyle (Simioni et al., 2018). There are numerous demonstrated health gains in older adults, especially improvement or preservation of cardiovascular function, physical function, balance, flexibility, stability and posture, muscle mass, muscle power and strength , as well as body composition, among other aspects (Galloza et al., 2017). Following the publication "*Position Stand on Physical Activity and Exercise for Older Adults*" by the American College of Sports Medicine (ACSM), the importance of designing training programs for the maintenance and improvement of functional fitness in older adults was emphasized (AM), where exercises that work the aerobic component, strength, balance and flexibility are included, thus forming a multicomponent training program (EMC). Studies such as those by Bouaziz et al. (2016), Freiberger et al. (2012), Leite et al. (2015) and Marques et al. (2011) showed that the EMC practiced regularly presents improvements in the reduction of fat mass, increase in muscle strength, cardiovascular fitness and agility, and therefore, at the level of AM functionality.

Currently, the elastic material stands as a very valid material to carry out physical activity, since it is easy to apply and maintain, portable and inexpensive, allowing to increase, among other physical qualities, power and muscle strength (Aboodarda et al. al., 2016; Colado et al., 2018, 2020). As far as AM is concerned, studies such as the one by Flandez et al. (2020), Fritz et al. (2018) and Gargallo et al. (2018) verify the effectiveness of these devices to enhance isokinetic, isotonic and isometric muscle strength in healthy and ailing HS, for which they advise the use of this type of device in order to increase and preserve musculoskeletal fitness.

For all of the above, the purpose of this study was to analyse the effects of a multicomponent training program with some short-term elastic exercises on body composition and balance parameters in older adults. Our hypothesis is that the application of a short duration multicomponent training program using some elastic exercises will contribute to significantly improve body composition and static and dynamic balance in older adults.

MATERIAL AND METHODS

Participants

24 older adult women (mean age: 67.87 years; mean weight: 70.08 kg) were randomly assigned to two experimental groups [1] control (CG, n = 12); [2] multicomponent exercise (MCE, n = 12). All groups were homogeneous in terms of number, gender, age and weight. The initial characteristics of the participants are presented in Table 1. All the ethical considerations and the work protocols of this study were approved by the Ethics Committee of the University of Valencia (No. H1508742840440), supporting the requirements established in the Declaration of Helsinki. from 1975, revised in 2008. 24 older adult women (mean age: 67.87 years; mean weight: 70.08 kg) were randomly assigned to two experimental groups [1] control (CG, n = 12); [2] multicomponent exercise (MCE, n = 12). All groups were homogeneous in terms of number, gender, age and weight. The initial characteristics of the participants are presented in Table 1. All the ethical considerations and the work protocols of this study were approved by the Ethics Committee of the University of Valencia (No. H1508742840440), supporting the requirements established in the Declaration of Helsinki. from 1975, revised in 2008.

Table 1. Initial characteristics of the studied sample.

Characteristics	GC (*n* = 12)	GEMC (*n* = 12)
Age (years)	67.92 ± 5.68	67.83 ± 3.19
Weight (kg)	68.22 ± 8.30	71.95 ± 16.92
Height (m)	1.57 ± 0.06	1.59 ± 0.07
IMC (kg/m^2)	43.52 ± 5.24	44.98 ± 9.71
Fat mass (%)	40.49 ± 4.49	40.08 ± 7.79

Note. Data are presented as mean ± standard deviation. BMI = body mass index; CG = control group; GEMC = multicomponent training group.

Measures

The analyses of the different variables were carried out in the same municipal activity centres for the elderly in Valencia. The participants attended two weeks before the beginning of the physical intervention program, and two weeks after its conclusion to undergo the evaluations, adhering to the same interval and time period.

Size

Height was verified to the nearest 0.01 cm using a portable stadiometer (Seca T214, Hamburg, Germany).

Weight and body composition

Weight and body composition (fat mass and lean mass) were assessed using the Tanita® BF-350 bioimpedance digital scale (Tanita Corp., Tokyo, Japan). Participants were advised to: a) fast for 12 h the day before the measurement, allowing water consumption; b) avoid intense exercise 12-24 h prior to the test; c) maintain a correct position of feet, body and head when positioning on the apparatus.

Balance

This variable was analysed using three evaluation tests: a) Balance test in tandem position: the participants placed the dominant foot in front and maintained the position as long as they could. The test was scored 0 if they lasted <3 s; 1 point if they held between 3-9 seconds; 2 points if they remained in the correct position for 10 seconds; b) One-legged balance test with eyes open/closed: the participants stood with their arms extended to the sides and then lifted one foot off the ground. Time was stopped if the support foot moved; if the foot suspended in the air touched the ground; if the maximum equilibrium time established in 30 s was reached. The participants first performed the test with their eyes open and then with their eyes closed; c) Dynamic balance test by walking speed: the 4m test at maximum speed extracted from the "*Short Physical Performance Battery*" was used. (SPPB) (Guralnik et al., 1994). The participants ran 4 m at the maximum possible speed without actually running, starting the walk at a reference point located 1 m before the 4 m evaluated and ending it 1 m beyond the stipulated deceleration. Participants were allowed two attempts to familiarize themselves with the test. The best time of both attempts was recorded and coded as follows: a) <4.82 s = 4points; 4.82 – 6.20 sec = 3 points; 6.21 – 8.70 sec = 2 points; >8.70 sec = 1 point; without execution = 0 points). In all the balance measurement tests, a digital stopwatch and a record sheet were used to record the results. Likewise, prior instructions were given to all the participants so that they executed the tests in the best way.

Procedures

Training protocol

The supervised intervention program included 2 weekly sessions of 50 min to 1 hour performed on non-consecutive days (48 hours apart) for 12 weeks. Following the advice of the American College of Sports Medicine, each exercise session was divided into three phases: a) a 10-minute general warm-up; b) 35-40 minutes made up of exercise blocks for balance (static and dynamic), strength (thruster and stride), aerobic and agility (displacements modifying speed, direction and amplitude) and flexibility (active static stretching); c) a cooling phase of 10 minutes. Multi-joint exercises were performed to emphasize major and minor muscle groups (Garber et al., 2011). The participants performed the exercises in the same order. Elastic bands (TheraBand®, Akron, OH, USA) and a metronome were used as equipment.

The intensity and volume of work of the EMC group evolved progressively in each of the blocks: a) balance: the intensity increased by reducing the support points and eliminating the visual component; while the volume was increased by increasing the duration; b) strength: the participants performed 15 submaximal repetitions at moderate intensity. The level of perceived exertion on the OMNI-RES Scale for elastic bands (Colado et al., 2012) progressed from 6-7 (somewhat hard) in the first 4 weeks to 8-9 (hard) in the remaining 8 weeks. Intensity control using this method (which takes into account colour, grip width, and number of bands) has been validated in older adults (Colado et al., 2018). The number of sets per exercise progressed from 3 in the first 8 weeks to 4 sets in the remaining weeks. The speed of execution of the strength exercises was controlled by means of a metronome that marked the cadence (2 s of concentric contraction and 2 s of eccentric contraction). The participants underwent four familiarization sessions prior to the intervention to: i) select the colour, the grip width and the number of bands; ii) adapt to the rate of perceived exertion; iii) Learn the proper technique for exercises. Loads were adjusted weekly to maintain appropriate training intensities by tailoring the colour and number of elastics along with grip width. Training attendance at each session was recorded; c) aerobic and agility: the intensity was increased by increasing the speed of displacement, the amplitude of stride, as well as the number of displacements; f) flexibility: during the training protocol the same exercises and execution times were maintained. Regarding the rest time, 90 s of active rest were allowed between exercises (slow rhythmic rocking of the limbs without using the elastics) in order to increase caloric expenditure and improve the cardiovascular system. As for the break between exercises, the participants had 60 s to hydrate and dry off the sweat.

Statistical analysis

Statistical analysis was performed with commercial software (SPSS, Version 26.0; SPSS Inc., Chicago, IL). All data were reported as mean and standard deviation. The assumption of normality and homogeneity of the dependent variables was verified with the Kolmogorov–Smirnov and Levene tests, respectively. An independent samples t-test was used to determine at the intergroup level the effects of the intervention over time on the variables evaluated (% fat, tandem balance, open eyes balance, closed eyes balance and dynamic balance), and subsequently performed a related samples t-test to detect possible differences over time at the intragroup level. A confidence level of 95% was accepted (significance of $p \leq .05$). Cohen's coefficients (d value) were used as indicators of the size of the effect on intragroup evolution (trivial < 0.2; small 0.2 - 0.49; moderate 0.5 - 0.8; large > 0.8). The percentage of increase/decrease of each variable was calculated with the following formula: % = [(post-test value – pre-test value/pre-test value] x 100.

RESULTS

Twelve weeks of the EMC protocol were sufficient to cause a statistically significant positive effect or trend compared to the control group.

The independent samples T-test indicated that there were significant differences or trends between the following study variables with respect to the control group: a) tandem balance, $t(22) = 1.915$, $p = .07$; b) open eyes balance, $t(22) = 1.926$, $p = .07$; c) eyes closed balance, $t(22) = 2.107$, $p < .05$; d) dynamic equilibrium, $t(22) = -2.149$, $p < .05$. There were no statistically significant differences between groups with reference to the baseline mean values of the different dependent variables.

Table 2. Effects of the intervention on the dependent variables.

Variable	Group	Initial	Post-test	Δ%	Size effect *d*
Fat mass (%)	GC (*n* = 12)	40.44 ± 4.49	41.34 ± 4.83**+**	2.23	-0.19
	GEMC (*n* = 12)	40.08 ± 7.79	38.55 ± 7.60**+**	-3.82	0.20
Balance Tandem(s)	GC (*n* = 12)	1.75 ± 0.45	1.75 ± 0.45	0.00	0.00
	GEMC (*n* = 12)	1.92 ± 0.29	2.00 ± 0.00**^**	4.17	0.39
Balancing Eyes Open (s)	GC (*n* = 12)	20.06 ± 10.99	17.77 ± 10.79**+**	-11.42	-0.21
	GEMC (*n* = 12)	16.26 ± 9.88	25.84 ± 9.72**+^**	58.92	0.98
Balance Eyes Closed(s)	GC (*n* = 12)	4.35 ± 2.65	3.56 ± 2.34**†**	-18.16	-0.32
	GEMC (*n* = 12)	5.57 ± 5.39	9.28 ± 9.11***†**	66.61	0.49
Dynamic Balance(s)	GC (*n* = 12)	2.06 ± 0.26	2.24 ± 0.26**†**	8.74	-0.69
	GEMC (*n* = 12)	2.22 ± 0.27	2.04 ± 0.20***+**	-8.11	0.76

Note. Data are presented as mean ± standard deviation. Δ% = percentage change from pre to post-test; CG = control group; GEMC = multicomponent training group; *Significant differences between groups (p ≤ .05); +Significant intragroup differences (p ≤ .05); ^Statistically significant trend between groups (values between 0.06 and 0.12); †Statistically significant within-group trend (values between 0.06 and 0.12). Cohen's coefficients (d-value): trivial < 0.2; small 0.2 - 0.49; moderate 0.5 - 0.8; large > 0.8.

The EMC group presented the following dissimilarities or significant trends on the dependent variables over time: a) % body fat, t(11) = 4.389, $p < .05$; b) open eyes balance, t(11) = -3.136, $p < .05$; c) eyes closed balance, t(11) = -1.938, p = .08; d) dynamic equilibrium, t(11) = 2.109, p = .06. The changes in the variables analysed at different times of the study are presented in Table 2.

DISCUSSION

The main and novel finding of the present study was that the EMC executed with elastics produced improvements in the values of % body fat, static and dynamic balance. The AM of the EMC group managed to significantly reduce the % body fat compared to their previous values by 3.82%. For its part, the CG significantly increased this same parameter by 2.23%. However, no significant differences were found at the intergroup level, possibly due to the short duration of the study.

The results obtained regarding body composition coincide with those obtained by Marques et al. (2011) where the participants of the EMC group manage to reduce the % of body fat possibly due to the aerobic component that this protocol incorporated. Another investigation led by Villarreal et al. (2012) studied AM with obesity by subjecting them to a 12-week CME protocol. This research group pointed out significant differences in the % of body fat, concluding that this protocol is beneficial to improve the motor functionality of the AM due to the increase in muscle mass and reduction in fat mass. Finally, Bouaziz et al. (2016) in their systematic review concludes that the EMC facilitates functionality and health, in addition to generating improvements at the metabolic level in the AM.

Regarding static balance, improvements were achieved in this study. If the effects of training in the EMC group are compared, a trend towards improvement of 4.17% is observed in the tandem balance test with respect to the CG. On the other hand, the balance test with open eyes produced a significant difference at the intragroup level (EMC, 58.92% improvement) and a tendency to improve with respect to the CG (11.42% worse). Regarding balance with eyes closed, the EMC improved by 66.61%, establishing a significant difference with respect to the CG and a tendency to improve at the intragroup level. The CG worsens 18.16%, generating a negative trend with respect to the previous measure.

To date, studies such as Toraman, Erman & Agyar (2004) in which a 9-week MA CME program was applied support our results of improved balance. Another investigation that supports our findings is that of Freiberger and collaborators (2012). In this study, an EMC protocol with AM was applied where the balance was analysed in the short and long term, finding significant differences. Freiberger and collaborators (2012) evaluated the incidence on the reduction of falls, however, they could not point out significant dissimilarities. In contrast to the findings of the previous study on falls, the research by Cho et al. (2018) applied an EMC protocol for 8 weeks in AM, achieving significant effects on balance at the intragroup level, as in our study. Thanks to this improvement, Cho et al. (2018) achieved a significant difference by reducing the level of risk of falling from high to low in 22 of the 53 participants.

In reference to dynamic balance, our study reflects that the EMC group reduced the time invested in running the 4-meter walk at maximum speed by 8.11%, reaching a significant difference at the intragroup and intergroup level compared to the CG. This worsened by 8.74%, reaching a worsening trend at the intragroup level.

In the study carried out by Leite et al. (2015) the dynamic balance was evaluated through the 7 m walk test at maximum speed. As in our research, Leite et al. (2015) managed to record improvement results after a

12-week EMC protocol. Another investigation led by Forte et al. (2013) analysed the dynamic balance of the participants through a 10 m walk test at maximum speed. The results after 12 weeks of intervention applying EMC generated a significant effect of improvement in dynamic balance, supporting our thesis. Finally, the study by Ferreira et al. (2018) supports our findings regarding dynamic equilibrium. Ferrera et al. (2018) evaluated the dynamic balance in AM after 12 weeks of EMC intervention through the 4 m walk test at maximum speed with a round trip. In summary, a short-term supervised CME program that includes elastics has a positive impact on the walking speed of the AM, which facilitates the improvement of their functionality and quality of life.

Finally, the present investigation has some limitations that must be taken into account when trying to draw conclusions based on the evidence. The results presented in this study are specific to healthy older women, so they should not be extrapolated to other populations. In addition, the small sample size of the groups was another limitation. Lastly, we did not control or assess daily physical activity levels or nutritional intake, although our participants were asked to maintain their usual daily activities throughout the study period and not to change their nutritional habits. Future studies should be carried out applying and comparing other physical exercise protocols.

CONCLUSIONS

Our results show that a 12-week progressive EMC training protocol using elastics can significantly improve short-term body composition in healthy AMs by decreasing % body fat, which could improve their metabolic health. These results reveal a possible dose-response relationship, although we found no significant differences between groups. More research is warranted in this regard. In addition, we observed a significant improvement in the balance tests with eyes closed and eyes open, along with a trend towards improvement in the tandem balance test. Due to this, these improvements can be positively linked with the prevention of the risk of falls, which would avoid possible injuries and morbidities in the MA. Finally, this study establishes significant positive differences in the dynamic balance of healthy AMs by improving the recorded times. However, the benefits previously reported for static balance in conjunction with an improvement in walking speed have a positive correlation with respect to an increase in longevity and quality of life of people.

AUTHOR CONTRIBUTIONS

All authors have contributed positively in the research design, data collection, paper writing and paper revision.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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