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PROGRAM EFFECTS OF STRENGTH EXERCISE IN THE BALANCE AND PROPRIOCEPTION IN ELDERLY

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ABSTRACT

The study evaluated the acute and chronic effects of strength training on the balance and proprioception of lower limbs (MI) in the elderly. Eleven volunteers participated and performed 12 weeks of training. An increase in strength was observed in all tests (p<0.05), but there was no difference in the acute response for the area of displacement of the center of pressure (CP) (p=0.59 and 0.65 - right MI (MID) and left (MIE), respectively). The same occurred after 12 weeks of training (p=0.95 MID and 0.50 MIE). For the anteroposterior displacement of the CP, there was no acute difference, but there was a chronic difference (p=0.01). There were also no differences in proprioception (p=0.15 acute; p=0.41 chronic).

Key words: Elderly. Lower member. Proprioception. Training.

RESUMO

Efeitos de um programa de exercícios físicos de força no equilíbrio e propriocepção em idosos

O estudo avaliou os efeitos agudo e crônico do treinamento de força sobre o equilíbrio e a propriocepção de membros inferiores (MI) de idosos. Participaram 11 voluntários que executaram 12 semanas treinamento. Foi observado aumento da força em todos os testes (p<0,05), porém não houve diferença na resposta aguda para a área de deslocamento do centro de pressão (CP) (p=0,59 e 0,65 - MI direito (MID) e esquerdo (MIE), respectivamente). O mesmo ocorreu após 12 semanas de treinamento (p=0,95 MID e 0,50 MIE). Para o deslocamento anteroposterior do CP, não houve diferença aguda, mas constatou-se diferença crônica (p=0,01). Também não houve diferenças na propriocepção (p=0,15 aguda; p=0,41 crônica).

Palavras-chave: Idoso. Membro inferior. Propriocepção. Treinamento.

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INTRODUCTION

Aging is linked to numerous physiological changes, such as musculoskeletal changes, muscle wasting, cartilage degradation, and bone weakening.

It can also be emphasized reduction of elasticity, distensibility, and dilation of the arteries of the elderly, composing a cardiovascular scenario that differs greatly from that of a healthy young person. This context corroborates the occurrence of frailty syndrome, falling from one's height - one of the greatest geriatric medical concerns, especially due to damage to the locomotor system that is expected during senility, as well as comorbidities (Motta, 2014).

The regular practice of physical exercises has positive effects on muscle mass and strength, providing better physical functioning (Binotto, Lenardt, Rodríguez-Martínez, 2018).

Therefore, the relevance of physical exercise to beneficial changes in the physiology of the elderly, also confirmed by the improvement of the lipid profile, the provision of more functional pulmonary activity to the individual and the increase in the peripheral circulation. Besides, regular physical exercise containing activities that are related to balance, strength, and coordination, can minimize the risks of falling from one's height in this population (American College of Sports Medicine, 2009).

Investigation of falling in the elderly population is of such importance that the diagnoses should address even falls that occurred months before, as they can cause serious harm to the patient even in apparently harmless occurrences (Porto, 2001).

Therefore, as the basis of the studies of Machado (1985), in this maturational phase, there is an impairment of central nervous system functions in the processing of vestibular, visual and proprioceptive signals, responsible for maintaining body balance. By presenting a proprioceptive loss, thus, there is an increase of the threshold for the detection of the movement, which hinders the accurate reproduction of joint movements (Alfier, 2008).

Streit et al., (2011) observed in 230 physically active seniors that the chance of falling for those with a "Poor" rating for lower limb muscle strength was 2.66 times higher than for those with a "Good" rating.

It is noteworthy that, to understand the occurrence of falls, decreasing balance and altering proprioception are a priority in identifying the origin of the fall. This may be due to maladjustments either of the central and/or peripheral nervous system - via the musculoskeletal system - or by drug interactions or even by reduction of visual acuity (Goldman, Schafer, 2017). In this study, we aimed at the proprioceptive analysis of patients.

Nascimento et al., (2012) observed progress in the body balance of 9 elderly men and women who went through proprioceptive training for 4 weeks. This analysis was based on decreased body oscillations during the Romberg test - with eyes open and closed on stable soil and with eyes closed on unstable soil. There was also an evolution of balance on the Berg scale.

According to Lopes (2008), impairment of the proprioceptive system may trigger deficits in neuromuscular joint stability, facilitating the occurrence of postural destabilization and, therefore, injuries - confirming the relevance of proprioceptive training.

Eckardt (2016) when performing power training with different intensities, observed an increase in motor capacity in their strength and balance modalities. On the other hand, Schlicht et al., (2001) performed a strength training for 8 weeks in which was observed an improvement in muscle strength and consequent progress in the maximum walking speed test.

However, the study suggests that strength training does not alter the static balance on active older adults.

Therefore, the aim of this study was to evaluate the acute and chronic effect of strength training on bodybuilding, as well as the interference with static balance and lower limb proprioception in the elderly.

MATERIALS AND METHODS

All volunteers signed the Informed Consent Form, authorizing their participation in the study, which was approved by the Research Ethics Committee of the Federal University of Ouro Preto (UFOP), through the Official Letter No. 011/2012 (CAAE). 0079.0.238.000-11).

Sample

Initially, 32 volunteers from the Resistance Exercise and Aging project, from

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the UFOP Sports Center, were submitted to an evaluation containing information about personal data, disease history, and daily life. Screening was performed among the project participants, excluding those who had lower limb osteoarticular deformities, arthritis, arthrosis, rheumatism, labyrinthitis and other health compromises that could submit the volunteer to some injury or that could compromise the data of the present research. Fifteen individuals were selected and then anthropometric data (body mass, height, and BMI) was assessed, in addition to recording resting heart rate, systolic (SBP) and diastolic blood pressure (DBP) (Guedes, Guedes, 2004).

Procedures

After sample characterization procedures, the volunteers were evaluated regarding static balance, proprioception, and muscle strength.

To study lower limb muscle strength, two tests were used: a) Estimation of 1-RM (one-repetition maximum) (Brzycki, 1993), in which the volunteer, after a brief muscle warm-up - specific to the movement to be tested - performed up to 10 repetitions with the estimated maximum load for those repetitions.

If it exceeded 10 repetitions or could not complete at least 6 repetitions, the load was adjusted and after a 2-minute rest, a new attempt was made. From the results found, 1RM was estimated for each volunteer (estimated 1RM = weight raised (Kg) / 1.0278-0.0278 X, such that X is the number of repetitions performed).

This test was applied three times: before the first training session, to estimate the maximum muscle strength and establish the training load; after completing 6 weeks of training, readjusting the load; and 48 hours after the last session, at the end of week 12, to revaluate maximum muscle strength.

The test was applied to five lower limb devices used in training sessions (leg press, hip adductor chair, hip abductor chair, knee flexor chair, calf bench). And b) sit-up test, in which, for 30 seconds, the volunteer should sit and stand up from a chair as many times as possible, without the help of the hands to perform the movement (Gustavsson, et al., 2000).

The application of this test occurred before the first training session and 48 hours after the last session.

Static proprioception test was performed according to the protocol established by Lutz, Thompson (2003).

A Leighton® flexometer was placed on the volunteer's ankle and, with the help of the researcher, the elderly should extend the knee to an angle of 45º. Subsequently, he was asked to perform the movement alone for three consecutive times, seeking to achieve the angulation previously mentioned.

The analysis of the data obtained in this test was performed from the average of the three attempts. Static proprioception testing was applied before and after the first training session - to verify the acute effect of a strength training session - as well as 48 hours after the last training session - by analyzing the long-term effect.

To study the levels of static balance, the unipodal support test (adapted from Bohannon) (Bohannon, 1994) was used, in which the volunteer raised one leg, bending the knee, for 10 seconds, on a stabilometry/force platform (EMG System Brazil), which maps the center of pressure oscillations in the anteroposterior and mid-lateral directions, and which results in the center of pressure displacement area in cm^2.

The test was reproduced on both lower limbs and occurred at two times: before and after the first training session and 48 hours after the last exercise session.

The training sessions were performed at the Bodybuilding Laboratory and consisted of five lower limb exercises (leg press, hip adductor chair, hip abductor chair, knee flexor chair, calf bench) and five upper limb exercises (bench press, pulley, barbell dumbbell, triceps, lateral raise).

The training was circuit-shaped, with 30 seconds of stimulation for every 30 seconds of recovery, with two sets per training session, with an intensity of approximately 60% of estimated 1RM and twice weekly. At the end of 12 weeks of training, there were 11 volunteers, four men and seven women, who obtained frequency of training, greater than or equal to 80%, which criterion was used for data analysis.

Statistical Analysis

Data are presented as mean ± standard error and the acquisition and processing of the equilibrium test data were performed using BIOMEC 400 software. Statistical analysis of the results was

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performed using SPSS 18.0, in which the Student's t-paired test was performed, comparing balance and proprioception measurements taken before and after the first exercise session - as an acute effect - and before and after 12 weeks of training - the chronic effect. For the variable “muscle strength”, Student's t-test was also performed before and after 12 weeks of training. The significance level adopted was ≤ 0.05.

RESULTS

The sample consisted of 15 individuals, who had the following characteristics: age 64.4 ± 1.3 years; body mass 68.9 ± 3.4 kg; height 160.2 ± 2.3 cm; BMI 26.4 ± 0.9 kg/m^2; HR 67 ± 2.6 bpm; SBP 126 ± 3.7 mmHg; and DBP 80 ± 1.6 mmHg.

We studied whether resistance training of the lower limbs promoted increase in strength. Table 1 shows the results found for muscle strength in the 1RM tests estimated for the different lower limb exercises and for the sit-up test, comparing the data from before and after 12 weeks of bodybuilding training. Difference was observed for the estimated 1RM tests in all equipment: leg press (p=0.001); hip adductor chair (p=3.79E-06); hip abductor chair (p=3.65E-06); knee flexor chair (p=1.94E-05); calf seat (p=1.96E-05). The results observed for the sit-up test expressed improvement in performance after 12 weeks of training (p=0.005).

Table 1 - Estimated 1RM Test Results and the Sit and Lift Test. Values expressed as Mean and Standard Error, * (p<0.05 compared to Pre-Training).

	1RM Test (Kg)					(repetition numbers)
	Leg press	Abductor	Adductor	Calf	Flexor	Sit and Stand up
Before training	53,15±15,56	35,77±10,58	32,69±10,53	38,69±15,62	37,69±9,71	16,2±3,66
After training	57,15±16,31*	40,00±10,41*	36,92±10,32*	43,46±16,76*	42,31±10,53*	20,9±2,87*

Figure 1 covers the results of the unipodal support test (static balance) for lower limbs (right and left), comparing data from before and after a strength training session (acute effect), and before and after 12 weeks of strength training in bodybuilding (chronic or training effect).

There was no difference for acute effect (p=0.59 and 0.65 - right and left lower limb, respectively) and the same behavior was observed in the center of pressure displacement area for chronic effect (p=0.95 and 0.50 - right and left lower limb, respectively).

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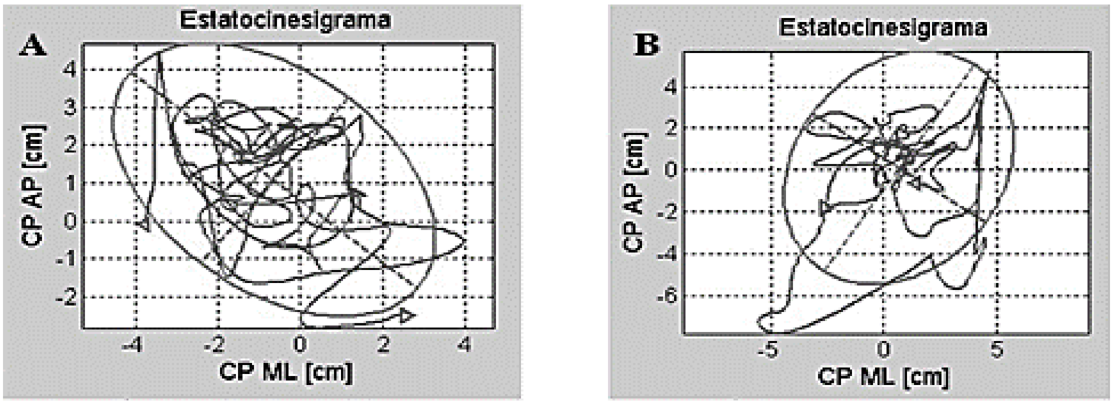

Figure 1 - Displacement areas of othe center of pressure in the unipodal support Test; A) Left limb. B) Right member.

There was no difference in the displacement of the center of pressure in the anteroposterior direction measured before the first training session (3.66 ± 2.04 cm for the left lower limb and 2.49 ± 2.01 cm for the right lower limb; p=0.09), when compared with the results measured after the first training session (2.27 ± 0.88 cm for the left lower limb and 1.84 ± 1.17 cm for the right lower limb; p=0.08). However, after 12 weeks, there was a difference (p=0.01) in the displacement of the center of pressure in the anteroposterior direction (1.07 ± 1.21 cm for the left lower limb and 0.81 ± 1.17 cm for the left Right lower limb - p = 0.01).

In Figure 2, A and B show the displacement area of the center of pressure during the unipodal support test of the left and right lower limbs, respectively, of the same individual. The pictures shown illustrate the results of a volunteer before training sessions.

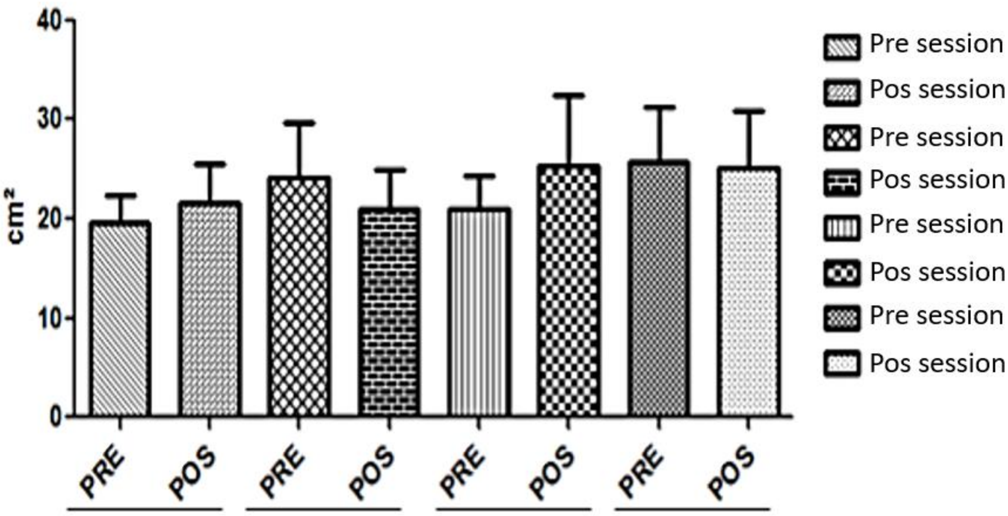

Figure 2 - Unipodal Support Test; Values expressed as mean and standard error.

The results of the lower limb proprioception test are expressed in Figure 3. No difference was observed after the first training session (p=0.15) or after the 12 weeks of training (p=0.41).

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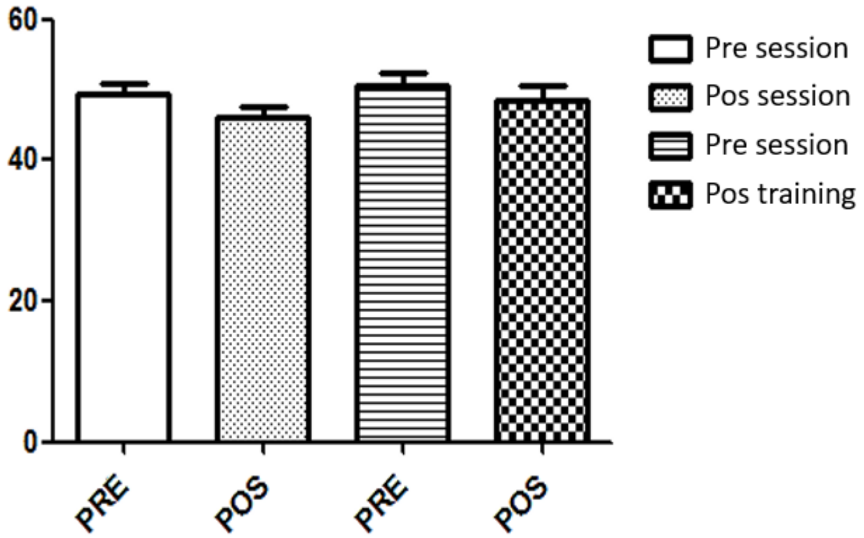

Figure 3 - Lower Limb Proprioception Test; Values expressed as mean and standard error.

DISCUSSION

Although aging is inherent to the human condition, degeneration linked to this phase can be minimized, in order to provide better quality of life for the elderly (Drummond, Paz, Menezes, 2018).

Therefore, strength training is beneficial for this population, and it is valid that its practice is disseminated and recommended.

Studies such as Lee et al., (2019) have demonstrated the ability of the elderly to adapt to practices such as strength training, with increased muscle strength, power and muscle mass (hypertrophy) even after 60 years old.

However, it is necessary that health professionals are adequately trained and qualified to deal with the peculiarities of this population, so that they obtain promising results and do not expose the elderly to exacerbated demands of the osteoarticular system.

From this perspective, the effects of 12 weeks of strength training on elderly members of the UFOP Resistance Exercise and Aging Extension Project were analyzed.

At the end of training, there was a significant increase in lower limb strength of 12.5% on average, considering the five lower limb exercises (leg press 7.9%; hip abductor chair 13.2%; adductor chair 14.9%, calf seat 13.8%, and knee flexor chair 12.5%). Thus, it is evident that the training methodology employed promoted the development of muscle strength, corroborating what Chodzko-Zajko et al., (2009) observed.

Eckardt (2016) analyzed changes in muscle strength after 12 weeks of training at different exercise intensities (20, 50 and 80% of 1RM) and found increased lower limb muscle strength in all groups, suggesting that even at low intensities, training can provide muscle strength gain in the elderly.

Schlicht et al., (2001) showed that individuals who trained at a weekly frequency of three workouts for eight weeks with an intensity of 77.8% of 1RM also produced increased muscle strength.

Regarding static balance, there was no difference in the displacement area of the center of pressure (p=0.59 for right lower limb; p=0.65 for left lower limb) right after the first training session (effect acute exercise).

Lelard, Ahmaidi (2015) reported a relationship between static balance and the number of falls suffered by the elderly, so that the deficit in static balance is positively related to a higher probability of falls.

The fact that no difference in static balance was observed after the training session can be interpreted as a positive effect, since training with a load of approximately 64% of 1RM was effective to increase muscle strength and did not reduce static balance after training, which could increase the likelihood of falling (Tomicki, et al., 2016).

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Significant improvement (p=0.01) of anteroposterior balance for both lower limbs was also observed.

Toledo, Barela (2010) report that the elderly oscillates more in the anteroposterior direction than young individuals and that this instability may increase the risk of their falls of. Changes in balance may be due to the aging process itself, due to visual loss, for example, as it is worth highlighting.

Factors such as age, gender and BMI are possible influencing the elderly's ability to balance (Rebelatto, et al., 2017). However, the methodology proposed for this study places each volunteer as their own control, allowing to disregard these factors that could intervene.

Another possible influencing variable would be muscle strength, which presents controversial results in the literature.

Eckardt (2016) observed that strength training improves balance in elderly individuals, especially at low intensity and faster movement execution (20% of 1RM).

In contrast, Schlicht et al., (2001) pointed that after an 8-week intervention of strength training (77.8% 1RM) there was an improvement in muscle strength (p<0.017), without, however, observing changes in static balance.

It is noted that the data from this study are in agreement with Schlicht et al., (2001), a study that found strength improvement without changes in static balance.

Although Silva et al., (2010) observed in active individuals a higher level of balance than in sedentary individuals, Eckardt (2016) pointed out that it is possible that the most relevant factor for preventing falls in the elderly is not muscle strength.

Thus, this prevention can be achieved with a higher velocity of muscle fiber shortening, as this speed can be a critical determinant in preventing falls.

The last variable analyzed was proprioception, which also showed no significant changes, either acute (p=0.15) or chronic (p=0.41).

Alfieri (2008) suggests that with advancing age there is a tendency to increase the threshold for motion detection, which would make it difficult to accurately reproduce joint movements.

Lanuez et al., (2011) mention that exercises with emphasis on proprioception lead to a significant increase in balance capacity, however Brandalize et al., (2011) point out that the gains obtained through training are lost with the interruption of such practice. This study suggests that there is no relationship between muscle strength gain with training and proprioception.

The major limitation of this study was the fact that some volunteers also performed other physical exercises, since the Project they took part, is an arm of Third Age Program of UFOP, which offered other activities besides strength exercises.

Thus, among the 11 volunteers who completed the 12 weeks of training, one volunteer practiced volleyball, one shuttlecock and volleyball, two gymnastics and volleyball, and three gymnastics, while the others participated only in weight training classes.

By separating the volunteers into two groups, one group that performed only weight training and one that trained weight training and other activities, no difference was observed in the results of the sit-up test (p=0.902) or in the equipment (p>0,05) - except for the calf bench, where a higher performance was found in the estimated 8RM test for the group that performed more than one activity (p=0.053).

Regardless of the other activities performed, the increase in strength observed after 12 weeks of training did not influence the static balance and proprioception parameters.

CONCLUSION

Training increased strength motor capacity, which was verified from the estimated 1RM and sitting and standing tests.

As for static balance, there was no change in the displacement area of the center of pressure soon after the first training session (acute effect) or at the end of 12 weeks (chronic effect).

However, an improvement in the displacement of the center of pressure in the anteroposterior direction was noted - which was observed only after 12 weeks, whereas the values remained with no distinct result for the acute effect. Proprioception was unchanged, either chronic or acute.

Therefore, it is suggested that studies should focus on exploring strength training with different intensities being used in training, which could bring significant interference results in the acute and chronic effects of training. In addition, we highlight the validity of a study that recruited volunteers who were not previously regular physical activity practitioners - which may have interfered with the results of

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this research through a long-term effect on the muscles, balance and proprioception of the elderly already exposed to exercise.

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