

Elderly strength training.

*Francisco Gonçalves**; *José Santos***; *Ágata Aranha****; *Paulo Mourão***

*: Maia Institute of Higher Education; Research Centre in Sports Sciences, Health Sciences and Human Development; Research Centre in Sport and Physical Activity; Sport Pedagogy Scientific Society.

** : Maia Institute of Higher Education.

***: Research Centre in Sports Sciences, Health Sciences and Human Development; Sport Pedagogy Scientific Society.

Abstract

With aging, muscles and bones are getting weaker that induce a decrease of strength, balance and mobility. A decrease of muscle mass is associated with the incapacity to realize the daily routine activities. On this way the strength training can be an effective method to promote a save walk in this population increasing muscle mass and strength. The main purpose of this study was to identify the modifications induced by a strength training programme by improving the maximal strength. Our sample consisted of seven old females (means of age: 70.43 ± 6.00 years). The protocol consisted of a nine weeks programme to stimulate the principal muscle groups with a progressive increase of intensity (60%-85% of one maximum repetition). During the implementation of the program, maximal strength scores were taken at the end of each tree weeks period, to see the evolution thought the nine weeks. The ANOVA for repeated measures evidenced significant gains in strength at every evaluation moment of the programme ($p < 0.05$). The participants increased significantly the levels of maximum strength at all muscular groups stimulated by training. There has been a significant statistic improvement in all conventional machines to develop the strength training program.

Keywords: Elderly; Exercise; Strength Training.

1. Introduction

The amount of muscle mass and the ability to produce strength decreases with age. The muscular malfunctions imply a dependence stage on other people. Nevertheless the strength training has been used as a means to reduce and prevent a sarcopenia (Roubenoff, 2001).

As time goes by, muscles and bones get more and more fragile; resulting on strength, balance and mobility reduction, likewise the decline of muscular mass is associated with the incapacity of performing daily activities. Since there are a considerable number of senior citizens, which is still on the go and that lead a sedentary lifestyle, the practise of exercise may work as away to compensate the diminishing of the functional abilities (Mazzeo & Tanaka, 2001).

Several writers have emphasized the benefits of applying strength training programs on individuals of different ages, including the elderly ones (Cavani *et al.*, 2002; Kell, Bell & Quinney, 2001). The final outcome is a functional improvement of both the skeleton and muscle as well as for the bone tissue, allowing a decrease in falls and making it possible a better performance in the daily activities of the individuals who endure such strength programs. The strength training is usually defined as the training where the resistance against which the muscle generates strength is gradually increased in due time (Carter *et al.*, 2001).

The muscular atrophy may come from a selective lost of muscular fibres, that seems to be more stressed in the rapid fibres, mainly due to the lack of exercise. This lost may be related to the reduction of the maximum levels of strength associated to the aging process, which may lead to huge difficulties in accomplishing the different daily activities and bring with it significant consequences associated to the functional skills (Lamoureux *et al.*, 2003; Tarpenning *et al.*, 2004).

The lost of muscular strength of the inferior members is connected to the falls, lack of mobility and walking ability. Whereas the lost of strength of the superior members is associated with the difficulties in performing personal tasks in the daily life. Like this, it is necessary a minimum level of arms' and legs' strength to perform the different daily activities (Hughes *et al.*, 2001).

The strength training may work as an effective means of promoting a safe locomotion for elderly people, inducing strength and muscular mass gaining, improving the functional ability of the senior population. It can, therefore, revert or soften the atrophy of type two fibres through progressive and high intensity training (Westhoff, Stemmerik & Boshuizen, 2000).

The strength training of the inferior members had as final outcome a significant increase of the walking speed, regarded by several authors as an important factor to take into account to reduce the risk of falling.

Despite all the benefits which it can be associated with, the strength training must follow certain principles. It must be progressive, individualized, inducing stimulus to the main muscle groups involved in daily activities. The exercises should be performed with a moderate intensity, in its maximum extent, in a slow, controlled manner and followed a rhythmic breathing thus ensuring the absence of any respiratory blockade, since it has direct influence in the high pressure rising (Gauchard *et al.*, 2003).

The extending muscles of the spinal column have a huge role in the elderly autonomy, in fact, the strongest sustaining muscles of the vertebral column imply getting less tired in work and a bigger independence in what concerns performing activities such as coming up and down the stairs, getting dressed and undressed and doing your own personal hygiene specially in the lower parts of your body (Frontera *et al.*, 2000).

Therefore, the exercise, specially the strength training, have proved to be effective in reverting or at least delaying the loss of muscular strength, improving the functional ability, reducing the risk of falling among the senior citizens and allowing them the autonomous performance of daily activities (Tarpenning *et al.*, 2004).

The number of people aged above 65 years old, commonly named as elderly, have been on the rise among our population, thus the importance of determine in what way the regular practise of physical activity can improve health, the functional ability, the independence and the quality of living of such population (Izquierdo *et al.*, 2004).

Therefore it was put forward the following hypothesis:

H¹: There are significant gaining of maximum strength after establishing a strength training program to an elderly group.

2. Methodology

It was involved in these study seven Portuguese participants, female without a regular practise of physical exercise. It was made an Anamnesis sheet about several aspects of particular order to characterize the sample and establish the inclusion and exclusion criteria. It is necessary putting aside participants with severe clinical problems to reduce the risks during the training programs

The individuals were placed in the sample according to the inclusion criteria, namely, aged between 65 and 80 (including), without serious balance problems, without any experience in strength training. As far as the exclusion criteria it was taking into account the medical diagnostic of neurologic decoders, cognitive disturbances, and the administrations of medicines which might interfere with the balance levels, muscular and skeleton disorders and hypotension. This study consisted in setting a strength training program of nine weeks.

All procedures were ethically approved and recognized by an Institutional Review Board and were carried out as specified. The participants consent about all the experimental procedures, according to Helsinki Declaration, defined in United Nations Declaration, as the model for the conduct of research in which humans are participants. The data analyses accomplished appropriate participants permissions.

Before starting the training programs it was held a meeting where the responsible monitors gave to the sample group of people the main aims of the study and the following evaluation tests they would have to do later on. Each elderly has decided whereas he/she should take part in the study by giving his/her oral agreement. Next they were taken on a visit to the facilities that were going to be used later on their training program. Before starting the exercise program, the participants gave the figures referring to the maximum strength they could achieve in each working machine (1 RM).

This evaluation method is supported by the methodology which has been used by several authors who have performed studies with the elderly to determine the evolution of muscular strength after the training programs.

Furthermore, before starting the training program, the group, has experienced a two weeks learning period to get familiar with the techniques of performing and adjustment to the training exercises. This procedure was necessary so that the nine weeks training could start after the suitable learning of the technical procedures by the participants.

Generally the literature considers high intensities as the ones performed above 80% of 1 RM (Swank *et al.*, 2002). Those performed at 50% - 60% of 1 RM are classified as of moderate intensity and finally those inferior or equal to 40% of 1 RM are regarded as of low intensity (Swank *et al.*, 2002). Therefore the intensity of the strength training program is placed

between moderate and high since its intensity starts on the 60% and goes up progressively until 85%.

The participants were submitted to a strength training program that little by little reached the 85% of maximum weight, in which resistance, strength and flexibility was worked.

The training sessions took place in the facilities of UTAD, each elderly was followed individually throughout the several training sessions by a specialized monitors.

During training the participants were divided into working groups with a supervisor for each group, allowing, like this, a more personalized tutoring. This working method made possible that while performing their tasks they were at the same time building a pleasant working atmosphere with a close control by the supervisor and a continuous interaction between all the participants.

We have tried that the elderly performed the exercises in a slow, controlled manner, followed by a rhythmic breathing, always avoiding the respiratory blockage (due to its influence in rising the levels of blood pressure) (Schlicht, Camaione & Qwen, 2001).

The execution techniques of all movements and exercises were a constant worry in the feedbacks given by the monitors during the development of all training sessions.

According to different authors the strength training should be performed twice a week or three times a week, eight to ten exercises, two to three series of eight to twelve repetitions each (Izquierdo *et al.*, 2004).

The strength training program used in the sample, which promote the muscular hypotrophy by increasing progressively the charges, was divided into three mesocycles. Each of them with a three week lasting which corresponded to six training sessions (twice a week). The number of series was the same for each exercise in the three mesocycles. Therefore, in the first session of each month it was performed two series, in the remaining sessions it was accomplished three

series. In the first mesocycle the charge intensity was of about 60% of 1 RM, with ten to twelve repetitions; in the second mesocycle it was of 70% to 75% of 1 RM with a volume of eight to ten repetitions and in the last and third mesocycle the intensity was about 80% a 85% of 1 RM, performing six to eight repetitions.

In what concerns the program sessions, they were made by a warming up and general mobilization period, including a hike and stretching exercises. The main part of the session was about the performance of a circuit of ten muscle up exercises, two of them were done with their own body weight (abdominal reinforce and hyper stretching of the chest), occasional free weight lifting (shoulders rising) and the remaining exercises in conventional machines namely the leg's press, the supine, leg's pushups, the latissimus, the leg's stretching, *military press* and pushups. The use of such resistance machines allowed not only the controlled accomplishment of the movement with the suitable posture, but also allows fitting the load to the muscular group as well as the person, obeying like this to the overload. Choosing the circuit training allows both a better session organization and makes it easier for the elderly to understand the different exercises. Furthermore the circuit work allows a better control of the recovery time, which is of outmost importance at this age.

The participants were evaluated at the level of maximum strength in all machines in four different moments, aiming making the necessary adjustments to the training loads to reach the aiming intensities.

3. Results

The assiduity of the members of the two groups of the sample that endures the programs of exercises was high; the people included in the sample have reached more than 80% of

assiduity in trainings. Throughout the exercise programs there were no muscular or skeleton injuries.

In what concerns the exercise in the leg's press, the group has started a training program with values of 1 RM of 86.07 Kg. The outcome of the training development allowed to increase the values from 1 RM of 86.07 Kg to 125.28 Kg. It were identified significant statistic differences between the evaluation moments (1° vs 3°, 1° vs 4°, 2° vs 3°, 2° vs 4°, 3° vs 4°) ($p<0.05$).

As far as the supine exercise is concerned, the group started the training program with values of 1 RM of 32.14 Kg. The outcome of the training development allowed to increase the values from 1 RM of 32.4 Kg to 45.71 Kg. It were identified significant statistic differences between the evaluation moments (1° vs 3°, 1° vs 4°, 2° vs 3°, 2° vs 4°) ($p<0.05$).

In connection to the leg's stretching exercise, the group has started a training program with values of 1 RM of 42.14 Kg. The outcome of the training development allowed to increase the values from 1 RM of 42.14 Kg to 58.57 Kg. It were identified significant statistic differences between the evaluation moments (1° vs 2°, 1° vs 3°, 1° vs 4°) ($p<0.05$).

Regarding the latissimus exercise, the group has started a training program with values of 1 RM of 37.14 Kg. The outcome of the training development allowed to increase the values from 1 RM of 37.14 Kg to 45.71 Kg. It were identified significant statistic differences between the evaluation moments (1° vs 4°) ($p<0.05$).

Concerning the leg's pushups exercises, the group has started a training program with values of 1 RM of 30.71 Kg. The outcome of the training development allowed to increase the values from 1 RM de 30.71 Kg to 40.00 Kg.

Referring to the exercise of *Military Press*, the group has started a training program with values of 1 RM of 28.57 Kg. The outcome of the training development allowed to increase the values from 1 RM of 28.57 Kg to 42.14 Kg.

Concerning pushups, the group has started a training program with values of 1 RM of 20.71 Kg. The outcome of the training development allowed to increase the values from 1 RM of 20.71 Kg to 24.29 Kg.

4. Conclusions

The participants increased significantly the levels of maximum strength at all muscular groups stimulated by training. There has been a significant statistic improvement in all conventional machines to develop the strength training program.

Considering the shown results we have to accept the hypothesis H¹, that is: *There are significant gaining of the maximum strength after applying a strength training program to an elderly group.*

These changes meet the results shown in several studies which account that strength training brings gaining of maximum strength among the elderly population (Hughes *et al.*, 2001; Lamoureux *et al.*, 2003; Rosário *et al.*, 2003).

Previous studies which have applied the high intensity strength training to elderly groups have accounted for gaining of strength similar to the ones observed in the present study (Rosário *et al.*, 2003; Swank *et al.*, 2002).

Nevertheless the intensity used in this study has been progressive and the training program has started on the intensity grounds of 60% of 1 RM, finishing with 85% of 1 RM. Therefore this program is not considered exclusively of high intensity level as it is held by the above

authors, on the contrary this program sets roots on a training program which ranges from moderate to high intensity.

From the four moments of evaluation of maximum force (1 RM) the applied intensities were always different. Thus, between the first and second evaluation moments, the members of the group of strength training have always been working at a 60% of 1 RM, between the second and third evaluation moments they have been working between 70% to 75% of 1 RM, and between the third and fourth moment they have been working at about 80% to 85%. However, with the exception of pushups, that from the third to the fourth moment did not allow us to identify progresses, the maximum strength gaining was always (bit by bit) in the remaining machines rather progressive.

These data suggest that both levels of intensity, moderate and high, were effective to allow gaining of maximum strength. Besides these data emphasize one of the most recent suggestions concerning strength training in the elderly, which held that training in a low to moderate intensity is so effective as training at a high intensity, to a level of induction of strength gaining in the elderly population (Gauchard *et al.*, 2003; Mazzeo & Tanaka, 2001).

One determinant factor to the increase in the strength gaining, besides the training in itself, is the neural adjustments occurred in the first weeks of training. These adjustments are related to an increase in the usage/activation of the mobility units, which are responsible for the gaining verified at the beginning of the training program, especially if the participants don't have any experience whatsoever in the strength training.

It is also important to draw your attention to the fact that none of the participant has endured any injury during all the training process. This fact is largely due to the two familiarize weeks previous to the beginning of the training program and the security measures always strictly followed.

As a conclusion we might say that the present study has confirmed that the elderly may endure moderate to intense programs of training (when followed all the safety measures) and that the strength level increases in fact the levels of maximum strength among this population. To sum up, we have witnessed that a program of progressive intensity increased significantly ($p < 0.05$) the levels of maximum strength at the end of a period of nine weeks.

5. References

- Carter, N., Khan, K., Petit, M., Heinonen, A., Donaldson, M., Janssen, P., Mallinson, A., Riddell, L., Kruse, K., Prior, J. & McKay, H. (2001). Results of a 10 week community based strength and balance training to reduce fall risk factors: randomised controlled trial in 65-75 year old women with osteoporosis. *British Journal of Sports Medicine*, 35 (5), pp. 348-351.
- Cavani, V., Mier, C., Musto, A. & Tummers, N. (2002). Effects of a 6-week resistance-training program on functional fitness of older adults. *Journal of Aging and Physical Activity*, 10, pp. 443-452.
- Frontera, W., Hughes, V., Fielding, R., Fiatarone, M., Evans, W. & Roubenoff, R. (2000). Aging of skeletal muscle: a 12-yr longitudinal study. *Journal of Applied Physiology*, 88, pp. 1321-1326.
- Gauchard, G., Tessier, A., Jeandel, C. & Perrin, P. (2003). Improved muscle strenght and power in elderly exercising regularly. *International Journal of Sports Medicine*, 24, pp. 71-74.

- Hughes, V., Frontera, W., Wood, M., Evans, W., Dallal, G., Roubenoff, R. & Singh, M. (2001). Longitudinal muscle strength changes in older adults: influence of muscle mass, physical activity, and health. *Journal of Gerontology: Biological Sciences*, 56A (5), pp. 209-217.
- Izquierdo, M., Ibañez, J., Aakkinen, K., Kraemer, W., Larrion, J. & Gorostiaga, E. (2004). Once weekly combined resistance and cardiovascular training in healthy older Men. *Medicine & Science in Sports & Exercise*, 36 (3), pp. 435-443.
- Kell, R., Bell, G. & Quinney, A. (2001). Musculoskeletal fitness, health outcomes and quality of life. *Sports Medicine*, 31 (12), pp. 863-873.
- Lamoureux, E., Sparrow, A. Murphy, A. & Newton, R. (2003). The effects of improved strength on obstacle negotiation in community-living older adults. *Gait and Posture*, 17, pp. 273-283.
- Mazzeo, R. & Tanaka, H. (2001). Exercise prescription for the elderly. Current recommendations. *Sports Medicine*, 31 (11), pp. 809-818.
- Rosário, J., Villani, G., Harris, J. & Klein, R. (2003). Comparison of strength-training adaptations in early and older postmenopausal Women. *Journal of Aging and Physical Activity*, 11, pp. 143-155.
- Roubenoff, R. (2001). Origins and clinical relevance of sarcopenia. *Canadian Journal of Applied Physiology*, 26 (1), pp. 78-89.
- Schlicht, J., Camaione, D. & Qwen, S. (2001). Effect of intense strenght training on standing balance, walking speed, and sit-to-stand performance in older adults. *Journal of Gerontology. Medical Sciences*, 56A (5), pp. M281-M286.

- Swank, A., Funk, D., Bailey, C., Pinkham, K. & Soldner, K. (2002). Cardiovascular and subjective responses to one- and three-repetition maximum strength testing. *Clinical Exercise Physiology*, 4 (2), pp. 96-100.
- Tarpenning, K., Hamilton-Wessler, M., Wiswell, R. & Hawkins, S. (2004). Endurance training delays age of decline in leg strength and muscle morphology. *Medicine Science Sports Exercise*, 36, pp. 74-78.
- Westhoff, M., Stemmerik, L. & Boshuizen, H. (2000). Effects of a low- intensity strength and functional ability of frail older people. *Journal of Aging and Physical Activity*, 8, pp. 325-342.