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Original Article

Effects of strength training with and without blood flow restriction on quality of life in elderly women

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Abstract:
Objectives: To analyze the effects of RT with and without previews BFR wrist exercise on quality of life index, functional capacity test and maximum strength gains in elderly women. **Method:** 33 elderly women volunteers performed twice a week 14 week of whole-body RT at 70% 1RM. However before of the RT session 16 volunteers performed three set of 15 reps of wrist flexion at 40% 1RM with BFR(LL-BFR), and the other 17 volunteers performed this exercise at 70% 1RM without BFR (HL control group). BFR was applied only on wrist joint flexion RT. Pre- and post-intervention quality of life was assessed by the validated questionnaire, WHOQOL-BREF. Functional capacity and maximal strength were respectively evaluated through the sit/stand test in 30 seconds and the 1 RM test. **Results:** Quality of life improved significantly from pre- to post-test in both training programs (F= 67.21; p <0.05). The physical domain (F = 57.32), Social Domain (F = 71.59), Psychological domain (F = 29.80) and environmental domain (F= 3.62). There was no statistically significant difference between the groups in relation to these domains. 1RM wrist flexion and functional capacity increase in both groups, however BFR group has greater increase in theses variable when compared to control group. **Conclusion:** It was concluded that the exercise of wrist flexion (at 40% 1RM) with BFR performed immediately before a traditional RT session (70% 1RM) were able to produce greater gains in maximal dynamic force and lower limb functional strength than RT alone.
Key Words: Blood flow restriction, Resistance training, Physical function, Quality of Life, Elderly

Introduction

The increase in life expectancy brings with it the need to study strategies that promote the improvement in the health and quality of the elderly population (Ruaro, 2015). One of the consequences of the natural process of aging is the decline of various physiological functions, exposing the elderly to greater fragility and loss of autonomy (Doro et al., 2018). The muscular system undergoes important alterations like the reduction of strength and muscle mass, which has been observed in both men and women and may be associated to loss of autonomy, risk of falls, metabolic complications, reduction of bone density and decline of aerobic capacity (Fusco et al., 2012). Previous reports provide evidence that the effects of sarcopenia imply health care costs, demonstrating the need to avoid and delay the loss of strength and muscle mass during aging (Breen & Phillips, 2011; Loenneke & Pujol, 2011; Marini et al., n.d.; Studenski et al., 2014).

The acquisition and maintenance of moderate levels of muscle strength are important for the daily activities of the elderly, such as carrying weights, climbing stairs, getting up from the chair. Resistance training (RT) strengthens and minimizes the deleterious effects of aging, making them independent for daily tasks, thus increasing the quality of life the elderly subject (Vale, Barreto, Novaes, & Dantas, 2006). In addition, women have a greater decline in muscle strength compared to men, regardless of age, because the decrease in the cross-sectional area of the muscle is more pronounced (Garcia, Dias, Dias, Santos, & Zampa, 2011). In females, there is also a progressive decrease in the capacity to develop maximal tensions, especially after menopause (Garcia et al., 2011).

Skeletal muscle mass plays a very important role with both metabolism and functional capacity. It is well established by (Janssen, Heymsfield, & Ross, 2002) that the aging process leads to a significant decline in muscle mass and the strength of both.

In this context, high load (HL; ≥70% 1RM) RT exercise has been indicated to reduce the risk of falls and increase strength and functional capacity in the elderly (Garber et al., 2011). However, some seniors are contraindicated to participate in the formation of HL-RT and are in need of other modalities to increase strength and functional capacity. In this sense, low load (LL; <50% 1RM) RT associated with blood flow restriction

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(BFR) exercise emerged as an alternative to traditional HL-RT (Abe, Beekley, Hinata, Koizumi, & Sato, 2005). Studies have shown the efficacy of LL-RT plus BFR on neuromuscular variables, such as strength gains and muscular hypertrophy (Hughes, Paton, Rosenblatt, Gissane, & Patterson, 2017; Pearson & Hussain, 2015).
Several studies have shown that increases in strength and muscle hipertrophy that occur with BFR-RT are similar to those observed in HL-RT (≥70% of 1RM) (Cezar et al., 2016; Cook, Brown, DeRuisseau, Kanaley, & Ploutz-Snyder, 2010; Cook, Scott, Hayes, & Murphy, 2018; G. C. Laurentino et al., 2012; Lowery et al., 2014; Martín-Hernández et al., 2017; Ruaro, 2015; Takarada et al., 2000).

It has been well demonstrated that BFR plus RT promotes a higher metabolic response (e,g increased lactate, and nitric oxide production and also greater neuronal recruitment and mTOR pathway downstream activation) when compared to RT without BFR, this may lead the body to a superior adaptation to physical exercise stimuli. Therefore, the present study aimed to verify the effects of LL-BFR versus HL-RT only on strength gain and the perception of quality of life in the elderly.

Material & methods

We selected 40 volunteers aged over 60 years. The sample size was calculated considering a statistical power of 80%, a significance level of 0.05 (two-tailed distribution), a standard deviation of the main outcome variable (muscle strength) of 10 units (based on other studies conducted by group), a minimum detectable difference between treatments of 9.0 units and a sample loss of 15%. Included in the study were elderly women who had no clinical or motor restrictions for physical exercise and who had not participated in physical training programs in the three months prior to the study.

Each of the subjects selected to compose the sample received a three-digit numbering, generated from a table of random numbers, with was recorded their respective registration card. Subsequently, adhesives containing these numbers were randomly glued on opaque and sealed envelopes, containing inside tags identifying either the resistance training with low-load blood flow restricted (LL-BFR) plus RT or the group assignment to high-load (HL) RT only. From this procedure, 20 elderly women were assigned to the LL-BFR group and 20 to HL-RT. The randomization was performed by a researcher who did not participate in the research team. During the intervention period, four elderly women from the LL-BFR group and two from the HL-RT group gave up on personal grounds and one from the HL-RT group was not included in the final analysis of the data because they had missed more than three consecutive sessions, or four or more sessions over the 14 weeks of intervention. The descriptive statistics of the groups are inserted in Table 1.

Table 1: Descriptive statistics of the sample by group assignment to high-load (HL) and low-load blood RT plus blood flow restricted (LL-BFR).

Variables	HL	LL-BFR
Number of volunteers	17	16
Age (years)	67,12 ±4,97	64,69 ±3,74
Mass (kg)	69,69 ±11,91	68,78 ±10,62

Procedures for data collection

Measurement Quality of life

Quality of life was assessed by applying the WHOQOL-Bref questionnaire(Fleck et al., 2000) before and after 14 weeks of training. This questionnaire was developed and validated by the World Health Organization's (WHOQOL) Quality of Life (WHOQOL) group, and the Portuguese version was developed at the WHOQOL Center for Brazil [19]. The WHOQOL-Bref presents 26 questions related to the domains: physical, psychological, social relations and the environment, being characterized as a short extension instrument, applicable to varied populations and presents good internal consistency and content validity [20]. To categorize the percentage of subjects with mean values above the 90th percentile for quality of life, we used the normative values for the different quality of life domains validated for this population [21]. The exploratory analysis of the data was performed through the Shapiro Wilk normality test and the test to verify the homogeneity of Levene variances.

Maximum Dynamic Force Rating

To evaluate muscle strength, a maximal repetition test (1-RM) was performed for the wrist flexion exercise, following the recommendations of the American Society of Exercises Physiologists described by (Brown & Weir, 2001). After general warming (dynamic procedures of flexion and extension of the wrist and elbow joints and circumference of the shoulder joint) and specific (two sets of the wrist flexion exercise with interval of one minute between them only with the weight of the bar - 1.5 kg). A series of eight replicates (50% of estimated 1-RM) followed by an additional series of three replicates (70% of estimated 1-RM) were performed sequentially. At the end of the warm-up period, the participants remained at rest for three minutes prior to the start of the test. Each participant performed a maximum of five attempts to achieve the 1-RM load, with a two-minute interval between attempts. For the first attempt a load 10 to 15% higher than the load used in the last series of heating of the specific heating was used.

Evaluation of functional strength of lower limbs

In order to evaluate the level of functional strength of lower limbs, the *Chair Stand Test* (Jones, Rikli, & Beam, 1999). A chair with a backrest without support for the upper limbs and a height of 46 cm was used. The test consists of lifting and sitting the chair as many times as possible for 30 seconds, from the sitting to the standing position. For evaluation was considered the number of times the person sat and got out of the chair at the stipulated time.

Resistance training

Strength training was performed twice a week over 14 weeks and divided into two stages characterized as baseline and advanced phase. In the basic phase the exercises used and their respective order of execution were: 1) behind-the-neck lat pulldown ; 2) leg press 45º; 3) Lying bench press machine; 4) seated leg adduction; 5) Dumbbell alternate Bicep Curl; 6) seated leg abduction; 7) triceps press down; 8) lying legs curl; 9) shoulder lateral raise; 10) Wrist flexion and extension and; 11) abdominal crunch. In the advanced phase (6th to 10th week) the following exercises were added to the training program: 1) row seated on the low handle; 2) seated leg extension; 3) bench press in the machine e; 4) back squat or smith machine-squat. The number of series and repetitions were performed according to the one mentioned in the respective phases (basic and advanced).

Wrist flexion exercise with Blood Flow Restriction

The wrist flexion exercise was performed with the sitting participant, with supinated forearms resting on an upholstered arranged over her legs, with her feet resting on the ground and her knee joint in 90º flexion. The exercise consisted of three sets of 15 repetitions of the exercise of complete flexion and extension of the wrist joint, with 40 seconds interval between sets and a velocity corresponding to 1.5 seconds for the concentric phase and 1.5 seconds for the eccentric phase. The repetition count, exercise velocity, and interval between series were performed using a digital metronome (Sanny Personal Counter®, São Bernardo do Campo-SP, Brazil). The occlusion pressure used at each session corresponded to 70% of systolic blood pressure, measured after five minutes of rest (performed before each strength training session). The LL-BFR group performed the exercise at 40% 1-RM and the HL only performed the exercise at 70% 1RM.

Intervention protocols

The LL-BFR group performed 28 strength training sessions preceded by performing a wrist flexion exercise with vascular restriction, as previously described. Immediately prior to each training session, subjects in group HL group performed 28 strength training sessions the wrist flexion with cuffs attached to the arms, but without any occlusion pressure. Immediately after this period, subjects will perform strength training, as described previously.

Statistical analysis

The data were submitted to statistical treatment in the Statistical Package for Social Sciences (SPSS version 21.). Descriptive statistics were used with mean and (±) standard deviation as a way to characterize the groups and variables observed. For analysis of normality and homogeneity of data were confirmed by the Shapiro-Wilk and Levene test, respectively. The normality of the data was also verified before the correlation and comparison tests between the groups. The homogeneity of the data was also verified by the Levene test before the ANBFRA tests. The comparisons that require a more detailed analysis to understand the phenomenon are accompanied by the 95% confidence interval (CI) and the effect size: η^2, for ANBFRA and; d of Cohen, for comparisons in pairs Cohen's d was calculated using (Borenstein, Hedges, Higgins, & Rothstein, 2010). The level of significance was set at $p < 0.05$.

Results

The sample of the present study consisted of 33 randomized women in two groups: HL (n = 17; age = 67.12 ± 4.97; Mass = 69.69 ± 11.91) and LL-BFR (n = 16 , age = 64.69 ± 3.74, Mass = 68.78 ± 10.62). There were no statistically significant differences between the mean values of anthropometric variables and age between groups ($p < 0.05$).

In order to identify the effects of muscle strength (1RM wrist flexion test) during the 14-week training in each group in isolation, the paired t-test (pre- vs. post-intervention) was used in the LL-RT plus BFR and in the control group with HL-RT (Table 2). There was a statistically significant ($p < 0.05$) difference in the mean values of the 1RM test of the flexion of the LL-BFR group when compared to the HL-RT group.

Table 2: Mean pre- and post-test of wrist flexion 1RM (Kg).

Groups	n	Pre (Kg)	Post (Kg)	t	p	*d*	95% CI
LL-BFR	16	16.47 ± 2.42	25.58 ± 3.96*	-11.75	0.001	3.79	-10.76256/-7.47274
HL	17	14.41 ± 3.62	21.58 ± 4.37	-12.30	0.001	1.99	-8.41251/-5.94043

Note. group with BFR and RT (LL-BFR, 40% 1RM); control group (HL70% 1RM); d= *Cohen's d;* * p> 0.05 when compared to HL group.

In the functional capacity test both groups improved from pre to post-test, but there was no significant difference. Data from the LL-BFR group showed a large effect size. The HL group had an average effect size (Table 3).

Table 3: Mean and standard deviation of Functional Strength of Lower Members (Chair Stand Test).

Groups	n	Pre *Chair Stand Test*	Post *Chair Stand Test*	t	p	*d*
LL-BFR	16	13,10 ± 2,82	16,00 ± 3,33	-4,67	0.001	0.93
HL	17	12,75 ± 2,99	14,82 ± 3,11	-3,37	0.001	0.64

Note: The data refer to the mean (± standard deviation) in the pre and post test for the variables: Functional strength of lower limbs evaluated from the chair stand test. d= *Cohen's d;* p> 0.05.

Table 4 shows the WHOQOL-BREF validated questionnaire data before and after 14 weeks of training. After this analysis it was verified that there was a statistically significant improvement (p <0.05) of both groups in the physical, psychological, social and general quality of life domains.

Table 4: Pre- and post-assessment of WHOQOL-BREF domains.

Domain	**Groups**	**Média**	**SD**	***F***	***P***
Physical	HL(Pre)	42.68	10.1	57.32	P<0.0001
	LL-BFR (Pre)	40.71	9.3		
	HL (Post)	73.4*	12.4		
	LL-BFR (Post)	75.54*	12.7		
Psycological	HL (Pre)	57.09	7.54	29.8	P<0.0001
	LL-BFR (Pre)	57.3	6.17		
	HL (Post)	72.91*	9.42		
	LL-BFR (Post)	74.16*	7.49		
Social	HL (Pre)	42.09	13.38	71.59	P<0.0001
	LL-BFR (Pre)	37.51	7.42		
	HL (Post)	75.42*	11.93		
	LL-BFR (Post)	76.26*	10.56		
Environmental	HL (Pre)	60.79	9.65	3.622	0.0168
	LL-BFR (Pre)	60.94	7.89		
	HL (Post)	67.2	12.64		
	LL-BFR (Post)	69.84*	11.92		
Quality of Life	HL (Pre)	50.66	7.66	67.21	P<0.0001
	LL-BFR (Pre)	49.12	3.92		
	HL (Post)	72.23*	8.86		
	LL-BFR (Post)	73.95*	7.87		

Note. * p< 0.05 when compared to pre-assessment.

Quality of life improved significantly from pre - test to post - test in both training programs with $p < 0.05$ and with effect size (F = 67,21). The physical domain (F = 57.32), Social Domain (F = 71.59), Psychological domain (F = 29.80) and environmental domain (F = 3.62). There was no statistically significant difference between the groups in relation to the domains.

Discussion

Maximum dynamic force and functional capacity

The present study focused on identifying the differences in effects caused by two strength training programs with and without exercise-restricted blood flow in quality of life in elderly women submitted to 14 weeks of training. However, although the hypothesis is centered on the occurrence of a significant increase in the mean values of the quality of life domains of the elderly submitted to LL-RT plus BFR intervention when compared to the control group (HL-RT) no statistically significant differences were found.

The main finding of the present study was the fact that 14 weeks of strength training preceded by wrist flexion exercise with restriction of blood flow produced an increase in maximum dynamic force higher than that achieved with strength training only (54.70 vs 48.86%, respectively). Similarly, lower limb functional strength increased significantly from pre- to post-test only in the occlusion exercise group immediately before each strength training session (23.08%).

Although we have not found any research with an experimental design similar to the one of the present study in the literature to which we have access, the improvement in strength in response to RT plus BFR is well documented in the literature (Cook, LaRoche, Villa, Barile, & Manini, 2017; Karabulut, Abe, Sato, & Bemben, 2010; G. Laurentino et al., 2008; Loenneke et al., 2012; T. Manini et al., 2007; Sumide, Sakuraba, Sawaki, Ohmura, & Tamura, 2009; Takarada & Ishii, 2002; Takarada, Sato, & Ishii, 2002; Takarada et al., 2000).

However, the RT plus BFR protocol used in the study, which consisted of the exercise of wrist flexion immediately before the strength training session, does not resemble studies published in the literature.

The idea that the exercise of wrist flexion with restriction of blood flow could create a physiological condition that potentiated the response to subsequent strength training was based on studies that pointed to an acute increase in mTOR (mammalian target of rapamycin), an important factor associated with the muscular hypertrophy mechanism (Drummond et al., 2009) in response to blood flow restriction exercise (Fry et al., 2010). Also (Fujita et al., 2007) demonstrated that RT plus BFR enhances the phosphorylation of S6K1 (ribosomal 6 kinase 1) and protein synthesis, evidencing activation of the mTOR signaling pathway is an important mechanism to explain hypertrophy associated with this type of training. Another important study showed that a single exercise session with occlusion increased protein signaling, creating a favorable condition for short and long term hypertrophy (1 and 24 hours post exercise) (Wernbom et al., 2013).

The acute marker responses associated with exercise-induced protein synthesis, such as growth hormone (Reeves et al., 2006; H. Takano et al., 2005), mTOR-S6K1 signaling pathway (Fry et al., 2010), IGF-1 (Haruhito Takano et al., 2005), among others, provide evidence that may support the hypothesis that performing BFR immediately prior to the training session may potentiate dynamic and functional strength responses in the elderly.

Regarding the functional strength of lower limbs (Table 3), only the LL-BFR group showed increases from pre to post-test (23%). Two studies found that a strength training program using the BFR technique acted efficiently in increasing muscle strength and functional capacity in the elderly (Karabulut et al., 2010; Vechin et al., 2015).

The maintenance of functional capacity in the elderly is fundamental, as the decrease in muscle strength is associated with a decline in the ability to perform simple daily activities and also increasing the risk of falls (Cress & Meyer, 2003; Fusco et al., 2012; Henrique, Dantas, & Gomes De Souza Vale, 2004; Kim et al., 2012; Legrand et al., 2014; Liu & Latham, 2011; Todd Manini et al., 2007). The evaluated training protocol may represent a viable alternative in relation to the optimization of strength training responses in the elderly with important impacts on their quality of life in general, since the preservation of autonomy, independence and maintenance of physical and mental abilities are determinants for the functional capacity of the elderly (Fusco et al., 2012).

Quality of life

In the domains related to quality of life, there was a statistically significant difference between the pre- and post-test interventions. Therefore, we affirm that 14 weeks of strength training with and without BFR contribute significantly to the increase of the quality of life. It should be noted that within this domain there was an exception that was related to the part that evaluated the personal relationships, in this there was significant improvement. There were no statistically significant changes for the part of the questionnaire that measured the environment in the home.

These results are in accordance with a preview study (CARVALHO, 2001), when they demonstrate that a regular practice of strength training can be an indicator of quality of life improvement, provided that other important and basic factors such as autonomy, subsistence, safety and others are preserved. The human being when he exercises and participates in programs of physical activities such as resistance training will be reached or complemented in his needs not only in the physical plane, but also equally in the psychological and emotional, human and social. Demonstrating thus that the strength training performed by the elderly can be a means of improvement and obtaining socialization and even improvement of quality of life.

As the aging process seems to reduce muscular strength in the elderly, RT with and without BFR can contemplate the development of the force, being fundamental to maintain the quality of life of this population and also to perform the daily activities of the reducing the risk of falls (Carvalho & Soares, 2004).

This is the first study comparing two 14-week RT programs associating a wrist flexion exercise with BFR in order to investigate the effects of muscle strength and functional capacity on the perception of quality of life in the elderly.

Conclusions

It is concluded that the exercise of wrist flexion with BFR (LL-BFR at 40% 1RM) performed immediately before a whole-body traditional session (HL-70% 1RM) twice a week over 14 weeks were able to produce greater gains in maximal dynamic force (in wrist flexion) and lower limb functional strength (sit/stand test) than RT (70% 1RM) alone.

The study showed that two strength training programs with and without previews BFR wrist flexion contribute significantly to improving the quality of life of this population. In future studies, it is recommended that this research be applied to a larger sample. It would be equally important that this study be done using the same protocols in different age groups. It is important to emphasize that in many cases the elderly can not train with high loads, and through this type of training they could benefit by preventing and reducing joint losses.

Conflicts of interest. The authors declare that there is no interest or relationship with trademarks that manufacture or distribute the instruments used by this study.

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