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Case Study

Changes Neuromuscular and Functional Performance of Elderly After Velocity-based Resistance Training

Ewertton de Souza Bezerra[1]*, Suzy Pinto[2], Tiago Nogueira[1], Leonardo Mendes[1], Aluísio Avelino[1], Inês A. Streit[1], Abderraouf Ben Abderrahman[2]

[1]*Federal University of Amazonas, Brazil,* [2]*Higher Institute of Sport and Physical Education of Ksar-Said, Tunisia*

ABSTRACT

The aim of this study was to investigate whether 24 sessions of velocity based training (VBT) exercise could changes the neuromuscular and functional performance in the elderly women. Six elderly participants (65 ± 5 years; 1,51 ± 0,05 m; 64 ±16 kg) were submitted to a progressive VBT regime (two sessions/week) using a squat jump barbell exercise. Time up and go (ES 0.86, large; p=0.01), squat jump (ES 0.71, moderate; p=0,03), squat jump barbell (ES 1.37, large; p=0,03), and dynamic knee extension (ES 0.54, moderate, p=0,04) were statistical different within period (POST better than PRE). On the other hand, results isometric knee extension (ES 0.12, small, p=0,58) and dynamic knee flexion (ES 0.08, small, p=0,72) did not show changes after the experimental period. In summary, the results of this study suggested that 24 sessions of VBT exercise influenced the functional performance (TUG); squat jump height and load of the barbell squat jumps; fast concentric knee extensor (180o/s), but not the flexion concentric (180o/s) and isometric knee extensor torques in a group of elderly women.

Keywords: Power training, aging, isokinetic

INTRODUCTION

The aging process is characterized by physiological and functional changes in the different systems of the human body. These changes appear in different progressions, and mainly affect the functions of the muscular systems. Within the more affects structure are: i) at the level of the motor neuron, there is the loss of motor units, neuronal atrophy and the reduction of the velocity conduction of the action potential; ii) at the level of the neuromuscular junction (synapse), the transmission of the neuromuscular response is slowed down; and iii) at the level of the muscle fibers, the reduction in the number and the size of the fibers characterize the muscular atrophy in the elderly people (1). Indeed, these alterations can explain the progressive decline of the physical functions (strength, flexibility, muscular and cardiorespiratory endurance), and neurological (coordination, balance), that can lead to functional consequences such as loss of autonomy and increased risk of falls and fractures (2,3).

However, these deleterious physiologic effects of aging could be attenuate and even reverse by hormone therapy, nutritional strategies and physical activities. For the latter, there are two types: endurance training, which is based on the development of maximal aerobic power (VO2max) and resistance training (RT), which is based on the development of muscle

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Address for correspondence:
Ewertton de Souza Bezerra, Av. General Rodrigo Octavio Jordão Ramos, 1200 - Coroado I, Manaus - AM, Brazil.
Zip code: 69067-005; E-mail: ewertton_bezerra@ufam.edu.br

functions (strength, power and muscular endurance). The currently literature has shown that TR allows to increase the surface of muscle fibers (hypertrophy), muscular protein synthesis, maximum muscle strength and power (1). Two regimes of training are used to develop muscular functions: i) high intensity training whose prescribed loads are equal to or greater than 85% of 1 maximum repetition (1-RM) and ii) the power training whose charges are prescribed between 30 to 60% of 1-RM. The study conducted by Correa et al. (4) showed that these two regimes of training are the most effective for the development of strength and muscular power. Traditionally, RT prescription is based on the maximum percentage of 1-RM, what frequently it requires a lot of time and periodic reevaluation in order to adapt the training load(5,6).

In this regard, the velocity-based training (VBT) arises as an alternative method, because the prescription is based on the velocity of load travel, for example, for power, (30 -60% 1RM) the prescribed velocity would be 0.8-1.3 m/s (7). In addition, adjusting the load in real time, to maintain the target velocity, can guarantee a better optimization of the training. However, to date this hypothesis was valued just sports studies (5,8). Conversely, no study has referred to the effects of the VBT program on the muscular functions of the elderly. Thus, our aim was evaluate the effects of VBT program on neuromuscular and functional performance of elderly women.

METHOD

Participants

Six female elderly over 60 years (65 ± 5 years; 1,51 ± 0,05 m; 64±16 kg) participated in the present case study. Participants were free from existing lower limb musculoskeletal disorders, and had no fractures or orthopaedic surgery in the last 5 years. All subjects signed an informed consent form and the Ethics Committee of Human Research approved the procedures (approval number: 3.139.675), in agreement with the Declaration of Helsinki (as 64th WMA General Assembly, Fortaleza, Brazil, October 2013).

Materials and Procedures

The vertical jump test was performed with an App my jump2® connect to iOS plataform (9). Participants performed 3 trials of squat jump (SJ) movement. During the SJ, the following command "squat", wait (3s) and "jump" were performed followed by the maximum vertical jump, the knee flexion was self selected. Both hands were kept positioned on the hips during the entire movement and legs were maintained in full extension during the flight phase. The interval between each jump was 60s. SJ height value was analysed. The best of the three attempts was adopted for analysis.

Muscular torque of the preferred limb was assessed via knee extension maximum voluntary isometric contraction and during on extension and flexion knee dynamic contraction (180°/s) an isokinetic dynamometer (Biodex® System 4, Biodex Medical Systems, Shirley, NY, USA). Participants were positioned in the dynamometer and the evaluated limb as well as the torso and pelvic region were stabilized using non-elastic straps to avoid compensatory movements. The seat was positioned at 85° of hip flexion and 70° of knee flexion (0° hip in neutral position and knee full extension). Subjects were instructed to produce force "as fast and hard as possible," with emphasis placed on a fast initiation of contraction. Verbal encouragement was given before and throughout the test. After positioning, an isokinetic warm-up was performed with 10 repetitions of concentric knee extension-flexion contractions at a range of motion from 20° to 100° and an angular velocity of 120°/s^{-1}(10).

Time up and go was recorded using a digital camera at a sampling frequency of 52 Hz (Sony®, model W800 New York City, New York,USA) and timed offline by an evaluator with specialized software (Kinovea®, France). The trial with the lowest completion time was used for further analysis. These procedures have been proposed to reduce measurement errors (11). Participants completed three trials with 30 seconds rest between attempts. The TUG test consisted of measuring the time needed to rise from a seated position, walk forward, and then return 2.44-m to a seated position as quickly as possible. The trial with lowest performance time was adopted for analysis(11).

The procedures to obtain the load which the subjects executed jump squat exercise on a free barbell between 0.75 and 0.9 m/s followed recommendations of Loturco et al.(12); barbell velocity was control by accelerometer (Push Training® 1.0, Toronto, CA)(13). Subjects were instructed to execute 3 trials at maximal velocity for each load, starting at 10% of their body mass. Participants executed a knee flexion until the thigh was parallel to the ground and, after an initial command, jumped as fast as possible. Prior to each muscle power assessment, an experienced test administrator instructed the participant to maintain constant downward pressure on the barbell throughout the jump, to prevent the bar moving independently of the body. A load of 10% of body mass was gradually added in each set until the velocity target was achieved. This was observed after, on average, 5–6 sets. A 5-minute interval was provided between sets. A blinded researcher performed all tests.

Training Program

The velocity-based resistance training (VBT) program consisted of the exercise squat with barbell (4 sets X 6 repetitions) with 2 minutes of interval between sets. The displacement velocity in the concentric phase was controlled by the accelerometer (Push Band 1.0), which is always maintained between 0.75 and 0.90 m/s. Previously the sessions were performed a specific warm-up (core and joint mobility), as well as, the bench press exercise was used to complementary the training session. There was increment (minimum of 10%) and/or maintenance of the load (reevaluations were done every four sessions).

Statistical Analysis

All values are reported as mean ± SD. Normality of distribution and homoscedasticity for outcome measures were tested using the Shapiro-Wilk test and Levene's criterion, respectively. Dependent student t-test was applied to analyze the differences within group after the experimental period. An alpha level of $p \leq 0.05$ was used to determine statistical significance The first part of statistical procedure was performed using SPSS 21 for windows (Statistical Package for the Social Science, IBM, Chicago, Ill, USA). Complementary analysis applied for practical significance using magnitude-based inferences was executed. The smallest worthwhile change (0.2 x between-subjects

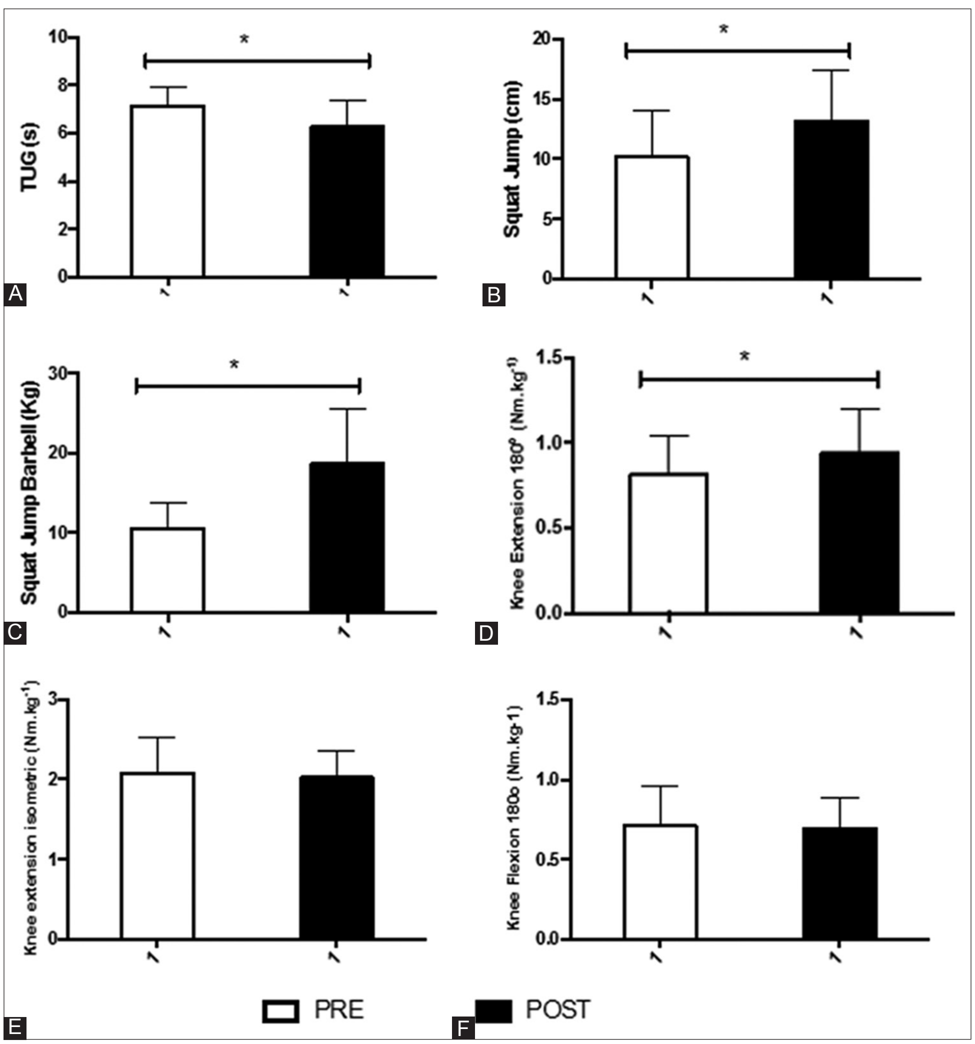

Figure 1: (A-F) Inferential analysis comparing measures in two different periods (PRE vs. POST),* statistical difference to PRE

standard deviation SD) and 90% confidence intervals (CI) were determined for between-trial comparisons (i.e., PRE vs POST time) (14). The quantitative chances of higher/beneficial, trivial/similar, or lower/harmful differences were evaluated qualitatively as follows: <1%, *almost certainly not*; 1% to 5%, *very unlikely*; 5% to 25%, *unlikely*; 25% to 75%, *possible*; 75% to 95%, *likely*; 95% to 99%, *very likely*; >99%, *almost certainly*(15). The true difference was assessed as unclear when the chances of having positive and negative results were both >5%. Threshold values for Cohen's effect size (ES)(16) statistics were >0.2 (small), >0.5 (moderate), and >0.8 (large).

RESULTS

Time up and go (ES 0.86, large; p=0.01), squat jump (ES 0.71, moderate; p=0,03), squat jump barbell (ES 1.37, large; p=0,03), and dynamic knee extension (ES 0.54, moderate, p=0,04) were statistical different within period (POST better than PRE), figure 1A to 1D, respectively. On the other hand, results isometric knee extension (ES 0.12, small, p=0,58) and dynamic knee flexion (ES 0.08, small, p=0,72) did not show changes after the experimental period, figure 1E and 1F, respectively.

The effect size and quantitative changes values of all variables analyzed are report in figure 2. Compared with the baseline, the post training report *likely* to TUG, SJ, SJ Barbell, and *possible to* knee extension 180º/s. On the other hand, isometric knee extension and flex knee extension 180º/s report *unclear*.

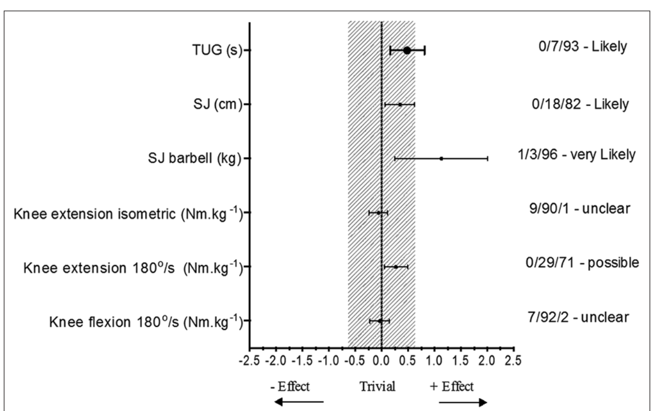

Figure 2: Post-intervention changes to post intervention regarding to baseline on neuromuscular and functional performance (expressed as standardized mean difference). Bars indicate uncertainty in the true mean changes with 90% confidence intervals. Trivial area was calculated from the smallest worthwhile change (see methods). Note - SJ: squat jump

DISCUSSION AND CONCLUSION

The main findings of the case study were that application of VBT with squat jump barbell (4 sets x 6 repetitions with 0,75 to 0,9 m/s) resulted in a decrease on time executed of time up and go test, as well as, improve on squat jump height, muscular knee extension torque with 180º/s, and load travelled during the squat a jump with barbell. However, no changes between two periods were observed for muscular knee flexion torque with 180º/s and isometric knee extension. The results confirming our initial hypothesis that VBT is able to improve neuromuscular and functional performance in elderly people.

Regarding the time up and go, an interesting finding was that the application of VBT was enough to increase performance. Some studies related changes after power training in functional performance (17,18), and it apparently occur with minimal session include on the RT program. Sakugawa et al. (19) showed decrease on time response for TUG after 16 sessions, within which only 4 sessions were performed with high speed; similarly Bezerra et al. (20) verified a significant reduction in TUG performance after 27 workouts of RT, the detail was that independent of periodization model (traditional or mixed session) both groups performance 27 sets with high speed during the concentric phase in two exercises (leg press and seated leg curl). Our current data present a likely magnitude-based inferences to TUG (see figure 1), the difference with the studies mentioned above was in the present protocol we control the velocity between 0,7 and 0,9 m/s, what according of force-velocity relationship the maximum power peak is found (21).

Squat jump height and load of the barbell squat jump results converge with similar TUG responses after intervention. Previous studies report increase in power jump height in the elderly (≅37%) after sessions with sets executed with high-velocity contractions (30–50% of 1RM) as part of a traditional heavy RT program (22,23) or training only with fast concentric contractions (24). The improvement in power performance might be associated with maintenance of fast-twitch muscle fibers, and an increase in maximal fiber contraction velocity in elderly people (21).

Our results showed that a short-term training program significantly increased the concentric peak torque 180º/s after 24 sessions of the VBT exercise. The findings of the current study are in agreement with previous studies (25) showing that strength training may result in neural and morphological adaptations that maintain or increase the strength production capacity even in elderly individuals. Our particular stimulus difference compared with others studies (19,23,26), it is while these studies applied percentage of one maximum repetition, we controlled the load with accelerometer what permit us constant adjust of it. This particular way of load control already applied with sports studies (5,8). However, to the best our knowledge it was the first study of applied in elderly people, our specific result in high velocity during isokinetic evaluate has direct connect with the velocity control during the exercise execute, maybe for this we did not observe changes in concentric knee flex during 180°/s and isometric contraction. Furthermore, it was possible that did not occur a complete adaptation in lower limb, as it observed to Orssatto et al. (27) after 12 weeks of RT applied just de leg press 45°, as the previous study we should considerate the specific adaptations caused by exercise and velocity of the load.

The present case study is inherent in limitations. First, our limited sample was justified for being a exploratory idea, while we know that is a limiter factor, however our data showed for a inference analyses to compare baseline to post intervention is necessary minimal of 30 subjects (G*Power Statistical Program, effect size: 0,71; Power (1-β err prob): 0.95; and α err prob:0.05). Second, these results are restricted to this population (range 60 and 70 years old) and training protocol; extrapolation for other conditions should be made with caution. In summary, the results of this study suggested that 24 sessions of VBT exercise influenced the functional performance (TUG); squat jump height and load of the barbell squat jumps; fast concentric knee extensor (180°/s), but not the flexion concentric (180°/s) and isometric knee extensor torques in a group of elderly women.

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