Effect of Different Volumes of Training of Pilates Exercises on Muscle Strength, Postural Balance, Flexibility, Functional Autonomy, Depressive Symptoms and Pulmonary Function on Elderly

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ABSTRACT

Background: aging is a progressive process that leads to decreased muscle strength and mobility, slowness in reaction time and impaired balance, compromising autonomy and quality of life. **Objective:** to compare the effect of different volumes of Pilates training on strength, balance, flexibility, functional autonomy, depressive symptoms and pulmonary function in the elderly community. **Method**: it will be a randomized clinical trial with elderly of both sexes. The Group A (GA) exercises with smaller volume and greater variability of exercises, Group B (GB) greater volume and lower variability and Group C (CG) will maintain its usual activities. The intervention will occur twice a week for 60 minutes for 12 weeks. In order to evaluate the strength, Biofeedback System for resting exercises with elastic overload (E-lastic®), 30-second chair stand test (30-s CST) and Palmar gripper dynamometer will be used. The balance will be evaluated in the semi-tandem, tandem and unipodal positions, by the Timed Up and Go (TUG) and Step Test. Flexibility will be assessed using the Wells database, functional autonomy, dressing-gown test (VTC), depressive symptoms by the Geriatric Depression Scale (GDS) and lung function by many vacuum and spirometry. Data distribution will be done using the Shapiro-Wilk test, frequency and percentage calculation for categorical variables, the mean and standard deviation for continuous variables with normal, median, and interquartile distribution for variables with non-normal distribution. For comparison of the three groups will be used ANOVA One Way with post hoc of Bonferroni or Kruskal Wallis with Bonferroni correction, comparison of the continuous variables at moments before and after twelve weeks of intervention the Student's t-test paired or Wilcoxon and for the comparison of the categorical variables the test chi-square. **Expected results:** significant improvement of outcomes in both intervention groups compared to CG, however, the group with higher training volume and lower exercise variability will have a greater effect than the group with lower volume and greater variability of exercises. Keywords: Exercise Movement Techniques, Elderly, Aging, Muscular Strength, Balance, and Flexibility

Introduction

Aging is an involuntary and progressive process that leads to biological, structural and functional changes such as loss of mass and muscle strength(1,2). The aging process leads to changes in the visual, vestibular, sensory and motor systems, causing slow reaction time, compromising the postural balance (L. (3,4) Flexibility and mobility also tend to decrease with aging favoring the onset of lesions and loss of functional autonomy (5,6). The regular practice of physical exercise helps to prevent these changes related to aging (5).

Among the various possibilities of physical exercise, the Pilates method has been well-suited for the elderly, since it incorporates the training components recommended by the American College of Sports Medicine (ACSM), is the strength, balance, and flexibility (7,8). However, researchers have questioned the lack of scientific evidence that confirms all the benefits of the method, especially in the elderly,(9,10). The findings described in the literature are still controversial. A systematic review of six randomized controlled trials (RCTs) has shown limited evidence in improving strength, flexibility, and balance in both sexes (9).

Physical decline negatively affects the personal autonomy and quality of life of the elderly and Pilates seems to have positive effects on these aspects. Rodrigues et al. (2010)(11) observed a significant evolution in the functional performance of healthy elderly women in rising from the seated position (11.8%) and lying position (26%) and a significant improvement in quality of life ($p = 0.04$) after intervention with Pilates exercises (11). As for depressive symptoms, Mokhtari et al. (2013)(12) identified a significant reduction ($p < 0.007$) in this symptomatology after Pilates practice (12). However, both studies reached only two points on the PEDro Scale. Recent investigations found a significant increase in maximal inspiratory pressure (MIP) of 19.5%, maximal expiratory pressure (MEP) of 8.7% and Abdominal Transversal thickness of 42.3% after the program(13). However, the study presented some limitations, such as the absence of a control group and the inability of the blindness of the evaluators.

It is also important to highlight the lack of reports on how the programs are carried out and when there is a description there is a heterogeneity in the prescription of the exercises. In the two reviews cited above (9,14), only two of

the included studies presented the prescribed volume: ten replicates (11)and three series of ten repetitions (15). Some studies have also described the volume: two sets of ten repetitions (16), two to four sets of 15 to 20 seconds of contraction for isometric exercises and 15 to 20 repetitions for dynamic exercises (17). A single series of 10 replicates with a 30-second interval between the series (18,19). It is known that the literature suggests for the muscular strength gain in the elderly a training volume of two to three sets per exercise, seven to ten repetitions per set and a moderate to high intensity (8,20) and as noted most Pilates exercise programs have not followed these recommendations.

The aim of the study is to compare the effect of different volumes of Pilates exercise training on muscle strength, postural balance, flexibility, functional autonomy, depressive symptoms and lung function in the elderly community. We believe that Pilates exercises will have beneficial effects for the elderly, but our hypothesis is that the group that performs a greater volume of Pilates exercise training will have a greater improvement in the investigated outcomes than the group with the lowest volume.

Methods

Type and location of study

This is a randomized clinical trial, which will be conducted at a Pilates studio in Goiânia.

Participants

The elderly will be invited through advertisements in social networks, local media, and posters distributed in the centers of coexistence of the elderly, health centers and churches and will be selected, considering the possibility of 20 % of sample losses, the first 57 eligible participants according to the following inclusion criteria:

- Age between 60 and 85 years;
- To present cognitive aptitude according to the Mental State Mini-Exam (MMSE);
- Independent walking, without the use of auxiliary walking devices;
- Not participating in other physical intervention research;

- Not having undergone physiotherapeutic treatment and not having participated in a structured physical activity in the previous month;
- Do not present neurological diseases, history of fractures or recent surgeries and serious cardiorespiratory diseases.

Participants will be excluded:

- Failure to attend all stages of evaluation;
- They did not complete 80% of the intervention.

Outcomes and Measuring Instruments

The dependent variables of the present study will be muscle strength, postural balance, flexibility, functional autonomy, depression and pulmonary function.

Muscle Strength

The muscle-dependent variable will be evaluated through the Biofeedback System for The Biofeedback System will be used for the practice of resistance exercises with elastic overload (E-lastic®), The 30-second chair stand test (30-s CST), and the palmar gripper dynamometer

- The Biofeedback System will be used for the practice of resistance exercises with elastic overload (E-lastic®). E-lastic® will measure maximal isometric voluntary contraction of the knee flexor and extensor muscles, flexors, extensors, adductors and hip abductors before and after the intervention. For the acquisition of force signals, a load cell is used to provide an electrical signal proportional to the force that deforms the equipment. The participants will perform 3 repetitions, maintaining the contraction for 5 seconds, with 60 seconds of recovery and the highest value will be recorded.
- The 30-second chair stand test (30-s CST) will be used. It consists of getting up and sitting on a chair as many times as possible within 30 seconds. A seat with backrest and without armrest (with a seat height of 45 cm) is used. Initially, participants remain seated and are instructed to look forward after command "1, 2, 3, will" they raise with their arms crossed on their chest. The evaluator will explain and demonstrate the test and the participant will do once for familiarization. You will be given a rest of 2 minutes to start the test.

- Will be measured using the Saehan® hydraulic palmar gripper dynamometer, the position recommended by the American Society of Hand Therapists (ASHT) will be adopted: sitting comfortably positioned with shoulder lightly bent, elbow bent at 90 °, forearm in neutral position and, finally, the position of the handle may vary from 0 ° to 30 ° of extension. It will be used to record the maximum and average manual grip strength of three measurements and the values will be compared with the reference values.

Postural balance

The static and dynamic body balance will be evaluated.

- Static postural balance: will be evaluated by measuring the time each participant can maintain in three progressively more difficult positions: semi-tandem, tandem and unipodal support. In all positions the individuals must be with their hands on their waist, the total time to stay in each position is 30 seconds and it will have 3 attempts in each position and the best time will be recorded. The evaluator will demonstrate the test once.
- Dynamic postural balance: to evaluate the dynamic balance, the Timed Up and Go (TUG) test and the Step Test will be used. The TUG starts with the participant sitting in the chair, in the "go" command, he gets up from the chair, walks 3 meters at a comfortable pace, turns around, goes back to the chair and sits down. It will be demonstrated once and then it will do a repeat for familiarization. In the Alternative Step Test, the participant is asked to make eight beats of the foot, alternating between right and left, on a step in front of him with a height of 18 cm. Time will be timed and used in the analyzes. The test should be performed in 10 seconds.

Flexibility

To evaluate the flexibility of the hamstring muscles will be used the Sit and Go Test, using the Wells bench, participants will remain without footwear, sitting with knees extended, shoulders flexed, elbows extended and hands overlapped. Participants should perform trunk flexion at the front, perform a forced expiration, and move the seat ladder as far as possible, this procedure will be performed three times and immediately noted by the evaluator, with the best.

Functional Autonomy

The functional autonomy of the upper limbs will be evaluated by the dressing test and a t-shirt. Initially, the evaluator will explain the test and the volunteer will do a brief training with two replicates. The execution time is marked in seconds and the shorter the execution time, the better the result. The subject must make two attempts, where the best performance attempt will be recorded.

Depressive symptoms

The Geriatric Depression Scale will be used for the evaluation of depressive symptoms in the elderly and screening for depression among older people. Geriatric depression scale will be presented as an interview and the questions have a yes / no format to be easy to understand. The short version consists of 15 questions, one point is given for each "yes" answer and the number of points is added to provide a single score. The score ranges from 0 to 15 and a score of zero to five is considered normal, six to ten indicates mild depression and 11 to 15 suggests severe depression.

Respiratory muscle strength

Respiratory muscle strength will be measured by assessing maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) in cmH2O. These measures represent the strength of the inspiratory and expiratory muscles respectively. It will be using the manometer of the brand Globalmed® MVD300, calibrated, the patient seated at 90º, a nasal clip and a nozzle connected to the equipment will be placed. In order to assess MIP, a maximum expiration up to the residual volume and, in the sequence, a maximum sustained forced inspiration will be required. And to assess PEmax inspiration will be required up to the total lung capacity and, subsequently, a forced maximum expiration up to the residual volume. Three reproducible measurements will be made, with variation less than 10% and the values found will be compared with those predicted.

Pulmonary function

Pulmonary function will also be evaluated by spirometry. The test measures forced vital capacity (FVC) in liters (L), forced expiratory volume in the first second (FEV1) in liters (L) and the FEV1 / FVC ratio. A One Flow® portable spirometer will be used, the individual will be seated with the head in the neutral position, inspiration will be requested up to the total lung capacity (CPT) and, thereafter, a

maximum expiration, with an explosive start, to the residual volume (lasting at least 6 seconds). A maximum of eight replications will be performed until three reproducible measures (less than 10% difference), 60 seconds of interval between measurements, will be considered the best value. It is recommended to compare the values obtained with predicted equations

Sociodemographic, Clinical, Anthropometric and Feasibility Indicators

To characterize the participants, gender, age, schooling, marital status, concomitant diseases, and life habits will be investigated through a sociodemographic and clinical characterization questionnaire developed by the researchers. A participant who performs at least 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity per week will be considered active (8,21,22). Body mass and height will be measured to calculate the Body Mass Index (BMI). The BMI will be classified according to Lipschitz(23) below 22 Kg / m² will be considered lean, between 22 and 27 kg / m² eutrophy and over 27 kg / m² overweight.

Feasibility indicators will be checked by means of the following items: retention (percentage of withdrawals and withdrawals), adherence to intervention (percentage of Pilates sessions attended and reason for absences), participant experience and feedback (Are the sessions pleasant? Pilates for other people? Did you realize benefits to your health? Would you like to continue with Pilates exercises?), safety (notification of adverse events, be it injury or medical event attributable to Pilates exercise).

Intervention

The intervention will consist of performing Pilates exercises on the apparatus (Reformer, Cadilac, Barrel, and Chair), on the ground and with accessories. It will always be performed by a physiotherapist with teaching certification in the Pilates methodology and will be supervised by two physiotherapist trainees properly trained so that all principles are followed and the exercises performed correctly. Participants will start the exercise program in small groups of up to 8 people, twice a week for 60 minutes, for 12 weeks, totaling 24 sessions.

The first day of intervention for both groups will be devoted to explaining the six principles described by Joseph Pilates: centralization, concentration, control, precision, fluidity, and breathing, and in all sessions these principles will be recalled by the physiotherapist. From the second day of intervention, the participants will follow different exercise programs. Group A (GA) will perform a training with lower volume and greater variability of Pilates exercises and group B (GB) with greater volume and lower variability of Pilates exercises. The control group (CG) will remain with their usual activities. The structure of the exercise program of each group will be detailed below, but both will start performing flexibility exercises, adopting dynamic stretching and then perform the strengthening exercises for the main muscle groups.

- Group A (GA): participants will follow a Pilates exercise program similar to that adopted in clinical practice and to what is described in the literature. The GA prescription will consist of 18 exercises, performed in a single series of seven to 10 repetitions, 60 seconds rest between exercises. Each week the exercises will be changed. The progression will occur increasing the resistance of the springs and the level of difficulty of the exercises, but without modifying the repetitions. The intensity of the training will be measured using the Modified Borg Effort Scale and then kept constant throughout the program in a score of 7. After the end of each exercise, participants will be asked to rate their effort so that the adjustment of the intensity can be carried out properly.
- Group B (GB): participants will conduct a Pilates exercise program based on the ACMS recommendations and the results of the systematic review of Borde, Hortobágyi, and Granacher (2015). The GB prescription will consist of 12 exercises, performed in three sets of seven to ten repetitions, the 60s of rest between sets. Every four weeks the exercises will be changed. The progression will occur increasing the resistance of the springs and the level of difficulty of the exercises. The intensity of the training will be measured by the Borg Scale and then kept constant throughout the program at level 7. After the end of each exercise, participants will be asked to rate their effort so that the intensity adjustment can be performed properly.

Evaluation procedures

Initially, everyone who agrees to participate in the study will sign the informed consent form, then the data concerning the variables: cognitive ability, sociodemographic, clinical characterization, and anthropometric measurements will be collected. All participants will be evaluated for muscle strength, balance, flexibility, functional autonomy, depression and lung function before and after the intervention, including those who do not complete 80% of their presence during the intervention. For the self-report questionnaires an evaluator will be trained and for the performance questionnaires/tests two evaluators will be trained and they will be blind to the intervention. Subjects will be randomized into three groups. The randomization process will be done at random.org and concealment of the allocation will occur using opaque and sealed envelopes.

Statistical analysis plan

A sample size was calculated using the effect size identified in the comparison of the results concerning the post-intervention moment of the intervention and control groups, using data from the literature (18,25,26). The calculation indicated the need for a sample size of 15 participants per group for a power of 80% and an alpha error of 0.05 in the intergroup comparison analyzes for the variables muscle strength, balance, and flexibility.

Initially, the distribution of the data will be determined by means of the Shapiro-Wilk normality test. Subsequently, the descriptive analysis will be performed with frequency and percentage calculation for the categorical, mean and standard deviation data for continuous data with normal distribution and for median and interquartile data for continuous data with non-normal distribution.

For the comparison of the three groups for the performance of the continuous data, the ANOVA One Way test with post hoc of Bonferroni or Kruskal Wallis with Bonferroni correction (according to the normality of the data) will be used. The t-test of paired student or Wilcoxon (according to the normality of the data) will be used to compare the continuous data at the before and after moments in each group. Comparison of categorical data will be done using the chi-square test. For each primary and secondary outcome, the values observed in each group will be described, the size of the estimated effect along with its accuracy (eg, 95% confidence interval). It will be adopted 5% significance level.

If necessary, the intention-to-treat analysis will be performed. The data will be tabulated with double entry. The analyzes will be performed using SPSS 23.0 software.

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