Abstract
Introduction: Chronic obstructive pulmonary disease (COPD) is a chronic disease related to various systemic manifestations including dyspnea, exercise intolerance and peripheral muscular dysfunction, with a direct impact on functional capacity. Objectives: To describe a whole body vibration exercises (WBVE) protocol to verify the clinical benefits, and the potential of exacerbation of the disease. Methods: Individuals diagnosed with COPD, aged ≥ 40 years, will be randomly distributed into 4 groups: control group (CG) who will not undergo WBVE, with their normal daily routine, group who will be exposed to WBVE in the sitting position in an auxiliary chair once a week (GS1) and twice a week (GS2) and WBVE group twice a week in the standing position with knee flexion (GP2). The protocol will last 6 weeks, each session will have 5 sets of 1 min vibration with 1 min rest, frequency 25 Hz and peak-to-peak displacement 2.5 mm. Muscle strength and function will be assessed through manual dynamometry and surface electromyography and dyspnea using the Modified Borg Scale (MBS) and the Medical Research Council (MRC) Scale. Discussion: WBVE, due to the various effects already described, seem to be a promising exercise modality for individuals with COPD, potentially being used as an instrument for pulmonary rehabilitation. Conclusions: The results of this study may provide evidence to justify a WBVE program to the improvement on the physical performance and on neuromuscular function of individuals with COPD.

Keywords: COPD; Whole-body vibration exercise; Muscular function; Pulmonary rehabilitation.

Effects of whole body vibration exercises on functional parameters: A study protocol involving chronic obstructive pulmonary disease

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Resumo
Efeitos dos exercícios de vibração de corpo inteiro em parâmetros funcionais: Protocolo envolvendo indivíduos com doença pulmonar obstrutiva crônica

Introdução: A doença pulmonar obstrutiva crônica (DPOC) é uma doença crônica relacionada a várias manifestações sistêmicas incluindo dispneia, intolerância ao exercício e disfunção muscular periférica, com impacto direto na capacidade funcional. Objetivos: Descrever o protocolo de um estudo que utilizará os exercícios de vibração de corpo inteiro (EVCI) como modalidade de exercício físico (EF) em indivíduos com DPOC com o objetivo de verificar os benefícios clínicos e o potencial de exacerbação da doença. Metodologia: Indivíduos com diagnóstico de DPOC, com idade ≥ 40 anos, serão distribuídos randomicamente em 4 grupos: grupo controle (GC) que não será submetido aos EVCI, grupo submetido aos EVCI na posição sentada 1 vez por semana (GS1) e 2 vezes por semana (GS2) e grupo submetido aos EVCI na posição agachada 2 vezes por semana (GP2). O protocolo terá duração de 6 semanas, cada sessão terá 5 séries de 1 min de vibração com 1 min de repouso, frequência de 25 Hz e deslocamento pico a pico 2,5 mm. Serão avaliadas força e função muscular usando o dinâmômetro manual e a eletromiografia de superfície e a dispneia pela Escala Modificada de Borg (EMB) e Escala Medical Research Council (MRC). Discussão: Os EVCI, em decorrência de vários efeitos já descritos, parecem ser uma modalidade de exercício promissora para uso em indivíduos com DPOC,
pulmonary function is an important predictor for this global disability and 5% of total deaths (2.9 million).\(^7\) \(^8\) According to the 2010 Global Burden of Disease (GBD) study, COPD was responsible for about 5% of the multimorbidity and on the life expectancy is still limited. Due to its chronic nature and its prevalence, it also results in several other related systemic manifestations, such as exercise intolerance, peripheral muscle dysfunction, dyspnea, recurrent acute and severe exacerbations, and the need for chronic pulmonary therapy, leading to hospitalization and resulting in impairment on the quality of life.\(^3\) \(^8\) \(^11\) \(^12\) Moreover, muscle weakness contributes to exercise intolerance\(^8\) which may contribute to the severity of the disease,\(^4\) \(^9\) generating high costs for the health system worldwide.\(^4\)

The skeletal muscle training being an important component of PR\(^9\) that improves exercise tolerance and performance in daily activities.\(^10\) The goal of this intervention program is to improve physical performance and reduce dyspnea to prolong the life of individuals with COPD. Together with a PR element, physical exercise (PE) is recommended for all individuals with COPD.\(^13\) The treatment program conventionally used for individuals with COPD is pulmonary rehabilitation (PR).\(^14\) The treatment of diseases, the well-being physical and psychological, and (iii) reduction of all causes of mortality.\(^19\) However, endurance and aerobic exercises\(^18\) are associated with a higher level of perceived dyspnea and the “fear of lacking air” lead individuals to have less effective in the treatment of these individuals.\(^15\) \(^16\) \(^17\) PE also reduces COPD exacerbations and mortality. It would be a common general intervention to the management of COPD, being related to (i) the prevention and treatment of diseases, (ii) the well-being physical and psychological, and (iii) reduction of all causes of mortality.\(^18\)
adherence to physical activities. The use of training for the peripheral musculature in the individual with COPD involves careful consideration of the possibility of exacerbations, risk of acute dyspnea or hypoxemia during resistance exercises and/or aerobics.

Knowing the importance of PE to improve life conditions of individuals with COPD, and since these modalities can promote exacerbation of the disease, research in this field is necessary, developing safe means to offer PE as a treatment. The whole body vibration exercises (WBVE) arise in this context. Studies have demonstrated the efficacy of WBVE, as a form of PE, without provoking exacerbation of the disease, with several benefits for these individuals. It is suggested that WBVE, when used as a modality of PE, under appropriated conditions, in individuals with COPD, does not lead to exacerbation of the disease, bringing several clinical benefits. Therefore, WBVE may be a great intervention in the management of these individuals, but more studies are needed.

WBVE are produced when the subject is in contact with the base of the oscillating/vibratory platform (OVP) turned on. OVP can be used to perform PA by transmitting mechanical vibration (MV) to the person’s body and can improve physical fitness. MV is a physical agent with periodic, deterministic oscillation, acceleration change, force and displacement over time.

WBVE induces muscle contractions through involuntary reflex and may be useful to aid in the treatment of COPD individuals. In this way, WBVE can be an option in the management of individuals with COPD, used as a PA in the PR protocol, in an effective, safe and viable intervention.

Accordingly, the current work aims to describe a whole body vibration exercises (WBVE) protocol to verify the clinical benefits, and the potential of exacerbation of the disease. In addition, it will investigate the effects of WBVE intervention on the electromyographic pattern of muscles of the lower limbs, in the handgrip strength (HS), on the exercise tolerance and on functional performance of COPD individuals. We will conduct a prospective and randomized controlled trial, crossover, to investigate the efficacy of a 6-week WBV exposition on comprehensive outcomes in COPD individuals. The results of this study will determine the effectiveness and provide scientific evidence for the use of the WBVE to the COPD individuals.

Methods

Ethics Committe

Project approved by the Comitê de Ética em pesquisa de seres humanos do Hospital Universitário Pedro Ernesto (HUPE), Universidade do Estado do Rio de Janeiro (UERJ) (CAAE: 49219115.3.0000.5259).

Study design

Prospective and randomized controlled, crossover, double-blinded trial. Individuals with diagnosis of COPD, aged 40 years and older, will be screened at the Serviço de Pneumologia by a physician, Polyclínica Piquet Carneiro (PPC), UERJ. The individuals will be randomized and allocated into 4 groups: control group (CG) who will not undergo WBVE, with their normal daily routine, group who will be exposed to WBVE in the sitting position in an auxiliary chair once a week (GS1) and twice a week (GS2) and WBVE group twice a week in the standing position with knee flexion (GP2).

Participants

Recruitment of participants is ongoing.

Inclusion criteria

Individuals of (i) both sexes and (ii) outpatient at the HUPE, diagnosed with COPD based on criteria established by the Global Initiative for Chronic Lung Disease (GOLD) with stable disease with Expiratory Volume Forced in the 1st Second (FEV1) < 50% and independents.

Exclusion criteria

Individuals with exacerbation of the disease for less than 3 months; (i) labyrinthitis; (ii) osteoporosis reported; (iii) other respiratory diseases; (iv) pacemaker; (v) previous history of fractures and/or other orthopedic diseases submitted to surgeries with implantation of metallic material; (vi) peripheral vascular disease and/or thromboembolism; (vii) heavy smoker and/or alcoholic beverage; (viii) decompensated cardiovascular disease; (ix) aneurysm; (x) previous vitreous hemorrhage; (xi) malnutrition; (xii) postoperative; (xiii) neurological disease that causes “fear” to the movements in the OVP; (xiv) serious or incapacitating clinical illness, at the decision of the investigator.

Withdrawal criteria and management

Withdrawal from the study will be allowed if the participant (i) made such a request, (ii) developed a serious disease, such as heart disease or stroke, and
continuing their participation became inappropriate in the opinion of the investigator and (iii) had an adverse reaction related to the WBVE

Characterization of the parameters used in the intervention with WBVE

The type will be a side-to-side alternating OVP (Novaplate fitness evolution, DAF Produtos Hospitalares Ltda, from Estek As, São Paulo). In the sitting position, individuals will be positioned seated in a chair placed in front of the OVP with their hands resting on the knees and the feet will be on the base of the OVP. In the standing position, individuals will be standing with 130 degrees knee flexion. The individuals will be without footwear. In all groups the peak-to-peak displacement will be 2.5 mm. The time of the interventions will be 6 weeks, each session will have 5 sets, with working time (WT) of 1 min interposed with a rest time (TR) of 1 min. The frequency used will be 25 Hz. A supervisor followed every procedure and instructed the patient to report any discomfort. Depending on the situation, the procedure may be finished.

Surface electromyography

Electromyography (EMG) is the technique that permits to evaluate the muscular function by means of the interpretation of the electric signals emitted by the skeletal musculature. Surface electrodes will be positioned in the vastus lateralis, vastus medial and rectus femoris muscles of the individuals (surface electrodes will be positioned according to SENIAM orientation). This electromyography pattern will be collected through a software coupled to the instrument (EMG832WF, EMG System, São José dos Campos) on the first and last day of the intervention (before and after the session) in all groups.

Handgrip strength

The handgrip strength (HS) will be evaluated with an isometric, hydraulic hand dynamometer (model EMG832WF, EMG System, São José dos Campos, SP). Dynamometry is a reliable, reproducible and easy-to-use tool.

Three measures of HS with the dominant hand, for 3 seconds each, with verbal encouragement, and a 15-second interval between evaluations will be performed before and after the intervention in each group. It will be considered the best of the three measures.

Modified Borg Scale and Medical Research Council Scale

The Medical Research Council (MRC) breathlessness scale comprises five statements that describe almost the entire range of respiratory disability from none (Grade 1) to almost complete incapacity (Grade 5). It will be used to assess dyspnea on the first and last day of the interventions.

The modified Borg Scale (MBS) is a numerical rule from “0” to “10”, where the individual indicates a score for their level of dyspnea, at the beginning and at the end of each session, “0” being no dyspnea and “10”, dyspnea maximum. It has the potential to provide quick, easy, and rapid information about a patient’s dyspnea state.

Sit-to-stand test five times

The sit-to-stand test evaluates an individual’s activity of daily living, and uses the repetitive motion of standing-up and sitting down on a chair.

The test begins with the individual sitting in a chair, with the spine erect, feet resting on the floor, and arms crossed against the chest. After the signal of the supervisor, the individual will stand up fully and then return to the fully seated position, being encouraged to sit and stand for five consecutive times. The supervisor records the total time that the individual takes to finish the test. This test will be performed on the first and last day of the intervention.

Statistical analysis

For the statistical analysis, the normality test of Shapiro-Wilk will be used and appropriate tests will be applied later. The software will be BioEstat 5.3. An intent-to-treat analysis will be performed including all participants in the analysis according to the original allocation of the group. The repeated measurement variance analysis will be used to evaluate the difference between and within the group. The Bonferroni post hoc test will be used to compare the results. Data will be presented as mean and standard deviation, and the significance will be set to 0.05.

Discussion

Strategies for prevention or ameliorating COPD exacerbations may have an important impact on the health burden of this common disease and thus improve the morbidity and mortality.

Gloeckl et al. has suggested that WBVE seem to be a promising exercise modality for patients with COPD.
and may enhance the effects of a multidisciplinary rehabilitation program. Moreover, Gloeckl et al. have pointed out that the implementation of WBVE improves postural balance performance and muscle power output. The neuromuscular adaptation related to improved balance performance may be an important mechanism of the improvement in exercise capacity after WBVE especially in COPD patients with impaired balance performance and low exercise capacity. Pleguezuelos et al. have verified that WBVE provide significant improvements in functional capacity in severe COPD patients without changes in muscular force. Braz Jr et al. have pointed out the WBVE may potentially be a safe and feasible way to improve functional capacity in the 6-minute walk test (6MWT) of patients with COPD undergoing a training program on the vibrating platform as well as in all domains of the Saint George’s Respiratory Questionnaire quality of life. Neves et al. have demonstrated that the WBVE induced clinically significant benefits regarding exercise capacity, muscle strength and quality of life in patients with COPD, that were not related to inflammatory-oxidative biomarkers changes.

Pleguezuelos et al., 2013 have reported that WBVE during hospitalized exacerbations did not cause procedure-related adverse events and induced clinically significant benefits regarding exercise capacity and health-related quality of life that were associated with increased serum levels of irisin, a marker of muscle activity. In this line, Furness et al. have verified in a community-based proof-of-concept trial that a session of WBVE can be completed with the absence of dyspnea for people with COPD. Furthermore, there were no meaningful differences among WBVE and no vibration group for heart rate and oxygen saturation. There is scope for long-term community-based intervention research using WBVE given the known effects of WBVE on peripheral muscle function and functional independence. Moreover, Furness et al. showed that WBVE did not exacerbate symptoms of COPD that can be associated with physical inactivity. The WBVE intervention improved tests to simulate activities of daily living such as rising from a chair, turning, and walking gait with greater effect than a no vibration group. As a standalone community-based intervention, WBVE was an efficacious mode of exercise training for people with stable COPD that did not negatively affect exercise tolerance or exacerbate the disease, while concurrently improving functional performance of the lower limbs. 

Putting together all the considerations, it is possible to suggest that WBVE seem to be an important modality of exercise for the management of individuals with COPD. This stimulates the elaboration of the protocols presented in the current work.

The strengths of our protocol are that 1) this investigation responses on neuromuscular function through the evaluation of the electromyographic pattern after WBVE in individuals with COPD in muscles, which has not been described in this population; 2) the study with two different protocols involving WBVE, with an intervention period of 6-weeks; 3) the evaluation of dyspnea through the MBS and the MRC will permit to verify the impact of the WBVE. On the other hand, the use of a large sample size will also address the current study’s limitation of relying on a relatively small study population and the fact that it is not a multicenter trial.

Conclusion

In conclusion, this study attempts to estimate the effect of WBVE on outcomes, including daily life function and neuromuscular control, in individuals with COPD. The study results may provide evidence to support the beneficial effects of a WBVE program on the physical performance and neuromuscular control of individuals with COPD. The findings of this study will fill the research gap in the efficacy of WBVE based on the results of the proposed project. Further comprehensive research on the exercise rehabilitation of COPD will be proposed. Furthermore, the possible mechanism of postural instability in COPD patients may be discussed.

References


