How to cite: Fernades HS, Tuon T, Rosado M, Lino PR, Pinho RA. Effects of dual-task exercise on postural instability and respiratory parameters in patients with Parkinson's disease. Rev Bras Fisiol Exerc 2021;20(1):52-63. DOI: 10.33233/rbfex.v20i1.4011

RBFEx
ISSN Online: 2675-1372

Revista Brasileira de Fisiologia do Exercício

Original Article

Effects of dual-task exercise on postural instability and respiratory parameters in patients with Parkinson's disease

Efeitos do exercício físico de dupla tarefa sobre a instabilidade postural e parâmetros respiratórios em pacientes com doença de Parkinson

Hérica Salvaro Fernandes[1], Talita Tuon[2], Miguel Rosado[1], Paulo Roberto Lino[1], Ricardo Aurinho Pinho[3]

1. Universidade do Extremo Sul Catarinense, Criciúma , SC, Brazil
2. Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil
3. Pontifícia Universidade Católica do Paraná, Curitiba, PR, Brazil

ABSTRACT

Introduction: Parkinson's disease presents physiological changes that compromise the patient's daily physical behavior, altering postural instability as well as injuries on the respiratory system. **Objective:** The aim of the present study was to verify the quality of life and the effects of dual-task exercise on postural instability and respiratory parameters in patients with Parkinson's disease. **Methods:** Fourteen patients underwent dual-task exercises (vestibular and respiratory), 3 times a week and lasting 45 minutes for a period of 60 days. Quality of life, disease staging, respiratory indicators, physical fitness and vestibular parameters were evaluated before and 48 hours after the intervention period. **Results:** The quality of life indicators, such as mobility, activity of daily living, emotional well-being, stigma, cognition, communication and body discomfort, showed a statistically significant difference when compared to baseline data. Lung function, physical fitness and vestibular system data showed improvement after the intervention program. **Conclusion:** The results obtained suggest that the effects of dual-task physical exercise in PD patients with Parkinson´s disease have positive effects on behavioral and functional aspects involved in the quality of life, contributing to the regulation of the vestibular system.

Keywords: parkinson's disease; physical exercise; muscle strength; balance; breath.

RESUMO

Introdução: A doença de Parkinson (DP) apresenta alterações fisiológicas que comprometem o comportamento físico diário do paciente alterando a instabilidade postural bem como agravos sobre o sistema respiratório. **Objetivo:** o objetivo do presente estudo foi verificar a qualidade de vida e os efeitos do exercício físico de dupla tarefa sobre a instabilidade postural e parâmetros respiratórios em pacientes com doença de Parkinson. **Métodos:** Quatorze pacientes com DP foram submetidos a exercícios de dupla-tarefa (vestibulares e respiratórios), 3 vezes por semana e duração de 45 minutos por um período de 60 dias. Indicadores de qualidade de vida, estadiamento da doença, respiratórios, aptidão física e parâmetros vestibulares foram avaliados antes e quarenta e oito horas após o período de intervenção. **Resultado:** Os indicadores de qualidade vida de pacientes com DP como mobilidade, atividade de vida diária, bem-estar emocional, estigma, cognição, comunicação e desconforto corporal apresentaram diferença estaticamente significativa quando comparadas aos dados basais. Dados de função pulmonar, de aptidão de física e do sistema vestibular, apresentaram melhora após o programa de intervenção. **Conclusão:** Os resultados obtidos sugerem que os efeitos do exercício físico de dupla tarefa em pacientes com DP exercem efeitos positivos sobre aspectos comportamentais e funcionais implicados na qualidade de vida de pacientes com DP, contribuem para a regulação do sistema vestibular.

Palavras-chave: doença de Parkinson; exercício físico; força muscular; equilíbrio; respiração.

Received: April 9, 2020; Accepted: July 20, 2020.

Correspondence: Talita Tuon, Programa de Pós-graduação em Ciências do Movimento Humano, Universidade Federal de Santa Catarina, Campus Araranguá, Unidade Mato Alto, Rua Pedro João Pereira, 150 Mato Alto 88905-120 Araranguá SC, talitatuon@gmail.com

Introduction

Parkinson's disease (PD) is a progressive, slow, and irreversible neurodegenerative disease, with an estimated prevalence of 1 to 3% in the world population aged over 55 years, with its main neuropathological characteristic being the loss of dopaminergic neurons [1,2]. The reduction in dopaminergic neurons may be associated with different mechanisms, including oxidative stress, excitoxicity, homeostatic calcium disturbance, inflammation, genetic factors, apoptosis, environmental factors and protein aggregation [1,3,4] which compromise daily physical behavior altering postural instability [5], as well as causing damage to the respiratory system [6].

Postural instability has been identified as one of the main complaints by PD patients [7] in which disturbances in sensory information, impaired sensory motor processing and impaired motor coordination affect the patient's postural control [8]. In addition, PD promotes dysfunctions of the respiratory system, such as dyspnea, hypoventilation, atelectasis, retention of pulmonary secretions, abnormalities associated, mainly with a greater predisposition to respiratory infections, decreased chest mobility and peak expiratory flow [8]. These dysfunctions are associated with muscle stiffness and this induces a loss of flexibility in the respiratory muscles. Postural changes that, as a hyperkyphotic pattern, influence the lower chest expansion resulting in less lung volumes and restrictive ventilation deficit, changes in muscle activation and coordination and involvement of the upper airways at the level of glottic and supraglottic structures [9].

In this scenario, the regular practice of physical exercises contributes to the control of neurodegenerative disorders related to PD [10]. In addition to improving motor functions [11], exercises help to improve ventilatory capacity and cardiorespiratory rate in individuals with PD [12]. Physical exercise can cause cortical activation patterns similar to those achieved with the use of pharmacological resources in these patients, which suggests that it is extremely important for the symptomatic relief of motor impairments of the disease [13]. Although the evidence points to the importance of physical exercise in controlling PD, the findings that reveal the role of dual-task exercises on vestibular and respiratory changes are still inconclusive. In this context, the aim of the present study was to verify the quality of life and the effects of dual-task physical exercise on postural instability and respiratory parameters, in patients with Parkinson's disease.

Methods

Participants and ethical procedures

The recruitment of participants was conducted through dissemination by local media. Those eligible were those who had a clinical diagnosis of PD confirmed by a medical report for at least 1 year, residing in the city of Criciúma / SC and region and registered in the UNESC's Pharmacy School program. All subjects met the

following inclusion criteria: Preserved level of consciousness, be between stages 1 and 4 on the Hoenh and Yahr scale and use the same class of drugs for the treatment of Parkinson's disease. Exclusion criteria were subjects who underwent some type of supplementation, who had physical limitations that compromised the performance of activities and / or other associated degenerative diseases and violated the inclusion criteria. The present proposal was inserted in the Platform Brazil and approved by the institution's ethics committee (CEP) under protocol No. 1,425,772. A total of 22 male subjects were interested in participating in the study, but only 15 met the inclusion criteria and 14 completed the intervention period, as shown in the flowchart below (Figure 1).

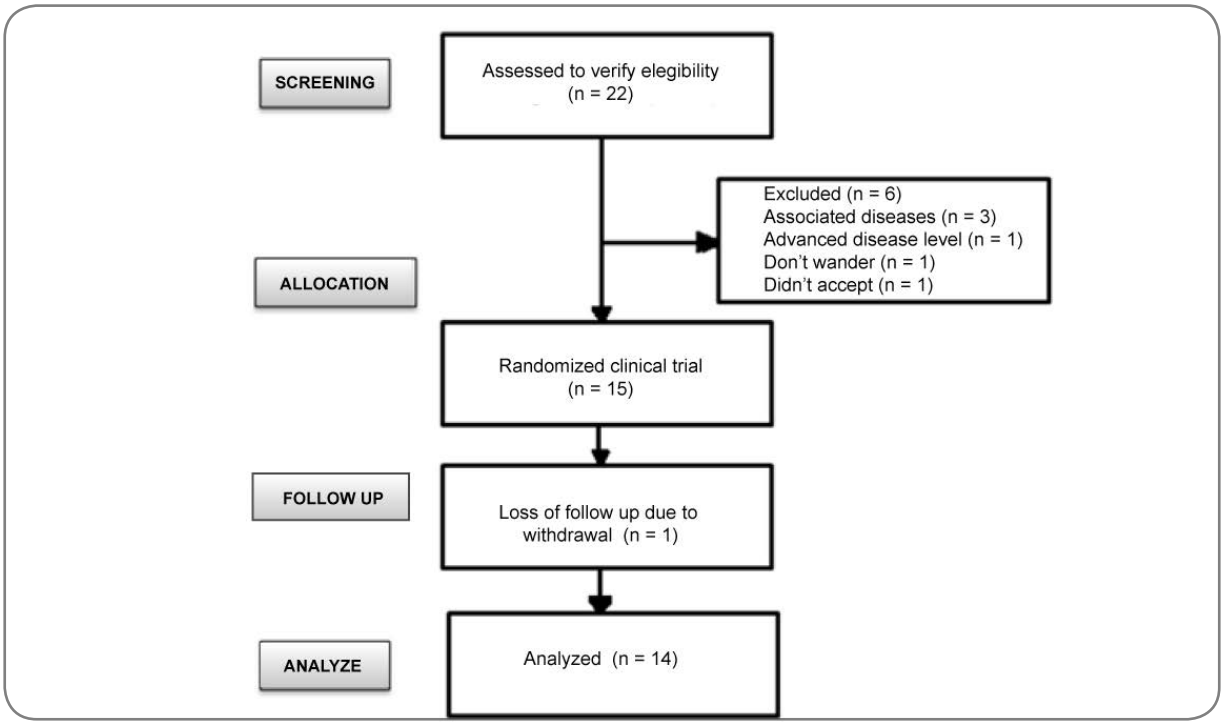


Figure 1 - Flowchart referring to the recruitment and selection of the sample

Initial data were obtained through prior assessment of patients during a home visit previously carried out before the intervention protocol. These sample characterization data are described in table I.

Intervention

The study was conducted for a period of 60 days, in the months of October, November and December, with training frequency of 3 times a week and duration of 45 minutes as recommended by the European Physiotherapy Guideline for Parkinson's disease. The training protocol consisted of warm-up exercises, strength exercises and proprioceptives. Vestibular rehabilitation exercises were based on the protocols of Cawthorne & Cooksey, by Herdman (2007). Breathing exercises [12] were performed in association with the other exercises.

Table I - Characterization of the sample (n = 14)

Variables	Mean ± SD or %
Age (years)	65.07±8.70
Age years)	8.43 ± 4.18
BMI (kg / m²)	27.43 ± 3.19
Systolic blood pressure (mmHg)	126.43 ± 1393
Diastolic blood pressure (mmHg)	82.86 ± 11.38
Heart rate (bpm)	80.29 ± 12.80
Oxygen saturation (%)	97.64 ± 1.44
Associated diseases	
Dizziness	64.3%
Systemic Arterial Hypertension	35.7%
Heart diseases	7.1%

Data presented as mean and standard deviation or percentage. Body mass index (BMI) mm of mercury (mmHg), beats per minute (bpm), percentage (%)

Functional assessments

The evaluations were performed before and 48 hours after the physical training program. Parkinson's disease stage and severity were evaluated using the modified Hoehn and Yahr Staging Scale, patients' quality of life through the Parkinson's Disease Questionnaire-39 (PDQ-39), the elderly's functional fitness by battery of Senior Fitness Test tests proposed by Rikli and Jones [14], evaluation of static balance through the sensitized Romberg test with open eyes and proprioceptive loss through the Fukuda steps test [8] and lung function by spirometry from a forced breathing maneuver using the spiro USB spirometer (Carefusion, USA).

Statistical analysis

Initially the data were analyzed by GraphPad, considering an alpha = 0.05. Subsequently, the Kolmogorov-Smirnov test was used to verify the normality of the data obtained. The data were analyzed by the Wilcoxon test considering a statistical difference when the p was < 0.05. All data were expressed as mean ± standard deviation and percentage.

Results

Quality of life

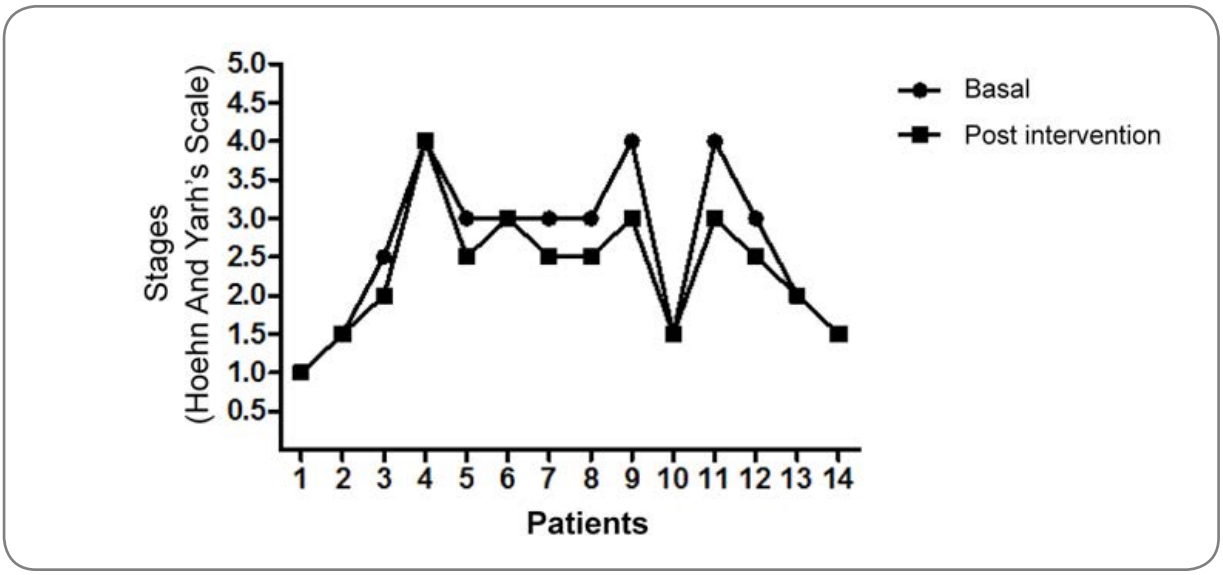
As seen in Table II, quality of life indicators such as daily life activity, emotional well-being, stigma, cognition, communication, and body discomfort showed a statistically significant difference when compared to data prior to the intervention program.

Table II - Quality of life indicators of patients with Parkinson's disease submitted to a dual task physical exercise program

	Score (mean ± standard deviation)		p-Value
	Basal	Post-intervention	
Mobility	25.78 ± 9.97	15.71 ± 9.47	<0.001*
Daily Life Activity	14.64 ± 5.13	10.00 ± 5.32	<0.001*
Emotional well-being	11.07 ± 4.32	8.64 ± 3.85	<0.001*
Stigma	6.35 ± 2.49	4.85 ± 2.95	0.016*
Social support	8.92 ± 0.91	8.50 ± 1.09	0.084
Cognition	6.85 ± 1.95	5.64 ± 1.21	<0.001*
Communication	6.35 ± 1.64	4.92 ± 1.43	0.007*
Body discomfort	5.78 ± 1.84	4.64 ± 1.59	0.011*

The data are presented as mean and standard deviation considering the maximum score obtained in the questions of the Parkinson's Disease Questionnaire. *Values obtained after application of Student's t tests for paired samples and Wilcoxon's T tests (n = 14)

Staging of PD: There were no statistical differences in the stages of development of PD, however, it is worth mentioning that some individuals showed changes after the intervention program that can have positive effects on PD control, as shown in Figure 2.



Baseline values compared to post-intervention values
Figure 2 - Developmental stages of PD according to the Hoehn and Yahr Staging Scale

Respiratory parameters

Table III shows, in average terms, that patients showed changes in functional breathing indicators after the intervention program. Although these values are not statistically different, they may represent an important change in the patients' breathing pattern.

Table III - Pulmonary function data of patients with Parkinson's disease submitted to a dual task physical training program

Variables	Basal (% predicted)	Post-intervention (% predicted)
VEF1 (L)	65.23 ± 5.7	71.44 ± 6.36
CVF (L)	74.92 ± 4.88	78.38 ± 5.60
PFE (L/s)	45.42 ± 5.44	54.25 ± 6.56
VEF1/CVF (%)	85,66 ± 4,10	91.29 ± 3.14

Values are expressed as mean and standard deviation based on the predicted value of each patient (n = 10). The values of Forced expiratory volume in the first second (FEV1), Forced vital capacity (FVC), Peak expiratory flow (PEF) and the FEV1 / FVC ratio

Physical aptitude

As noted in table IV, patients showed important differences after the intervention program. Only the test of sitting and reaching the feet did not show a statistically significant result. The other variables such as sitting and getting up from the chair, forearm flexion, walking 2.44 meters, reaching the back, and walking 6 minutes showed significant changes before and after the exercise program.

Table IV - Physical fitness data of patients with Parkinson's disease submitted to a dual task physical training program

	Score (mean ± PD)		p-Value
	Basal	Post-intervention	
Sit-ups 30s (number of repetitions)	8.14 ± 3.82	14.29 ± 4.42	<0.001*
Forearm flexion 30s (number of repetitions)	10.71 ± 5.46	16.64 ± 4.65	<0.001*
Sit and reach the foot (distance cm)	5.86 ± 7.89	3.21 ± 6.37	0.017
Walking 2.44m (time seconds)	13.24 ±10,47	7.05 ± 3.13	0.001*
Reach behind the back (distance cm)	24.71 ± 15.01	15.64 ± 9.63	0.001*
Walking 6 minutes (distance m)	278.57 ± 136.76	345.71 ± 130.36	<0.001*

Data are presented as mean and standard deviation considering the maximum score obtained in the questions of the Senior Fitness Test. * Values obtained after application of Student's t tests for paired samples and Wilcoxon's T tests (n = 14)

Vestibular system

The variables for assessing the vestibular system were described in Table V. The presence of nystagmus was observed in 71.4% of the sample population. The Romberg test, which assesses body balance with eyes open, showed a statistically significant difference, showing that in the initial evaluation only 35.7% were able to perform the test and in the final evaluation, after the intervention, 78.6% were able to perform it. The Fukuda test also showed significant results both in the angle and in the displaced meters before, and after the intervention.

Table V - Vestibular system parameters data of patients with Parkinson's disease submitted to a dual task physical training program

Variables	Mean ± PD or n (%)		p-Value
	Basal	Posts-intervention	
Nystagmus			
Yes	71.4%		
No	28.6%		
Romberg test			
Yes	64.3%	21.4%	0.031**
No	35.7%	78.6%	
Fukuda test			
Displaced meters	0.78 ± 0.33	0.42 ± 0.19	0.001*
Angle (degrees)	31.79 ± 17.17	16.43 ± 12.00	0.005*

Data are presented as mean and standard deviation or percentage considering the maximum score obtained in the different tests. * Values obtained after application of Student's t tests for paired samples and Wilcoxon test (n = 14)

Discussion

Behavioral changes, such as the adoption of a more active lifestyle or participation in physical training programs for specific purposes, have been pointed out in several studies as a fundamental condition for maintaining health or reducing the risks associated with several chronic-degenerative diseases. In this sense, PD consists of a neurological, chronic, and progressive disease affects body movements and is highly susceptible to the effects of exercise. Experimental studies in animal models of our group [3,4] or studies in humans [10,15] have revealed that regular physical exercise promotes quantitative and qualitative benefits to neurological functions. Despite these advances and scientific reports, the data obtained are still inconclusive since physical exercise is constituted by different forms and characteristics in its execution such as specificity, frequency, intensity, duration and type or model.

Dual-function or dual-task exercises involve performing a main activity, which is the focus of attention, and a secondary activity performed at the same time [16]. In this context, the motor and cognitive systems work with each other to guarantee more pronounced effects resulting from exercise. This exercise model, respecting specificity, intensity, frequency, and duration criteria, can be a relevant strategy that contributes to improving the behavioral, functional, and biochemical parameters of patients with PD. Thus, our study aimed to verify the potential effect of a dual-task physical exercise program on postural instability and respiratory parameters in patients with PD.

The quality of life of patients with PD consists of at least three major domains: physical, mental, and social [17]. Several instruments have been proposed to

identify the role of a given intervention on a patient's quality of life. In this scenario, the Parkinson's Disease Questionnaire - 39 (PDQ-39) has been indicated as the most appropriate instrument for assessing the quality of life of patients with PD [18]. Our results revealed that mobility and activity of daily living were the two domains that showed higher levels of commitment by patients, especially about tasks of motor origin, involving situations such as walking, performing leisure activities, bathing. This result is consistent with previous studies emphasizing that disorders related to the development of motor activities are detected as factors that negatively alter the perception of quality of life [17,19,20].

After the intervention period with physical exercise, a significant improvement was observed in almost all the domains investigated, except for social support. This is in agreement with Deane *et al*. [21], in which they demonstrate the practice of physical exercises in the rehabilitation of individuals with PD, reducing the debilitating effects of sensorimotor impairment in order to improve participation in social activities and consequent improvement in quality of life.

The etiology of PD is complex and, therefore, the disease progression stages depend on psychosocial and biological factors that can contain or delay the harmful and degenerative effects during life. The results of the Hoehn and Yahr Staging Scale (modified) show that the patients had scores from 1 to 4 on that scale, however the descriptive analysis reveals that some patients improved the disease stage after the intervention program. Studies show that there is an association between the severity of the disease and the upper and lower body strength. These effects are possibly associated with the improvement in the indicators of functional capacity or physical fitness promoted by the training program. In this sense, Wade and Tarsy *et al*. [22,23] suggest that several types of physical training are probably effective in improving the functional outcome for patients with PD, showing the effectiveness of the intervention given the functionality and stage of the disease of the investigated patients.

One of the factors apparently secondary to PD are changes in respiratory function, which potentiates the degenerative effects of the disease and worsens the patient's health status. This disorder probably remains unnoticed while the disease develops, because physical disability in PD generally leads the patient to lead a sedentary life, consequently limiting him from activities where breathing problems can become evident [24]. The results observed in the present study reveal that patients have spirometric characteristics compatible with restrictive ventilatory disorder. An increase of 9.52% in the values of forced expiratory volume in the first second (FEV1) and 19.44% in the peak expiratory flow (PEF) were observed. Although there is no statistical difference on these data, this difference can represent an important clinical improvement for these patients. The increase in such parameters in patients with restrictive functional characteristics may impact the increase in chest expansion and reduce the deficit in lung volume, compatible with the restriction pattern [24]. In this sense, although the respiratory function does not undergo significant changes, it does not exclude the importance of dual-task exercise for the clinical condition of

patients with PD.

The assessment of functional capacity in PD has been increasingly reported in the literature, highlighting a sensitive measure that could be used as a possible predictor for the evolution of the disease. In this context, Gustafsson *et al*. [25] demonstrate the importance of motor assessment through batteries of tests in normal individuals. The authors observed, from a prospective study involving 1,317,713 men, deficits in isometric strength of the upper limbs, three decades before the first symptoms of PD manifestations. In the present study, we used the Senior Fitness Test battery, which, according to Rikli and Jones [14], measures the physical fitness of the elderly to perform activities of daily living in old age and is composed of six motor tests that assess the strength of the upper limbs and lower limbs, flexibility of upper and lower limbs, agility / dynamic balance and aerobic endurance. The results observed in the present study show important differences after the intervention program. In particular, the variables of sitting and getting up from the chair, forearm flexion, walking 2.44 meters, reaching the back, and walking 6 minutes, showed significant changes after the exercise program. These results are in line with previous studies in which they demonstrated that an intervention through exercises can improve strength, measures of static postural stability and motor symptoms in people with PD [11,26,27].

According to Christofoletti [28], among the several benefits promoted by physical training, the increase in tone and strength of the muscles involved in walking and balance promote improvements in the mobility of patients with PD. The data from the present study corroborate these findings. In addition to observing the significant improvement in the strength of the lower and upper limbs, the training program promoted the biomechanical alignment of the posture, the reduction of the time of execution of the motor tasks and the improvement of the gait speed [22,25].

According to Colnat-Coulbois *et al*. [29], parkinsonian patients have an inadequate interaction of the systems responsible for body balance, vestibular, visual and proprioceptive systems due to changes in low dopamine levels that, when leading to inefficient movement control, affect the processing of vestibular, visual and proprioceptives responsible for maintaining body balance [22,26]. The results of this study show that 71.4% of the patients had nystagmus and were completely reversed after the exercise program. In addition to these findings, the patients' body balance was also significantly improved with regular physical exercise. The possible effects of exercise on these postural parameters are possibly associated with the dual task used in the exercise protocol. According to Azadian *et al*. [15], when the training has dual task exercises, positive effects are observed in space-time parameters, such as walking speed, stride size, oscillatory dynamic balance, and symmetry of the lower limbs. Zeigelboim *et al*. [30] demonstrate that vestibular rehabilitation can induce or even cancel the signs and symptoms triggered by PD.

Conclusion

The results observed in the present study reveal that patients with Parkinson's disease have spirometric characteristics compatible with restrictive ventilatory disturbance but have shown changes in functional breathing indicators after the intervention program. Although there is no statistical difference on these data, this difference can represent an important clinical improvement for these patients. Taken together, the results obtained suggest that the effects of dual-task physical exercise have positive effects on behavioral and functional aspects involved in the quality of life of patients with Parkinson's disease, as well as contributing to the regulation of the vestibular system.

Acknowledgements
We are grateful to all patients with Parkinson's disease who participated in this study. We would also like to thank the Physiotherapy Course of the Universidade do Extremo Sul Catarinense for assigning the physical space to carry out the activities.

Potencial conflict of interest
No conflicts of interest with potential for this article have been reported.

Financing
This study was partially supported by the National Council for Scientific and Technological Development (CNPQ).

Academic link
This study is linked to the Graduate program in Health Sciences – PPGCS, from the Universidade do Extremo Sul Catarinense.

Authors' contribution
Conception and design of the research: Fernandes HS, Tuon T, Pinho RA; **Data collection:** Fernandes HS, Tuon T, Rosado M, Lino PR; **Analysis and interpretation of data:** Hérica S. Fernandes, Talita Tuon, Ricardo A. Pinho; **Writing of the manuscript:** Fernandes HS, Tuon T, Pinho RA; **Critical review of the manuscript for important intellectual content:** Tuon T.

References

1. Emborg, M. E. Evaluation of animal models of Parkinson's disease for neuroprotective strategies. J Neurosci Methods 2004;139(2):121-43. https://doi.org/10.1016/j.jneumeth.2004.08.004

2. Protter D, Lang C, Cooper AA. α Synuclein and mitochondrial dysfunction: a pathogenic partnership in Parkinson's disease? Parkinson's Disease 2012;1-12. https://doi.org/10.1155/2012/829207

3. Tuon T, Souza OS, Santos MF, Pereira FT, Pedroso GS, Luciano TF *et al*. Physical training regulates mitochondrial parameters and neuroinflammatory mechanisms in an experimental model of Parkinson's disease. Oxidative Medicine and Cellular Longevity 2015;1-10. https://doi.org/10.1155/2015/261809

4. Tuon T, Valvassori SS, Lopes-Borges J, Luciano T, Trom CB, Silva LA *et al*. Physical training exerts neuroprotective effects in the regulation of neurochemical factors in an animal model of Parkinson's disease. Neuroscience 2012;227:305-12. https://doi.org/10.1016/j.neuroscience.2012.09.063

5. Ni M, Signorile JF, Mooney K, Balachandran A, Potiaumpai M. Comparative effect of power training and high-speed yoga on motor function in older patients with Parkinson disease. Arch Phys Med Rehabil 2016;97(3):345-54. https://doi.org/10.1016/j.apmr.2015.10.095

6. Ramos ML, Neves DR, Lima VP, Orsini M, Machado D, Bastos VH, Santos AP. Análise de parâmetros pneumofuncionais em pacientes com doença de Parkinson: estudo piloto. Rev Bras Neurol

2014;50(2):38-43

7. Suarez H, Dario G, Ferreira ED, Nogueira S, Arocena S, San Roman C, Suarez A. Balance in Parkinson's disease patients changing the visual input. Braz J Otorhinolaryngol 2011;77(5):651-5. https://doi.org/10.1590/S1808-86942011000500019

8. Sallem AF, Sapienza CM, Okun MS. Respiratory muscle strength training: treatment and response duration in a patient with early idiopathic Parkinson´s disease. Neuro Rehabilitation 2005;20:323-33

9. Ferreira FV, Cielo CA, Trevisan ME. Aspectos respiratórios, posturais e vocais da doença de Parkinson: considerações teóricas. Rev CEFAC 2011;13(3):534-40. https://doi.org/10.1590/S1516-18462010005000135

10. Zigmond M, Cameron JL, Hoffer BJ, Smeyne RJ. Neurorestoration by physical exercise: moving forward. Parkinsonism Relat Disord 2012;18(Suppl1):147-50. https://doi.org/10.1016/S1353-8020(11)70046-3

11. Kurtais Y, Kutlay S, Tur BS, Gok H, Akbostanci C. Does treadmill training improve lower-extremity tasks in Parkinson disease? A randomized controlled trial. Clin J Sport Med 2018;18(3):289-91. https://doi.org/10.1097/JSM.0b013e318170626d

12. Pelosin E, Faelli E, Lofrano F, Avanzino L, Marinelli L, Bove M, Ruggeri P, Abbruzzese G. Effects of treadmill training on walking economy in Parkinson's disease: a pilot study. Neurol Sci 2009;30(6):499-504. https://doi.org/10.1007/s10072-009-0141-8

13. Alberts JL, Phillips M, Lowe MJ, Frankemolle A, Thota A, Beall EB, *et al*. Cortical and motor responses to acute forced exercise in Parkinson's disease. Parkinsonism Relat Disord 2016;24:56-62. https://doi.org/10.1016/j.parkreldis.2016.01.015

14. Rikli Re, Jones CJ. Functional fitness normative scores for community-residing older adults, ages 60-94. J Aging Phys Act 1999;7:162-81. https://doi.org/10.1123/japa.7.2.162

15. Azadian E, Torbati HR, Kakhki AR, Farahpour N, Azadian E. The effect of dual task and executive training on pattern of gait in older adults with balance impairment: A Randomized controlled trial. Arch Gerontol Geriatr 2016;62:83-9. https://doi.org/10.1016/j.archger.2015.10.001

16. Christofoletti G, Andrade LP, Beinotti F, Borges G. Cognition and dual-task performance in older adults with Parkinson's and Alzheimer's disease. Int J Gen Med 2014;7:383-8. https://doi.org/10.2147/IJGM.S65803

17. Assumpção FB, Kuczynski E, Sporovieri MH, Aranha EMG. Escalas de avaliação de qualidade de vida. Arq Neuropsiquiatr 2000;58:119-27. https://doi.org/10.1590/S0004-282X2000000100018

18. Marinus J, Ramaker C, Van Hilten JJ, Stiggelbout AM. Health related quality of life in Parkinson's disease: a systematic review of disease specific instruments. J Neurol Neurosurg Psychiatry 2002;72(2):241-8. https:doi.org/10.1136/jnnp.72.2.241

19. Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. Neurology 1967;17(5):427-42.

20. Lana RC, Álvares LMRS, Nasciutti-Prudente C, Goulart FRP, Teixeira-Salmela LF, Cardoso FE. Percepção da qualidade de vida de indivíduos com doença de Parkinson através do PDQ-39. Rev Bras Fisioter 2007;11(5):397-402. https://doi.org/10.1590/S1413-35552007000500011

21. Deane KH, Jones D, Playfor DED, Ben-Shlomo Y, Clarke CE. Physiotherapy for patients with Parkinson's Disease: a comparison of techniques. Cochrane Database Syst Rev 2001;3.CD002817. https://doi.org/10.1002/14651858

22. Wade DT, Gage H, Owen C, Trend P, Grossmith C, Kaye J. Multidisciplinary rehabilitation for people with Parkinson's disease: a randomised controlled study. J Neurol Neurosurg Psychiatry 2003;74(2):158-62. https://doi.org/ 10.1136/jnnp.74.2.158

23. Tarsy D, Hurtig HI, Dashe JF. Nonpharmacologic management of Parkinson disease. Uptodate: last literature review 2008;1-5.

24. Torsney KM, Forsyth D. Respiratory dysfunction in Parkinson's disease. J R Coll Physicians Edinb 2017;47(1):35-39. https://doi.org/10.4997/JRCPE.2017.108

25. Gustafsson H, Strahle JAS, Nordstrom A, Nordstrom P. Low muscle strength in late adolescence and Parkinson disease later in life. Neurology 2015;84(18):1862-9. https://doi.org/10.1212/WNL.0000000000001534

26. Jöbges EM, Spittler-Schneiders H, Renner CI, Hummelsheim H. Clinical relevance of rehabilitation programs for patients with idiopathic Parkinson syndrome. II: Symptom-specific therapeutic approaches. Parkinsonism Relat Disord 2007;13(4):203-13. https://doi.org/10.1016/j.parkreldis.2006.07.018

27. Goodwin VA, Richards SH, Taylor RS, Taylor AH, Campbell JL. The effectiveness of exercise interventions for people with Parkinson's disease: a systematic review and meta-analysis. Mov Disord 2008;23(5):631-40. https://doi.org/10.1002/mds.21922

28. Christofoletti G, Freitas RT, Cândido ER, Cardoso CS. Eficácia de tratamento fisioterapêutico no equilíbrio estático e dinâmico de pacientes com doença de Parkinson. Fisioter Pesqui 2010;17(3):259-63. https://doi.org/10.1590/S1809-29502010000300013Colnat

29. Colnat-Coulbois S, Gauchard GC, Maillard L, Barroche G, Vespignani H, Auque J, Perrin PHP. Bilateral subthalamic nucleus stimulation improves balance control in Parkinson's disease. J Neurol Neurosurg Psychiatry 2015;76:780-7. https://doi.org/10.1136/jnnp.2004.047829

30. Zeigelboim BS, Klagenberg KF, Teive HA, Munhoz RP, Martins-Bassetto J. Vestibular rehabilitation: clinical benefits to patients with Parkinson's disease. Arq Neuro-Psiquiatr 2009;67(2):219-23. https://doi.org/10.1590/S0004-282X2009000200009