

Patients with Parkinson's disease under physiotherapeutic care present better pulmonary parameters than sedentary controls

Pacientes com doença de Parkinson sob assistência fisioterapêutica apresentam parâmetros pulmonares melhores do que controles sedentários

Pacientes con enfermedad de Parkinson bajo cuidados fisioterapêuticos presentan parámetros pulmonares mejores que los de controles sedentarios

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ABSTRACT | The aim of this study was to investigate the pulmonary parameters (spirometry and impulse oscillometry) of patients with Parkinson disease (PD) and healthy control peers, comparing the values of the subjects that were participating or not on a physiotherapeutic assistance program. Thirty-seven subjects were divided into four groups: two were formed by patients with PD (practitioners and non-practitioners of a physiotherapeutic protocol performed twice a week during 6 months) and the other two groups were formed by control peers (practitioners and non-practitioners of the same therapeutic protocol). The subjects underwent evaluation of chest cirtometry, spirometry and impulse oscillometry, being all the PD patients evaluated on the "off" state of their anti-PD medication. Data analysis occurred through the use of the non-parametric test of Kruskal-Wallis, with pairwise comparisons being done with Dunett T3 tests. Significance was set at 5%. Regarding the results, with a statistical similarity between groups for chest mobility, patients with PD who underwent the physiotherapeutic protocol showed better pulmonary parameters than sedentary patients. Comparison with control peers indicates better results of the PD group submitted to physiotherapy than sedentary controls. There were no differences in pulmonary parameters of both PD and control groups submitted to physiotherapy. In conclusion, the findings delimit promising results

promoted by physiotherapy on pulmonary parameters in subjects with PD, and emphasize the need for more longitudinal studies of the clinical trial type for proof of cause and effect relationships.

Keywords | Parkinson Disease; Respiratory Function Tests; Lung Volume Measurements.

RESUMO | Este estudo teve como objetivo investigar os parâmetros pulmonares (espirometria e oscilometria de impulso) de pacientes com doença de Parkinson (DP) e controles eutróficos, comparando os valores dos sujeitos participantes e os não participantes de um programa de assistência fisioterapêutica. Trinta e sete sujeitos foram divididos em quatro grupos independentes: dois grupos formados por pacientes com DP (praticantes e não praticantes de um protocolo de exercícios fisioterapêuticos realizados com frequência de dois atendimentos semanais durante 6 meses) e dois grupos compostos por sujeitos controles eutróficos (praticantes e não praticantes do mesmo programa terapêutico). Os sujeitos foram submetidos à avaliação de cirtometria torácica, espirometria e oscilometria de impulso, sendo os pacientes com DP avaliados na fase off da medicação. A análise dos dados ocorreu por meio do teste não paramétrico de Kruskal-Wallis, sendo a comparação aos pares realizada pelo pós-teste de Dunett T3. A significância foi estipulada em 5%. Sobre os resultados, com similaridade entre

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grupos para mobilidade da caixa torácica, os pacientes com DP que realizaram atendimento fisioterapêutico apresentaram parâmetros pulmonares melhores do que os pacientes sedentários. A comparação com os sujeitos eutróficos vislumbra melhores resultados dos participantes com DP em relação a controles sedentários. Não houve diferença significativa entre os sujeitos com DP e controles submetidos ao mesmo protocolo terapêutico. Em conclusão, os achados delimitam resultados promissores do tratamento fisioterapêutico sobre parâmetros pulmonares na DP, e sentenciam a necessidade de novos estudos longitudinais do tipo ensaio clínico para comprovação da relação causa e efeito das variáveis em questão.

Descritores | Doença de Parkinson; Testes de Função Respiratória; Medidas de Volume Pulmonar.

RESUMEN | En este artículo se propone a investigar los parámetros pulmonares (espirometría y oscilometría de impulso) en pacientes con enfermedad de Parkinson (EP) y controles eutróficos, y comparar las puntuaciones de los sujetos participantes y de los no participantes de un programa de cuidados fisioterapéuticos. Se han dividido 37 participantes en cuatro grupos independientes: dos grupos conformados por personas con EP (practicantes y no practicantes de un protocolo de ejercicios fisioterapéuticos realizados frecuentemente en

dos atenciones semanales durante seis meses), y dos grupos controles eutróficos (practicantes y no practicantes del mismo programa terapéutico). A los participantes les sometieron a evaluación de cirtometría torácica, espirometría y oscilometría de impulso, siendo los pacientes con EP evaluados en la etapa en off de medicación. Para el análisis se empleó la prueba no paramétrica de Kruskal-Wallis, siendo aplicada para la comparación con pares la pos-prueba de Dunnett T3. Se empleó el nivel de significación del 5%. Acerca de los resultados, igual que entre grupos para movilidad de la caja torácica, los pacientes con EP, que realizaron atención fisioterapéutica presentaron parámetros pulmonares mejores que los sujetos sedentarios. La comparación con los participantes eutróficos vislumbra mejores resultados de los participantes con EP con relación a los controles sedentarios. No hubo diferencias significativas entre los sujetos con EP y los controles sometidos al mismo protocolo terapéutico. Se concluye que los hallazgos delimitan resultados prometedores del tratamiento fisioterapéutico sobre los parámetros pulmonares de la EP, y llaman la atención para la necesidad de hacer nuevos estudios longitudinales del tipo ensayo clínico para comprobar la relación de causa y efecto de las variables estudiadas.

Palabras clave | Enfermedad de Parkinson; Pruebas de Función Respiratoria; Mediciones del Volumen Pulmonar.

INTRODUCTION

The human respiratory system undergoes structural changes regarding capacity, flow, and volume during aging. This process is a result of lost elasticity, associated with alveolar dilatation and decreased transmission of stimuli in the respiratory muscle^{1,2}. When associated with chronic-neurodegenerative conditions such as Parkinson's disease (PD), the physical and functional decline is potentiated, leaving the patient vulnerable in the everyday performance of basic and instrumental activities².

PD is a progressive extrapyramidal disease characterized by clinical signs of bradykinesia, rigidity, tremor at rest, and postural instability³. Impairment of pulmonary function is often found among the first motor symptoms of the disease^{4,5}. Pulmonary dysfunction is aggravated by progressive rigidity of chest wall, with limitations in flexibility, compromise of airways, and muscle weakness - causing difficult in speech and swallowing^{6,7}. Postural changes also

influence the patient's limitation concerning respiratory capacity, resulting in increased resistance to airflow and decreased pulmonary compliance⁸.

Despite the neuro-physio-pathological changes being already well elucidated in PD, there are still doubts concerning the pulmonary pattern of patients being more concentrated on obstructive or restrictive conditions². In addition, the systematic review conducted by Reyes, Ziman, and Nosaka⁹ reports that the results are still insufficient with regard to the study of respiratory capacity in PD, especially when related to effects generated by the practice of exercise.

Considering such context, we conducted this study aiming to investigate the pulmonary parameters (spirometry and impulse oscillometry) of PD patients and eutrophic subjects, participants or non-participants in a physiotherapy care program. In the methodological design presented, in which probable interference of the factors "medical condition" (PD vs. control) and "physiotherapy" (practitioners vs. non-practitioners) is observed, we determined the following hypothesis:

1) PD patients who undergo physiotherapy care have better pulmonary parameters than sedentary patients; 2) PD patients who undergo physiotherapy have better pulmonary parameters than sedentary controls, and close to active control subjects.

METHODOLOGY

This is a mixed experimental study, with longitudinal follow-up and cross analysis, with 37 subjects of both sexes, divided into four independent groups: G1 (composed of patients diagnosed with PD¹⁰ in moderate stage¹¹ practitioners of a physiotherapy program of 6 months of duration); G2 (composed of patients with PD¹⁰ in moderate stage¹¹ non-practitioners of physiotherapy program); G3 (composed of participants without chronic-degenerative diseases practitioners of the same physiotherapy program); and G4 (composed of control subjects in relation to the disease and the physiotherapy program). The guidelines established by STROBE¹² and CONSORT¹³ were used for characterization of the cross-sectional and longitudinal aspects of this research, with ethical approval obtained from the institutional ethics committee (Protocol No. 438,277).

Regarding inclusion criteria, we admitted participants (with and without PD) with functional independence for orthostatism and bipedestation. As exclusion criteria, we determined prior smoking habits, prior respiratory disorders, thoracic deformities and cognitive decline (assessed by Mini Mental State Examination¹⁴ and referenced by the approval scores established by Brucki et al.¹⁵). Furthermore, we excluded from the study those subjects who practiced any regular physical activity in addition to the physiotherapy protocol proposed in this study.

Sample size calculation considered the subjects' scores obtained in the ratio between forced expiratory volume in 1 second and maximum tidal volume. Thus, we identified an effect of 0.771 that, considering analyses from 4 independent groups, under error type 1 in 5% ($\alpha=0.05$) and error type 2 in 10% ($1-\beta=0.90$), determined a minimum sample of 32 subjects.

Proposed protocol

The methodological protocol comprised 4 independent groups, with 2 submitted to a program of

physiotherapy exercises while 2 remained inactive. In the groups of physically active and sedentary subjects, there was a division of subjects with and without PD, to investigate the effect of the medical condition and of the practice of exercise on pulmonary parameters.

The same therapeutic protocol was applied to participants with and without PD, for six months. In the sessions we determined, as therapeutic strategies, the application of exercises that promoted respiratory and motor stimuli on the subjects – emphasizing activities comprising trunk rotation, dissociation of waistlines, and mobility of upper and lower limbs. Every day, the session was initiated with general stretches, performed in active and active-assisted manner. At the end of each session, playful activities were conducted, with stimuli to motricity.

The main part of the sessions involved activities with subjects sitting and standing, promoting stimuli to muscle strength, coordination, and gait. Exercises were carried out by respiratory feedback, emphasizing expansive lung stimuli (such as deep inhalation, breathing fractioned in times, brief expiration, and sustained inspiration) and thoracic mobility. No incentive spirometry (volume-oriented or flow-oriented spirometer) was used by participants. The materials used in the therapy consisted of Swiss balls of various sizes, rolls, balance boards, sticks, elastic tapes, and mattresses.

Intensity of exercises was calibrated using Borg scale, and activities should be graded between scores 11 (relatively easy) and 14 (slightly tiring)¹⁶. The limit of four absences was defined as a parameter for permanence in this study, considering the interference on results generated by the lack of treatment.

Evaluation procedures

Evaluation procedures involved the measurement of thoracic cirtometry, standardized in the patient's right and left axillary points. Through this procedure, we analyzed thorax mobility in situations of normal breathing, sustained maximum inspiration and expiration.

Spirometry and impulse oscillometry analyses were performed at the Clinic of Pulmonology of the hospital complex of the Federal University of Mato Grosso do Sul. For spirometry, we used the equipment Viasys Healthcare Vmax 22[®], which enabled the investigation of the parameters of maximum tidal volume (TV_{max}), forced expiratory volume in 1 second (FEV1), forced

vital capacity (FVC), ratios of FEV1/FVC and FEV1/ TV_{max} , peak expiratory flow (PEF), and forced expiratory flow between 25-75% of the total volume expired (FEF_{25-75%}). For impulse oscillometry, we used the device IOS Care Fusion Jaeger®, which enabled the analysis of the parameters of total volume (VT), central airway resistance (R5), peripheral airway resistance (R20), and lung reactance (X5).

As for the dynamics of the assessments, all procedures were carried out in the morning period, and PD patients were evaluated in the off phase of medication. Oscillometry was applied prior to spirometry, because the first involved a passive activity, without the patient's effort.

As for the impulse oscillometry, participants were advised to breathe calmly through a mouthpiece (tidal volume and spontaneously). During the maneuvers, we used a nasal clip and the cheeks of the subjects were supported by the evaluator's hands to minimize the loss of oscillatory pressure from the musculature of face and upper airway. Regarding spirometry, normative recommendations from the American Thoracic Society¹⁷ were included and the predicted values were calculated according to the references for normality established by Pereira et al.¹⁸ An external evaluator specialized in pulmonary function was responsible for the spirometry reports for each participant, classifying them as "normal pattern", "obstructive ventilatory disorder", or "restrictive ventilatory disorder".

Statistical procedures

As for the statistical analysis, descriptive data were detailed through mean, standard error, and confidence interval, set at 95%. The precepts of normality and homogeneity of variances were determined through the Shapiro-Wilk and Levene tests, which pointed to the need for non-parametric statistics in the inferential analysis.

Thus, we applied the Chi-square test to analyze the ratio of persons and the classification of the spirometry

report in each group. Although this study consisted of a longitudinal survey of 6 months of follow-up, we focused the statistical analyses on post-intervention endpoints, as we understood that investigation of interactions from relations among the 4 independent groups and 2 different times would require repeated analyses of the factors "interaction", "groups", and "times", which would tend to increase the error type 1 of the tests. Thus, the Kruskal-Wallis test was used to analyze the final anthropometric, spirometric, and oscillometric variables of the groups – presenting the Dunnett T3 post-test to perform comparison in pairs in the case of significant differences. For all analyses, we adopted a significance level of 5% ($p < 0.05$).

RESULTS

Initially, 40 participants were approached in this study, 20 with PD (G1=13 and G2=7) and 20 controls (G3=12 and G4=8). Of the initially screened subjects, 3 were excluded (2 with PD and 1 control) for presenting cognitive values below the reference scores by Brucki et al.¹⁵ Of the initial 37 subjects in the study, 5 sample losses occurred (13.51%), remaining 17 PD patients and 15 controls in the final evaluation. Reasons related to sample losses involved change of residence (n=2), diagnosis of dementia during the follow-up period (n=1), and private reasons (n=2). No subject was excluded due to intolerance to the proposed treatment.

At the end of the study, 32 seniors remained, 15 men (46.87%) and 17 women (53.13%), average age of 69.77 ± 1.66 years (95%CI: 63.37 to 73.17). Table 1 presents the general characteristics of the groups. As observed, the groups are homogeneous for sample size, weight, body mass index, cognition, educational level, and thoracic circumference. The only difference observed in the initial characterization refers to the height of participants, and the comparison in pairs evidenced significant difference between groups G1 and G4.

Table 1. Anthropometric characteristics of the groups

	G1	G2	G3	G4	P
Sample	11	6	9	6	0,522
Age (years)	70,00±2,76 (63,82-76,17)	73,80±2,38 (67,14-82,45)	66,77±3,43 (58,85-74,69)	70,50±4,49 (58,95-82,04)	0,469
MMSE (points)	26,81±0,48 (25,74-27,89)	27,83±0,60 (26,28-29,37)	26,44±0,55 (25,16-27,72)	27,16±0,70 (25,35-28,97)	0,307

continues...

Table 1. Continuation

	G1	G2	G3	G4	P
Educational level (years)	2,90±0,54 (1,69-4,12)	4,00±0,51 (2,67-5,32)	2,33±0,72 (0,65-4,01)	4,33±0,42 (3,24-5,41)	0,148
Weight (Kg)	74,43±3,26 (67,16-81,71)	57,94±5,87 (41,63-74,24)	69,33±4,69 (58,83-80,49)	63,91±8,77 (41,37-86,46)	0,194
Height (m)	1,64±0,02 (1,58-1,69)*	1,53±0,05 (1,39-1,67)	1,61±0,02 (1,54-1,67)	1,53±0,01 (1,49-1,57)*	0,040
BMI	27,32±0,83 (25,46-29,18)	24,59±2,24 (18,35-30,84)	26,56±0,98 (24,28-28,83)	25,64±3,02 (17,86-33,43)	0,837
Basal cirt. (cm)	97,63±1,81 (93,59-101,67)	87,00±4,23 (75,22-98,77)	94,94±3,18 (87,59-102,29)	90,00±4,08 (79,50-100,49)	0,146
Inspirat. cirt. (cm)	101,18±1,87 (97,00-105,36)	89,20±4,32 (77,18-101,21)	98,38±3,37 (90,60-106,17)	92,66±4,12 (82,05-103,27)	0,078
Expirat. cirt. (cm)	96,27±1,84 (92,16-100,37)	85,70±4,20 (74,03-97,36)	93,22±3,29 (85,61-100,82)	88,41±3,87 (78,44-98,38)	0,162

Caption: G1: PD subjects practitioners of physiotherapy program; G2: PD subjects non-practitioners of physiotherapy program; G3: non-PD subjects practitioners of physiotherapy program; G4: non-PD subjects non-practitioners of physiotherapy program. MMSE: Mini Mental State Exam. BMI: Body mass index Cirt.: Cirtometry. *Significant difference (p<0.05) in comparison with pairs

Spirometry and impulse oscillometry

Table 2 details the values obtained in the spirometry and impulse oscillometry of participants. Spirometry reports point to 30 subjects with ventilatory responses consistent with normality parameters and 2 with mild obstructive disorder. These two participants were allocated in group G2 (sedentary PD patients), and the Chi-square test pointed to significant difference for this condition (p=0.026).

Individual analysis of each spirometric factor showed significant difference among groups for TV_{max} , FEV1, and FVC. Comparison in pairs showed that, for the variables in question, PD participants who underwent physiotherapeutic care had better pulmonary values

than sedentary PD participants (non-practitioners of the aforementioned program). When compared to the eutrophic control subjects, the physically active PD participants presented better spirometric results than sedentary controls (non-practitioners of the physiotherapy program) and similar results in relation to the physically active controls (practitioners of the program).

The results obtained by impulse oscillometry indicated similarity of values of the groups for central and peripheral airway resistance and for lung reactance. We observed significant difference among groups for the variable VT, which showed difference only in the comparison between groups G1 and G2 (composed of active and sedentary PD participants). The other comparisons showed no statistical significance.

Table 2. Values for spirometry and impulse oscillometry per group

	G1	G2	G3	G4	p
Spirometry					
TV_{max} (L)	3,91±0,17 (3,52-4,31)* ^f	2,36±0,38 (1,36-3,36)*	3,76±0,22 (3,25-4,26) ⁱ	2,50±0,16 (2,07-2,93) ^{f,i}	0,001
FEV1 (L)	2,95±0,13 (2,66-3,24) ^{ab}	1,72±0,24 (1,10-2,34) ⁱ	2,95±0,19 (2,50-3,39) ⁿ	1,94±0,15 (1,55-2,32) ^{ab,n}	0,001
FVC (L)	3,83±0,17 (3,43-4,23) ^{b,y}	2,32±0,39 (1,30-3,34) ^b	3,75±0,22 (3,23-4,26) ⁱ	2,46±0,17 (2,01-2,91) ^{y,i}	0,001
FEV1/FVC (%)	77,47±1,75 (73,57-81,37)	78,27±4,76 (66,01-90,52)	76,09±1,48 (72,66-79,52)	79,05±3,46 (70,15-87,94)	0,920
FEV1/ TV_{Max} (%)	75,72±1,56 (72,23-79,21)	76,49±4,46 (65,03-87,96)	75,50±1,33 (72,42-78,58)	77,55±3,51 (68,52-86,58)	0,938
PEF (L/s)	6,49±0,67 (4,99-7,099)	4,06±0,50 (2,77-5,36)	5,83±0,50 (4,67-6,99)	4,96±0,57 (3,47-6,45)	0,054
FEF _{25-75%} (L/s)	2,49±0,22 (2,00-2,99)	1,52±0,29 (0,77-2,27)	2,40±0,28 (1,75-3,06)	1,68±0,29 (0,91-2,44)	0,043
Oscillometry					
VT (L)	1,06±0,10 (0,82-1,29) ^y	0,66±0,07 (0,47-0,84) ^y	1,09±0,12 (0,81-1,37)	0,89±0,12 (0,56-1,22)	0,037
R5 (kPas sL ⁻¹)	0,30±0,02 (0,25-0,34)	0,34±0,01 (0,20-0,48)	0,35±0,04 (0,26-0,45)	0,42±0,06 (0,24-0,60)	0,466
R20 (kPas sL ⁻¹)	0,25±0,02 (0,21-0,30)	0,27±0,03 (0,19-0,36)	0,30±0,03 (0,23-0,38)	0,32±0,04 (0,20-0,44)	0,561
X5 (kPas sL ⁻¹)	-0,11±0,01 (-0,15-0,08)	-0,13±0,01 (-0,26--0,01)	-0,13±0,01 (-0,18--0,08)	-0,16±0,01 (-0,24--0,07)	0,306

Caption: G1: PD subjects practitioners of physiotherapy program; G2: PD subjects non-practitioners of physiotherapy program; G3: non-PD subjects practitioners of physiotherapy program; G4: non-PD subjects non-practitioners of physiotherapy program; TV_{max} : tidal volume; FEV1: forced expiratory volume in 1 second; FVC: forced vital capacity; PEF: peak expiratory flow; FEF_{25-75%}: forced expiratory flow between 25-75% of the total volume expired. VT: total volume; R5: central airway resistance; R20: peripheral airway resistance; X5: lung reactance. *^f,ⁱ,^{ab},^b,^y,ⁿ,^{ab,n}: Significant difference (p<0.05) in comparison with pairs, that is, equal symbols among groups represent the significant difference among them

DISCUSSION

In the literature, there is still no consensus on the type of pulmonary dysfunction that is predominant in PD, and it is possible to observe both obstructive and restrictive ventilatory impairment^{4,19}. Due to this, we used spirometry and impulse oscillometry to investigate the characteristic pulmonary dysfunction and compare scores among groups.

In analyzing the subjects' spirometric values, we observed that two participants showed a pattern of mild obstructive disorder and 30 participants showed normal patterns for pulmonary function. The fact that the two subjects with obstructive disorders are found in group G2, consisting of physically sedentary PD subjects, indicates that both factors may be associated with the emergence of the obstructive process. Considering that this pattern was not observed in the group of physically active PD patients and neither in the group of inactive eutrophic subjects, it is possible to affirm that the response found is associated with these two conditions, in which the higher the severity of PD, the higher tends to be the patient's physical inactivity, predisposing the subject to the emergence of ventilatory disorders. Table 2 reinforces such results, indicating substantially lower results for subjects in G2 in relation to the others. This finding corroborates those found by Seccombe et al.²⁰ and reinforces the spirometry reports, which indicate an association between the decline in pulmonary function with PD and physical inactivity.

Impulse oscillometry is the exam used to measure total volume, lung reactance and resistance. This technique is very useful because, when applied as a complement to spirometry, enables a more accurate diagnosis of the subjects' pulmonary function. In the participants of this study, it was possible to observe a lower total lung volume in G2 compared to the other groups. Regarding this finding, it is noteworthy that the total volume is characterized by the balance between the forces of pulmonary expansion and retraction²¹. The parameters for total volume observed in the group of physically active PD patients show similar patterns in relation to the eutrophic subjects – referring to benefits generated by the physiotherapeutic program in the population under consideration.

Another finding that deserves reflection involves lung reactance. Reactance is measured at 5 Hz and represents the peripheral capacitance that reproduces the lung elasticity given changes in lung volume. In our study,

we found no difference among groups for this variable, with scores within the normality range determined by Schultz et al.²² Moreover, the individual oscillometric report reinforces the participants' parameters of normality - with levels of resistance and reactance close to the reference line and resonance value²³.

Thoracic mobility may represent a direction for studies that address the subjects' pulmonary function characteristics, as it has direct influence on patients' respiratory muscle strength²⁴. In conducting the spirometric assessment of all participants and observing statistical similarity among the groups in the comparisons of thoracic amplitude, we verified that such factor had no influence on the subjects' values for spirometry and impulse oscillometry. In addition, the exclusion of patients with possible alteration in thoracic dynamics (commonly present in cases of structural deformities) enabled us to isolate this aspect in the sample selection.

It is important to highlight that all PD patients were evaluated in the off phase of medication. We established this condition due to the intention of investigating the participants' actual pulmonary parameters, with no influence from antiparkinsonian medication²⁵. However, we suggest further studies comparing the subjects' lung assessments with and without the effect from medication, to analyze the pulmonary parameters of physically active and sedentary subjects during the on and the off phases of medication.

Limitations

Although we identify merits and qualities in this research, its limitations should not be overlooked. Firstly, it is noteworthy that the results were based on patients who were in a moderate stage of the disease. Exclusion of subjects in initial and advanced stages was due to our intention of standardizing the sample, avoiding cases in which the symptoms of the disease were not very expressive and others in which the degree of physical weakness was highly disabling.

Secondly, it is important to highlight weaknesses in relation to the methodological design adopted. Although we understand that longitudinal studies of the clinical trial type are more faithful for determining the relations of causes and effects, we justify the conduct of cross-sectional analyses under a six-month follow-up with the aim of controlling statistical errors. Performing mixed analyses from the investigation of 4

independent groups and 2 different times would require 6 combinations of interaction between group and time (G1 vs. G2, G1 vs. G3, G1 vs. G4, G2 vs. G3, G2 vs. G4, and G3 vs. G4), a fact that could increase the error type 1 to 26.49% (above the 5.00% accepted). Therefore, we decided to restrict the final analysis to a transversal vision controlled by post-tests, which, on the one hand, hinders pre- and post-treatment comparison, but, on the other hand, assures us that the data are not under influence from “false positives” and “false negatives”.

CONCLUSIONS

PD patients who underwent physiotherapy care showed evident results concerning pulmonary function compared to sedentary participants (with and without PD). Physical inactivity combined with PD may be associated with the emergence of obstructive ventilatory disorders, potentiated by the patient’s medical decline. Although the results are promising, we recommend the conduct of new studies that address the same subject of our work, to corroborate or not the findings and foster discussions regarding this subject.

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