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Influence of Nordic Walking and Respiratory Muscle Training in Patients with Parkinson: Randomized Clinical Trial

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Abstract

Objective: To verify the impact of respiratory muscle training associated with Nordic walking training on lung function and quality of life in patients with Parkinson's disease (PD).

Methods: 22 patients with PD were randomized into three groups: Respiratory Muscle Training (RMT; n=6), using Power breathe® linear resistor; the group that performed aerobic activity through Nordic Walking (NW; n=9) and the group associating the treatments: Nordic Walking plus Respiratory Muscle Training (RMT+NW; n=7). The variables analyzed were respiratory function, assessed by spirometry and manovacuometry, and quality of life assessed by the Parkinson Disease Questionary scale (PDQ-39). The intervention occurred over a period of 8 weeks, evaluated before and after treatment and subsequently the groups were compared to each other.

Results: The analyzes showed significant intragroup results, with no statistical difference in the comparison between groups. In the respiratory function, there was a gain in expiratory muscle pressure (p=0.008) and forced vital capacity (p=0.011) for the RMT + NW group; gain of inspiratory muscle pressure (p=0.004) for the RMT group and improvement in forced expiratory volume in one second (p=0.039) and in the range of 25%75% of forced expiratory flow (p=0.013) for the NW group. In the results obtained by PDQ-39, there was a positive reduction (p<0.05) in the total score before and after the treatment of each group.

Conclusion: Physical therapy through respiratory muscle training associated with Nordic walking generated positive results for variables related to lung function and quality of life.

Keywords: Parkinson's disease; Breathing exercises; Physiotherapy; Quality of life

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Introduction

Parkinson's disease (PD) affects mostly people over the age of 50 and is prevalent in about 550 per 100.000 inhabitants until 70 years old, being the second most common neurodegenerative disease in the elderly population [1].

It is characterized by affecting the nervous system, in the regions of the base ganglia, interfering in the dopamine actions, the main neurotransmitter responsible for body movements [2,3]. The cause of PD is idiopathic, some factors can be related such as age, family history, oxidative stress [4,5], besides of new investigated factors such as mesenteric alterations, due to the exacerbated manifestation of pre-synaptic alpha synuclein protein [6].

Among the motor characteristics, there is the resting tremor, bradykinesia, muscle rigidity, postural and gait changes, and the diagnosis is made clinically and by the positive reaction to pharmacotherapy [7,8]. However, respiratory dysfunctions were detected as the main cause of mortality and morbidity, due to degeneration of the dopaminergic vias, which can cause a ventilatory patterns reduction.

These respiratory limitations influence the reduction of functional capacity with fatigue and discomfort, in addition to impairing the individual's functionality in performing of Activities of Daily Living

(ADL) and in their quality of life [8]. In the advanced stages of the disease, there is a reduction in the efficient contraction of the chest wall muscles and reduction of effective cough. They also have susceptibility to aspiration pneumonia, which is the main cause of death in this profile of individuals [9].

As physiotherapy treatment, these individuals use kinesiotherapy resources, gait and balance training to improve the motor aspects; however, it is important associating physical practice with pulmonary rehabilitation. The main example of this association is the Nordic Walking (NW), which include the aid of sticks to gain balance, stability, coordination, reduce the exacerbated anterior flexion of the column, preventing falls and traumas. Furthermore, it allows the individual to obtain better functional capacity, and performing a stimulating aerobic activity [10, 11].

Associated with Nordic walking, the inclusion of Respiratory Muscle Training (RMT) in rehabilitation is necessary to maintain the aerobic capacity. One of the devices is the use of a linear resistor able to promoting resistance and strength gain of the inspiratory muscles [12]. The RMT is a therapeutic modality that stands out in the gain of maximum inspiratory and expiratory pressures, influencing the peripheral musculature. It favoring the practice of physical activities (walking) to possibly condition the patient to longevity and dignity of practice their ADL with better quality of life, allowing the retard of disease progress [12,13].

Therefore, the objective of this study was to verify the impact of Respiratory Muscle Training associated with Nordic Walking training on pulmonary function and quality of life in patients with Parkinson's disease.

Methods

Study configuration

This is a randomized clinical trial approved by the Ethics Committee in Research with Humans of the University of the State of Pará (opinion number 3,422,887) and registered in the Clinical Trials (at www.clinicaltrials.gov with opinion NCT04135924), following the technical recommendations of CONSORT (2010) [14] to produce scientific articles. It lasted four months, from July 1 to October 22, 2019, developed at the Unit of Teaching and Assistance of Physical Therapy and Occupational Therapy.

Recruitment of participants

The patients were recruited in June 2019 through the analysis of patient records and availability, which were in the queued for Physiotherapy and Occupational Therapy services of the University. In addition, invitations were made by means of posters published in electronic media.

The sample calculation was perform in Bioestat 5.3 software from the population of individuals registered at the University, considering a power of test of 80% and α-value of 5%, demonstrating a total of 58 patients.

Randomization

The participants were randomly designated to a group of intervention by a researcher who did not belong to the data collection team. The randomization was performed with drawn numbers from 1 to 3 in specific software (randomization.org) corresponding to the three groups of intervention (01: Respiratory Muscle Training (RMT); 02: Nordic Walking (NW); 03: Respiratory Muscle Training associated with Nordic Walking (RMT+NW). The same researcher placed the numbers in an envelope of opaque material, requesting that other research member conduct the draw and allocates the individual's name to the group. At the end of the data collection, they were decoded by numbers, and delivered to a researcher (blind type) who performed the statistical analysis.

Assessment

After the contact and invitation carried out by the researcher, the patients were assessed through an own sheet with nominal, anthropometric data, vital signs and data related to the intervention protocol: respiratory function and quality of life. The Hoehn and Yarh scale [15] was used to assess the degree of evolution and impairment of Parkinson's disease; and the Mini Mental State Examination (MMSE) [16] used to assess the cognitive aspect.

The height and weight were measured in an analog balance (Balmak®, Assunção - PAR), the data were used to measure the Body Mass Index (BMI) in kg/m², included as a parameter in the pulmonary function test when performing the spirometry with portable device Mir Minispir®, the WinspiroPRO software (MIR, Roma - IT) to store the data and manovacuometry in MVD 300-U® device (Homed, São Paulo - BR) using the formula for men: Maximal Inspiratory Pressure (MIP): y = -0,80 × age + 155,3; Maximal Expiratory Pressure (MEP): y = -0,81 × age + 165,3; For women: MIP: y = -0,49 × age + 110,4; MEP: y = -0.61 × age + 115,6.

The quality of life was evaluated by means of the Parkinson Disease Questionary (PDQ-39) scale, which contains 39 items distributed in 8 domains: mobility (10 items), ADL (6 items), emotional well-being (6 items), stigma (4 items), communication (3 items) and body discomfort (3 items). Each question can receive scores from 0 to 4, classified as never, rarely, sometimes, frequently and always. The result can be obtained for each domain by the formula: (total score in each domain/4x number of questions)x100 or for the total score: (total score/4 x 39)x100. At the end, on a score from 0 to 100, the closer to 0, better is the patient's quality of life [17].

Patient selection

The inclusion criteria were: volunteers without cognitive alterations, previously evaluated by the researcher; those who accepted to participate of the research through the signature of the Informed Consent Term; patients of both genders; any ethnicity and schooling; age over to 55 years old with a clinical diagnosis of Parkinson's Disease in grade 1 to 3 on the Hoehn and Yarh scale.

The exclusion criteria were: volunteers who presented cognitive alterations (evaluated by the MMSE), auditory and visual alterations, besides exacerbations of the motor function that could make it impossible for them to appear in three consecutive sessions or that did not perform at least 16 sessions proposed, during a minimum of 6 weeks; individuals with Diabetes Mellitus

and other metabolic diseases; severe comorbidities such as: heart diseases and uncontrolled arterial hypertension; alcoholics; smokers, those hospitalized at least six months before the study, as well as those who did not use the medication and correct dosage prescribed by the doctor; individuals with osteomioarticular disorders and other neurological diseases, as well as those who used mobility devices, or restricted to wheelchairs.

Those patients who completed at least 6 weeks of treatment were included, and those which were disconnected from the research because they missed more than 3 sessions or presented exacerbations of the motor signals, were included in the results by intention of treatment.

Intervention

The sessions took place 3 times a week, on alternate days during 8 weeks, representing a total of 24 sessions. During the exercises, there was always a researcher to follow up and guide as to the proper execution of the protocol.

All groups (RMT, NW and RMT+NW), before the specific protocol, performed a series of stretches to facilitate movements and contribute to the tonus modulation (the stretches included: cervical, trunk and limbs lengthening, performing flexion and extension for a minimum of 30 seconds). During this period, the patients were advised to not perform any other physical activity.

Nordic walking

In the Nordic walking training, the walking is carried out using two sticks to favor the return of mechanical impact and muscle recruitment of upper limbs, and facilitating the adjustment of posture and coordination. It was practiced in an external area, with terrain demarcated at 30 meters in length. Each patient walked an average of 30 minutes per session, with Heart Rate (HR) and peripheral oxygen saturation (SpO_2%) monitored by pulse oximeter, during the walk, at least 60% of intensity was achieved, from the HR at rest.

Respiratory muscle training

The respiratory muscle training was held with the use of electronic respiratory stimulators of PowerBreatheK3 brand (Warwickshire-UK), using a fixed load of 30% of the MIP obtained during the evaluation of manovacuometry. The patients performed at least two series of thirty repetitions, minimum of 30 minutes, using a nose clip. When holding the training, the patients remained seated, with an upright posture, without resting their backs on the seat; the series consisted of five deep and consecutive inspirations accompanied by a short rest.

Respiratory muscle training associated with nordicwalking

The protocol of the RMT+NW group was similar to that of the NW group, but the patients walked with the use of respiratory stimulators (Power breathe Classic), manually adjusted to the 30% of the MIP. During the walking, the patients put the stimulator in the mouth, biting the disposable nozzle and using a nose clip, to facilitate the respiratory muscle work.

Statistical analysis

The data were stored in Excel 2010 Software and analyzed in Bioestat 5.2 Software (Institute Mamiraua, Amazonas-BR). The normality of the data was verified by the Shapiro-Wilk test; the data variance through the Anova two way test; for the multiple comparisons the Tukeyhsd test was used, and the Chi-square test for the nominal data. All data were expressed in tables by its averages and standard deviations, considering p value ≤ 0.05.

Results

Adherence

In total, 88 patients with clinical diagnosis of PD were selected and invited to attend of the research; 22 patients were evaluated and randomly divided into three groups; at the end, 15 patients concluded the proposed protocol and their data were analyzed.

After 4 months of intervention, 68.20% of the patients evaluated completed the study after the proposed sessions. Two patients from the NW group gave up after the beginning of the protocol, due to the unavailability to carry out the treatment (sixth week, 18th session) which were included in the analysis because of the intention of treatment, and the other because of discomfort when performed the protocol (5th session); the same happened with the RMT group, one patient gave up because of the unavailability of time (8th session). In the associated group (RMT+NW), two patients gave up for not adapting to the protocol due to symptomatological exacerbations of Parkinson's disease and one requested to give up after the sixth week, being included in the analysis. The allocations of eligible and evaluated patients are described in **Figure 1.**

Clinical and demographic data

Among the 15 patients included for the data analysis, the majority were male (66.6%), the average age was 65.93 and the average BMI was 27.22 **(Table 1).**

The pulmonary function was analyzed through the variables obtained in spirometry and manovacuometry, expressed in **Table 2**, which shows the means and standard deviation before and after treatment, as well as the relation between the groups. It is observed an improvement of performance in the inter-group analysis for the Forced Vital Capacity (FVC) and Maximum Expiratory Pressure (MEP) for the RMT+NW group; in the

Table 1 Demographic and clinical data of the groups.

	Total Mean	NW	RMT	RMT+NW	p*
Age	65.93 ± 8.06	70.60 ± 7.02	66.60 ± 9.58	60.60 ± 4.82	0.31
Gender, n (%)					
Male	10 (66,66%)	3 (60%)	4 (80%)	3 (60%)	
Female	5 (33,33%)	2 (40%)	1 (20%)	2 (40%)	
BMI (kg/m^2)	27.22 ± 3.70	26.61 ± 2.66	27.28 ± 4.06	27.77 ± 4.86	0.30
H&Y	2.20 ± 0.59	2.40 ± 0.65	2.10 ± 0.65	2.20 ± 0.57	0.51
MMSE	25.93 ± 1.90	25.00 ± 2.00	26.40 ± 2.07	26.4 ± 1.67	0.79

NW: Nordic Walking; RMT: Respiratory Muscle Training; RMT +NW: Respiratory Muscle Training associated with Nordic Walking; BMI: Body Mass Index; H&Y: Hoehn and Yarh scale; MMSE: Mini Mental State Examination; p*≤ 0.05.

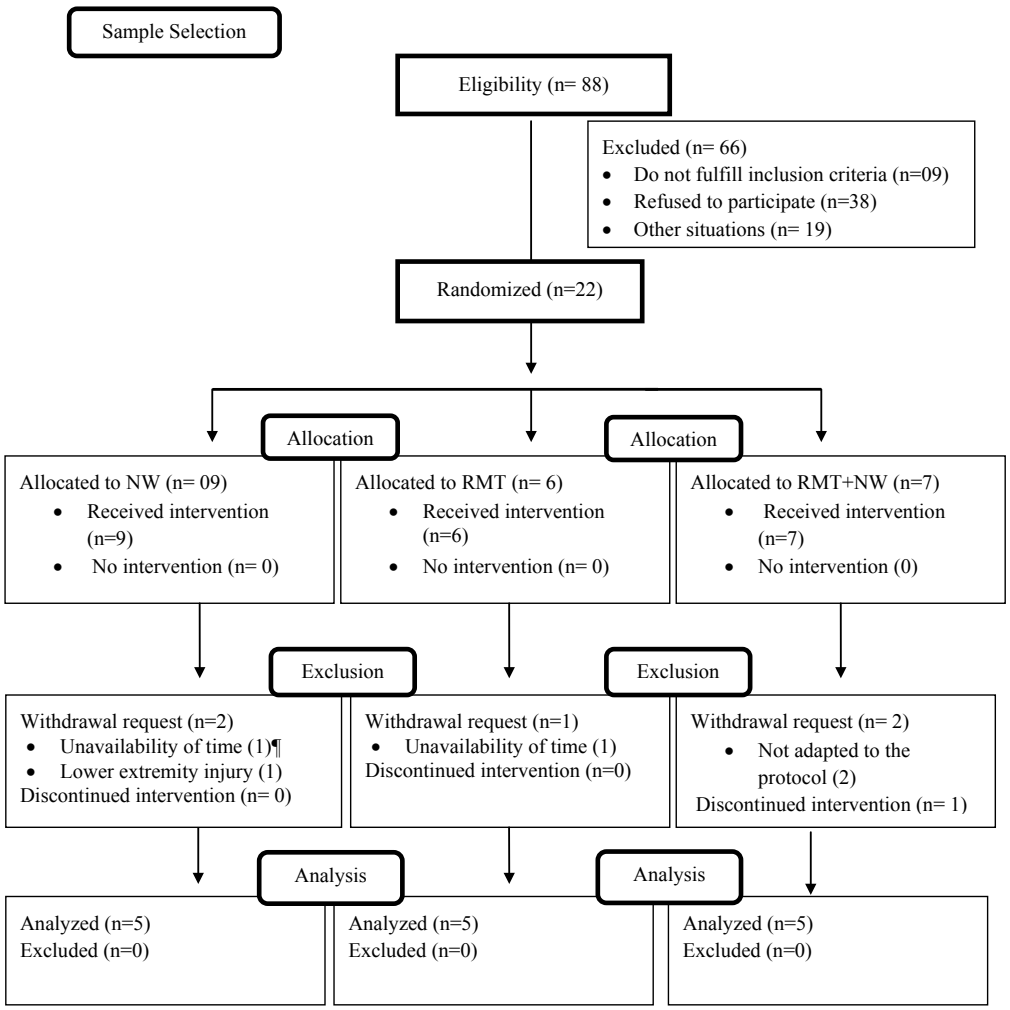

Figure 1 Distribution of patients, based on the criteria considered by Consort (2010).
¶: intention of treatment

Table 2 Analysis of the respiratory function of patients with Parkinson's disease, before and after intragroup treatment, and between groups.

Variables	NW (5)	RMT (5)	RMT + NW (5)	p – value
Vital Capacity (VC)				
Before	2.71 ± 0.44	2.69 ± 0.70	2.37 ± 0.56	0.392
After	3.14 ± 0.65	2.87 ± 0.99	2.84 ± 0.86	0.864
p – value	0.167	0.181	0.075	
Forced Vital Capacity (FVC)				
Before	3.16 ± 0.15	3.18 ± 0.39	3.10 ± 0.90	0.982
After	3.41 ± 0.35	2.97 ± 0.51	3.26 ± 0.95	0.632
p – value	0.136	0.190	0.011*	
Forced Expiratory Volume in the first second (FEV1')				
Before	2.15 ± 0.36	2.37 ± 0.50	1.47 ± 0.29	0.240
After	2.43 ± 0.24	2.31 ± 0.51	1.85 ± 0.52	0.184
p – value	0.039*	0.350	0.143	
FEV1/FVC Ratio				
Before	62.08 ± 14.54	74.74 ± 10.93	61.14 ± 9.75	0.216
After	68.22 ± 12.67	69.81 ± 10.35	64.32 ± 13.19	0.162
p – value	0.063	0.178	0.208	
Forced Expiratory Flow between 25 -75% (FEF 25 - 75)				
Before	1.07 ± 0.48	2.14± 0.98	1.26 ± 0.27	0.490
After	1.08 ± 0.22	1.70 ± 1.23	1.16 ± 0.66	0.564
p – value	0.013*	0.249	0.339	

Variables	NW (5)	RMT (5)	RMT + NW (5)	p – value
Peak Expiratory Flow (PEF)				
Before	5.72 ± 0.92	4.15 ± 2.06	6.61 ± 0.71	0.848
After	6.90 ± 1.60	4.17 ± 2.05	6.37 ± 0.29	0.0750
p – value	0.136	0.479	0.227	
Maximum Expiratory Pressure (MEP)				
Before	72.80 ± 15.27	64.20 ± 11.97	74.80 ± 18.86	0.606
After	74.86 ± 12.85	70.00 ± 25.33	78.60 ± 18.42	0.761
p – value	0.144	0.207	0.008*	
Maximum Inspiratory Pressure (MIP)				
Before	92.40 ± 60.56	65.00 ± 21.51	90.80 ± 33.45	0.511
After	96.40 ± 54.82	82.40 ± 24.66	93.40 ± 44.50	0.804
p – value	0.310	0.004*	0.372	

NW: Nordic Walking; RMT: Respiratory Muscle Training; RMT +NW: Respiratory Muscle Training associated with Nordic Walking. *p ≤ 0.05

Table 3 Analysis of the quality of life through the PDQ-39 scale in patients with Parkinson's disease, before and after the treatment of each group and between groups.

Variables	NW	RMT	RMT + NW	p – value
Mobility				
Before	34.4 ± 20.16	66.80 ± 14.54	51 ± 31.70	0.973
After	29 ± 19.22	62.80 ± 12.02	42.2 ± 22.20	0.092
p – value	0.188	0.3001	0.062	
Activities of Daily Living (ADL)				
Before	29.6 ± 17.38	45.4 ± 17.21	35.6 ± 36.22	0.706
After	22.2 ± 16.88	44.6 ± 24.75	29 ± 29.13	0.549
p – value	0.0014	0.4623	0.0826	
Emotional well-being				
Before	32.20 ± 19.69	54 ± 21.1	48.2 ±36.47	0.272
After	23.00 ± 20.54	38 ± 27.64	38 ± 29.47	0.511
p – value	0.059	0.0512	0.13	
Stigma				
Before	28.20 ± 27.22	27.4 ± 22.44	18.4 ±25.58	0.815
After	23.40 ±23.06	19.8 ±19.20	17.20±11.51	0.919
p – value	0.049*	0.526	0.186	
Social Support				
Before	62.8 ± 4.38	54.6 ± 11.03	56.2 ± 17.78	0.501
After	66.20 ± 6.01	53 ± 9.43	51.4 ± 16.78	0.146
p – value	0.186	0.156	0.162	
Cognition				
Before	39.4 ± 20.03	55 ± 11.57	43 ± 18.22	0.573
After	41.4 (17.72)	50.8 (8.98)	39.6 ± 12.23	0.576
p – value	0.422	0.301	0.233	
Communication				
Before	24.6 ± 22.01	44.6 ± 13.86	24.8 ± 20.41	0.295
After	11.4 ±17.93	24.8 ± 6.01	24.8 ± 22.73	0.558
p – value	0.497	0.0223	0.5	
Body discomfort				
Before	53 ± 23.86	51.8 ± 29.06	66.4 ± 28.45	0.673
After	39.60 ± 27.83	45.80 ± 22.11	41.2 ± 27.81	0.927
p – value	0.229	0.3655	0.0069	
TOTAL				
Before	36.48 ± 13.51	53.63 ± 7.40	39.82 ± 17.37	0.164
After	28.84 ± 12.15	43.17 ± 7.82	33.81 ± 13.21	0.192
p – value	0.0079	0.0304	0.0461	

NW: Nordic Walking; RMT: Respiratory Muscle Training; RMT +NW: Respiratory Muscle Training associated with Nordic Walking; *p ≤ 0.05.

Forced Expiratory Volume in one second (FEV1') and Maximum Inspiratory Pressure (MIP) for the RMT group; and in the variation of the Forced Expiratory Flow between 25-75% (FEF 25-75) for the NW group. In the comparison between the groups, there was no statistically significant variation on the variables.

The quality of life was assessed by the PDQ-39 scale, demonstrated in **Table 3**. It shows significant values for the analyses before and after treatment in the total score of the scale: RMT p≤ 0.01; NW p=0.03; RMT+NW p ≤ 0.05. In addition, intragroup improvement is observed for the ADL (p≤ 0.01) and Stigma (p≤ 0.05) domains

for the NW group, the communication domain (p=0.02) for the RMT group, and the body discomfort domain ($p \leq 0.01$) for the RMT+NW group. The data between the groups, there were no significant results ($p \geq 0.05$).

Discussion

The proposal of this study was to verify the influence of respiratory muscle training associated with Nordic walking, allowing the patients a possible improvement in functional aspects and consequently in quality of life.

The results demonstrated that both exercises contributed significantly to the improvement of patient's respiratory function and quality of life, after the eight week of individual treatment, but there was no significant prevalence when comparing the groups. However, among the evaluated groups there was not a control group, because the objective was to exclude the hypothesis of possible effects only from the RMT group with use of the resistor or only from the NW group.

With regard to the disease stage and the respiratory muscle strength of patients with PD, Zhang et al. [18] demonstrated in their study that the decrease in respiratory function is related to bulb and extrapyramidal dysfunctions which begin in the early stages of the disease, collaborating to this study, which used patients with mild to moderate stages characterized by the Hoehn and Yahr scale (from 1 to 3).

There are no studies in the literature that reported the NW associated with RMT for patients with PD. However, in the study conducted by Sapienza et al. [19] there are indications of physical exercises associated with the use of Threshold for patients with PD who presented obstructive disorders.

It is common for individuals with PD to present some ventilatory disorder (restrictive or obstructive) during the progress of the disease. The restrictive, progresses with the loss of alveolar units, causes micro atelectasis, generating a greater need for respiratory muscle strength, besides to stiffness in the chest wall causing a reduction in lung volumes and capacity, including Forced Vital Capacity (FVC) and Total Lung Capacity (TLC) [18,19]. Obstructive disorders presents as a limitation of ventilatory capacity, a consequence of high resistance and airflow limitation associated with decreased of respiratory muscle strength, and consequently to an increase in Residual Volume (RV), increase in Functional Residual Capacity (FRC) with normal or increased TLC [5,20,21].

The spirometry results showed that the RMT+NW group achieved significant improvement before and after treatment in vital capacity, assessed by FVC, which represents the largest volume of air mobilized during expiration. In addition to FVC, there was improvement in the MEP; however, there was no change in the FEV1/FVC ratio, as well as in the peak expiratory flow (PEF), important for the treatment of obstructive diseases [21].

These results were similar to the research of Guimarães et al. [12] and Alves et al. [22] who conducted studies demonstrating better performance of patients with PD in FVC variables compared with the predicted values, but did not obtain an improvement in the FEV1/FVC ratio, observed in this study only in the NW group, besides an improvement for FEV1.

It is observed that the RMT group, when performing the protocol for gain of inspiratory muscle strength, obtained an improvement after the treatment period, demonstrating the efficacy of using the linear resistor separately. Inzelberg et al. [23] showed an enhancement in MIP when using resistors in their protocol, revealing a 46% increase in MIP of patients with PD in relation to the individuals who did not perform RMT.

Comparing the groups RMT + NW and RMT, with respect to MIP, it was observed no statistically significant improvement for the first group, this can be explained by the rhythm of training imposed to the elderly with PD, because the protocol intended to use an exercise intensity of up to 60% of HR at rest, using, simultaneously, deep inspirations to overcome the load of 30% of MIP when utilizing the linear resistor. However, it was not possible due to the specific motor conditions of these patients, such as stiffness and bradykinesia, which interfered in the performance and reach of the proposed intensity.

Rayes et al. [8] describe in their studies that in PD patients there is a better effectiveness in expiratory muscle strength than inspiratory muscle strength. The improvement of expiratory muscle strength in these individuals is essential for an effective cough, besides the enhancement of respiratory flow and prevention of aspiration pneumonia [24].

The Nordic walking, an aerobic activity, also acts as an expiration facilitator in the respiratory phase, because triggering upper extremity levers and absorbing impacts generated by the stick when propelling it on the ground [25]. Moreover, the use of the Nordic walking promotes the recruitment of muscles of the upper limbs, through the balance phase performed by the use of sticks, improving the extension of the trunk by adequacy of plastic hypertonia, as well as the thoracic expansion, favoring motor coordination and balance [15,26,27].

In patients with Parkinson's disease, the use of NW is associated with the search for a better quality of life. A statistically significant difference was demonstrated by Reuter et al. [26] when using PDQ - 39, before and after the training of NW, for a period of twenty four weeks.

In the study conducted by Dauwerse et al. [27] the practice of physical exercise has improved the motor aspects, as well as can have influenced in non-motor factors, enhancing the domains such as physical discomfort and mobility, evaluated by PDQ - 39, which can influence psychological and emotional aspects.

These data corroborates with the results demonstrated in this study, which in all groups (NW, RMT and RMT + NW) there was improvement in quality of life, assessed by the PDQ-39 scale, before and after treatment in intragroup analysis, with specificities for the domains: stigma to the NW group, communication to the RMT group and body discomfort to the RMT+NW group.

In the execution of respiratory muscle training, the RMT group obtained a raise in the Communication domain, since it is assumed that the capacity of speech is related to subglottic pressure, facilitated by inspiratory exercises [27,28]. The aerobic

activity, practiced for a prolonged period, can decrease muscular discomfort, as well as improve the social stigma of these patients.

Thus, during the four months of the protocol application, there were no situations of risk to the integrity of patients, such as falls and hemodynamic imbalances; but, there was withdrawal in all groups, in about 31.80% of randomized patients, contributing to a low sample number.

In addition, during the activities, adjustments were necessary for the walking due to the individual characteristics of each patient. In the first week all patients who performed the NW, associated or not, receive training without the use of intensity to adjust posture and reduce postural instability; in some cases it was necessary to regulate the height of the sticks beyond what was predicted, in order to avoid postural instability. Moreover, the RMT associated with NW was not tolerated with the use of nose clip, justified by the respiratory discomfort of the patients, interfering with the rhythm of training.

Due to institutional factors, previously eligible patients [19] could not be evaluated and included in the research protocol. Besides that, the low sample number can have influenced the non-prevalence among the groups.

Conclusion

It is concluded in this study that the physiotherapy by means of respiratory muscle training associated with Nordic walking generated positive results for variables related to strength and lung function, besides to quality of life, with no prevalence among the groups analyzed.

Conflict of Interest

There is no conflict of interest.

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