Acute and Chronic Effects of Exercise in Health

Effects of binary dance rhythm compared with quaternary dance rhythm in fatigue, sleep, and daily sleepiness of individuals with Parkinson's disease: A randomized clinical trial

Jéssica Amaro Moratelli[1], Kettlyn Hames Alexandre[1], Leonessa Boing[1], Alessandra Swarowsky[2], Clynton Lourenço Corrêa[3], Adriana Coutinho de Azevedo Guimarães[1]

[1]Universidade do Estado de Santa Catarina, Departamento de Educação Física, Programa de Pós-Graduação em Ciências do Movimento Humano, Florianópolis, SC, Brazil; [2]Universidade do Estado de Santa Catarina, Departamento de Fisioterapia, Florianópolis, SC, Brazil; [3]Universidade Federal do Rio de Janeiro, Faculdade de Fisioterapia, Rio de Janeiro, RJ, Brazil.

Associate Editor: Cristine L Alberton. Universidade Federal de Pelotas, Pelotas, RS, Brazil. E-mail: cristine.alberton@ufpel.edu.br.

Abstract - Aim: People with Parkinson's disease constantly demonstrate low levels of physical activity, which is why dance has become increasingly important for the treatment of the disease. This study aimed to analyze the influence of binary and quaternary rhythm on fatigue, sleep, and daytime sleepiness in individuals with Parkinson's disease. **Methods:** 31 individuals participated in this randomized clinical trial with a mean age of 66.6 ± 10.2 years, 71% were male and 29% were female, allocated into two groups, binary and quaternary, where they participated in different dance interventions lasting 12 weeks. A questionnaire was applied including personal and clinical information; Mental State Mini-Examination (MMSE), Hoehn and Yahr (H&Y), Fatigue Severity Scale (FSS), Sleep Scale for Parkinson's Disease (PDSS), and Daytime Sleepiness Epworth Scale (ESS). **Results:** The groups that participated in binary rhythm classes showed improvement in sleep quality and daytime sleepiness after 12 weeks of intervention. However, no significant differences were found in the group that participated in the quaternary rhythm classes. Moreover, it was noted that the binary group managed to raise the heart rate during the 12 weeks of intervention, given that these results were not obtained in the quaternary group. **Conclusion:** The results showed the effectiveness of binary rhythm on non-motor symptoms and heart rate increase in individuals with Parkinson's disease. Thus, it is concluded that the binary rhythm was more effective than the quaternary rhythm.

Keywords: Parkinson's disease, dance, non-motor symptoms, binary rhythm, quaternary rhythm.

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects 1% of the world's population over 50 years[1]; and although it is commonly associated with motor symptoms, some non-motor symptoms can be as debilitating as motors[2]. Thus, there is a need to test alternative interventions that can improve the daily life of these individuals[3]. Some studies highlight the importance of physical activity programs for the treatment of PD, which aim to bring benefits to the motor and non-motor symptoms of this population[4,5].

Moreover, dance has become a popular alternative, being a promising way for the rehabilitation of the disease, as it promotes a pleasant environment associated with the improvement of the quality of life[6,7] and the improvement of motor and non-motor symptoms[6,-9]. There is a growing interest in the literature for research that investigates dance styles, musical rhythms, as well as intensities and frequencies of dance classes[6]. A meta-analysis on the effectiveness of dance compared to other physical activity interventions showed that dance significantly improved UPDRS scores, balance, gait speed, and quality of life compared to other interventions[10]. Another meta-analysis involving PD and the tango rhythm showed significant global effects on UPDRS as well as balance, and positive results were also found for fatigue and quality of life[11].

Other studies have shown that dance rhythms such as binary (*forró*; bolero; merengue) and quaternary (*samba de gafieira*; salsa; zouk; tango) can improve sleep quality and fatigue, in addition, to promoting well-being, such as physical, mental and emotional behavior of individuals with PD[10,12,13]. The binary rhythm is known for its compass formed by two beats, and it is a stimulating rhythm that provides harmony in the movements, being able to contemplate countless dance modalities around the world, such as *forró*, merengue, polka, bolero[8,12,13]. The

quaternary rhythm, on the other hand, is characterized by a compass formed by four beats with a great diversity of execution, containing movements that can be performed with greater or lesser speed and characterized by modalities such as tango, samba, salsa, zouk, among others[8,14].

Despite the evidence and the growing literature on this subject, we found only one study relating binary and quaternary rhythm in individuals with PD; Hashimoto et al[15]. compared the effects of 12 weeks of intervention with binary (bolero) and quaternary (tango; foxtrot) rhythm compared with sports training. This study showed that dance classes of both rhythms significantly improved motor performance, cognition, and depression. However, it is not clear which rhythm promotes the greatest benefit in individuals with PD, as most studies focus only on one type of quaternary rhythm[16-18]. Relating two different dance rhythms, but with the same intervention foundation, allows health professionals to justify their treatment decisions for individuals with PD. In view of this, the importance of clinical dance protocols is noted as a tool to assist in the rehabilitation and treatment of the disease for this population. Therefore, the guiding question was formed through the acronym PICO: What is the influence of binary and quaternary rhythm on fatigue, sleep, and daytime sleepiness in individuals with Parkinson's disease?

Methods

Study design

The 12-week two-arm randomized clinical trial presented an initial sample of 38 subjects clinically diagnosed with PD allocated in the binary group (BG) and quaternary group (QG). Individuals with PD were recruited through the Parkinson Santa Catarina Association (APASC) and invited to participate in the study. After accepting they were included in the Rhythm and Movement Program and BPaRkI of the College of Health and Sport Science from the Santa Catarina State University (CEFID-UDESC)[19].

The randomization process was performed using a computer program, Microsoft Excel (enter random mode). This step was performed by a third researcher from the Research Laboratory in Leisure and Physical Activity (LAPLAF) not involved in data collection or intervention.

Inclusion criteria were clinical diagnosis of PD following the London Brain Bank Criteria; stable doses and no change in medication within two weeks; not the practice of any kind of dance for at least three months previous to the study; and if he used assistive devices, they would have to be able to get around on their own. Exclusion criteria were not reaching Mental State Mini-Examination (MMSE) cutoff according to schooling; being classified in stage 5 of PD; performing combined practice of any physical activity and/or physical exercise in order to avoid bias of confusion before the intervention; 25% absence during the study stages.

Thus, 38 individuals were recruited and randomized into two experimental groups: a) BG (19 individuals) and b) QG (19 individuals); One subject was excluded for not meeting the cut-off points pre-defined in the MMSE exclusion criteria, one died and five did not fulfill the 75% of the prescribed classes. From the established criteria, 31 individuals completed the study, 18 individuals (68.3 ± 8.6 years) from BG and 13 individuals (64.3 ± 14.8 years) from QG.

The sample size calculation was performed using the G* Power 3.1.9.2 software, effect size 0.33, significance level 5% and test power 95%, and sample loss 20% based on the fatigue variable, at the end 20 individuals were expected for each group.

Procedures

The study was approved by the UDESC Human Research Ethics Committee (CEPSH) - protocol 2.380.719 and registered with the International Clinical Trial Registration platform "Clinical Trials.gov" n. NCT03235453. Individuals who voluntarily accepted to participate in the study signed the Informed Consent Form.

Intervention

The participants allocated in the BG performed the intervention following the binary rhythm protocol for individuals with PD, in the same way; the QG participants performed the intervention following the quaternary rhythm protocol for individuals with PD. The dance classes of binary and quaternary rhythm were held separately and lasted 12 weeks, twice a week for 45 min. All classes were conducted by trained researchers and members of the LAPLAF. All participants were in the "on" phase during the interventions[19].

Binary Protocol intervention

The class session was divided into a warm-up, the main part, and a cool-down. The warm-up (10 min) focused on dance styles that incorporate the binary rhythm. The main part (30 min) was carried out by a teacher who demonstrated and taught the steps to be performed clearly, afterwards the participants performed the steps alone and then with their partners. The participants exchanged partners every five minutes, so that everyone could have other experiences when dancing with their colleagues, as well as stimulating the leading of the partner. Stretching and slow walking (cool-down) were performed for five minutes to provide muscle relaxation[19].

The dance movements were performed at different intensities (light, moderate and vigorous) so that the individuals had a progression over 12 weeks. The degree of difficulty of the steps was increased each week of inter-

vention, along with the intensities. Blood pressure (BP) and heart rate (HR) were monitored during classes for the safety of participants during interventions and during increases in intensities. Table 1 presents the description of the steps of the binary rhythm.

Quaternary protocol intervention

All classes lasted 45 min and were organized into three parts: warm-up (10 min); main part (30 min) and cool-down (5 min). The warm-up focused on dance styles that include the quaternary rhythm. The main part was divided into three moments; first, the teacher demonstrated the step to be developed in the classroom, then, on the training track, the students danced. After that, they performed the same movement while looking at each other. During the cool-down period, they performed stretching and slow walking to provide muscle relaxation.

Both interventions were classified according to the intensity (mild, moderate, and vigorous). Each week the degree of difficulty of the steps taught along with the intensity increased. Blood pressure (BP) and heart rate (HR) were monitored during classes for greater safety for participants during interventions and during increases in intensities to avoid possible changes in blood pressure and discomfort. To establish the different rates of intensity, the songs of each protocol (binary and quaternary) were selected according to the bpm (beats per minute): light from 40 to 72 bpm, moderate from 72 to 120 Bpm, and vigorous from 120 to 208 bpm[1719]. Table 2 shows the description of the quaternary rhythm steps.

Evaluation measures

Data collect

For the comparisons between BG and QG, data collection took place two weeks before the intervention period (August), and two weeks after the intervention period (December), simultaneously between the groups (BG and QG). The data collection occurred through the application of individual interviews with reading the questionnaire by four trained researchers' members of LAPLAF, lasting approximately 30 min at the Santa Catarina Rehabilitation Center - CCR. The questionnaire used consisted of validated instruments: a) Personal and clinical information; b) Mini-Mental State Examination - MMSE; c) Disability Stages Scale - Hoehn and Yahr; d) Fatigue Severity Scale - FSS; e) Sleep Scale for Parkinson's Disease - PDSS; f) Daytime Sleepiness - Epworth Scale.

a) **Personal and clinical information:** regarding age, marital status, education, presence of clinically diagnosed diseases, use of medications, including sleeping and anthropometric measurements (BMI).

b) **Mini-Mental State Examination (MMSE):** used as an exclusion criterion for those individuals who did not reach the cutoff points according to the criteria of Bertolucci et al[20]. Provides information on different cognitive parameters, containing questions grouped into categories, designed to assess specific cognitive functions.

c) **Disability Stages Scale - Hoehn and Yahr:** developed in 1967 and validated, indicates the general condition of the patient with PD. It comprises five stages of

Table 1 - Description of the steps to be taught in the Binary rhythm intervention.

Steps	Description
Presentation of the binary rhythm	During the lesson movements are performed with songs of different speeds to set the students to the rhythm.
Dois para lá, dois para cá [a]	Characterized by two steps to one side and returning giving two steps to the other side, transferring the body weight.
Walk	Walk forward and back to back (two steps forward and two backwards).
Hinge	Opening sideways like a door, the lady will stand facing the gentleman with her hands, release one hand and take a step to the side, then returning to the starting position.
Fixation	Perform the *dois pra lá, dois pra cá* step, walk and hinge at different intensities and speeds of music.
Simple Spin	Leaving the basic step, the gentleman will lead the lady to perform the simple turn, the lady will perform the turn by moving forward and the gentleman will follow her movement by walking forward to her side.
Trocadilho [a]	The lady and the gentleman will walk to the side crossing their legs (crosses, opens) and will return to the other side in the same way.
Chuveirinho [a]	The lady will stand facing the gentleman with both hands, both will raise both their arms and the lady will make a half turn on the spot with her back to the gentleman, thereafter, will give another half turn, returning to the initial position.
Leque simples [a]	The lady and the gentleman will stand by side with their hands clasped, and they will walk forward and back with the same leg.
Double Spin	The lady and the gentleman will stand facing each other with their hands clasped, and they will walk to the left side, release their hands and make a turn on the spot.
Review	Students will review all the steps taught in class, to establish and reinforce what has been learned.
Dance Circle	The students will freely dance with each other, changing the partner, performing the steps learned in the form of a dance.

[a]The steps names were maintained in their original language.

Table 2 - Description of the steps to be taught in the Quaternary group intervention.

Steps	Description
Presentation of the quaternary rhythm	During the lesson, movements are performed to songs with different speeds to accustom the students to the rhythm.
Shift dialing	Take a 4-step/stroke walk back and forth at a slow pace.
Basic step forward / backward	Requires one step forward, two steps on the spot and one step back.
Basic side step	Requires a side step, two steps on the spot and one step back to the starting position.
Basic step forward / back and side	Combine the two previously learned steps, characterized by front / back / side / side.
Spin in place	Side by side, lady and gentleman start with the basic step forward / backward for a spin around the axis itself, marking with the same foot forward and back after the turn.
Practice the rhythm	Perform shifts with the learned steps of songs of different speeds and speeds.
Lady's turn	Leaving the basic step back, the lady performs a turn after marking the step forward around the shaft itself, the arm should be above the body with the aid of the gentleman.
Leading	Leaving the basic step, the gentleman must place his arm around the lady's waist leaving it to his side and lead it to the other side.
Turn the lady with displacement	Leaving the basic step, the gentleman takes a step to the side so that the lady is beside him, the lady moves away so that both have their arms extended and then returns curling the gentleman's arm around the body itself.
Step sequence	Students repeat the previously learned steps one after the other, initially at a leisurely pace, until they can perform to the rhythm of the song.
Review of steps	A review of all the steps learned to enhance learning
Crusade	With the aid of the gentleman, the lady crosses her feet toward the gentleman's, crossing in four times one foot at a time.
Choreographic design	Students execute steps learned in sequence with different pairs.

classification to assess the severity of PD and encompasses global measures of signs and symptoms that allow the individual to be classified according to the level of disability. Patients classified in stages I, II, and III have mild to moderate disability, while those in stages IV and V have more severe disability[21].

d) **Fatigue (FSS-BR):** It is an instrument for assessing the physical aspects of fatigue and its impact on the patient's daily function in a variety of medical and neurological disorders. Evaluating the impact of fatigue on motivation, exercise, physical functioning, the performance of tasks and responsibilities, and interference with work, family, or social life, higher scores indicate more severe fatigue[22].

e) **Parkinson's Disease Sleep Scale (PDSS):** This is a specific scale for the assessment of sleep disorders in PD patients. PDSS addresses 15 symptoms associated with sleep disorders. Patients should complete PDSS based on their experiences over the previous week. The maximum PDSS score is 150 (patient is free of all symptoms)[23].

f) **Epworth Sleepiness Scale:** validated in Brazil in Portuguese[24]. It is a questionnaire that assesses the probability of falling asleep in eight situations involving daily activities, some of which are known to be highly soporific. The overall score ranges from 0 to 24, and scores above 10 suggest the diagnosis of excessive daytime sleepiness.

Statistical analysis

Data were analyzed using the statistical package SPSS - IBM, version 20.0, in which descriptive and inferential statistics were performed. To verify the association between general information in BG and HQ, Fisher's Exact Test was used; In order to analyze the BG and QG in the pre and post-intervention periods, we used the two-way ANOVA with repeated measures and Bonferroni's correction. The significance level adopted of 5%.

Results

Thirty-one individuals diagnosed with PD were included in this analysis, with a mean age of 66.6 ± 10.2 years. The flowchart demonstrates the process of selection of participants and execution of the study protocol steps (Figure 1).

Adherence to classes was verified by the percentage (%) of completed prescribed sessions, considering the absences and non-compliance to a certain prescribed exercise, the participants performed 84.3% of the activities. Table 3 shows that most of the participants in the groups were male (BG = 13; QG = 9) and with initial characteristics of dominant tremor (BG = 10; QG = 6). Regarding the severity of the disease (according to the classification of Hoehn and Yahr) most had moderate disability (BG = 10; QG = 7). It is also noticed that most of the samples did not use sleeping pills (BG = 13; QG = 9).

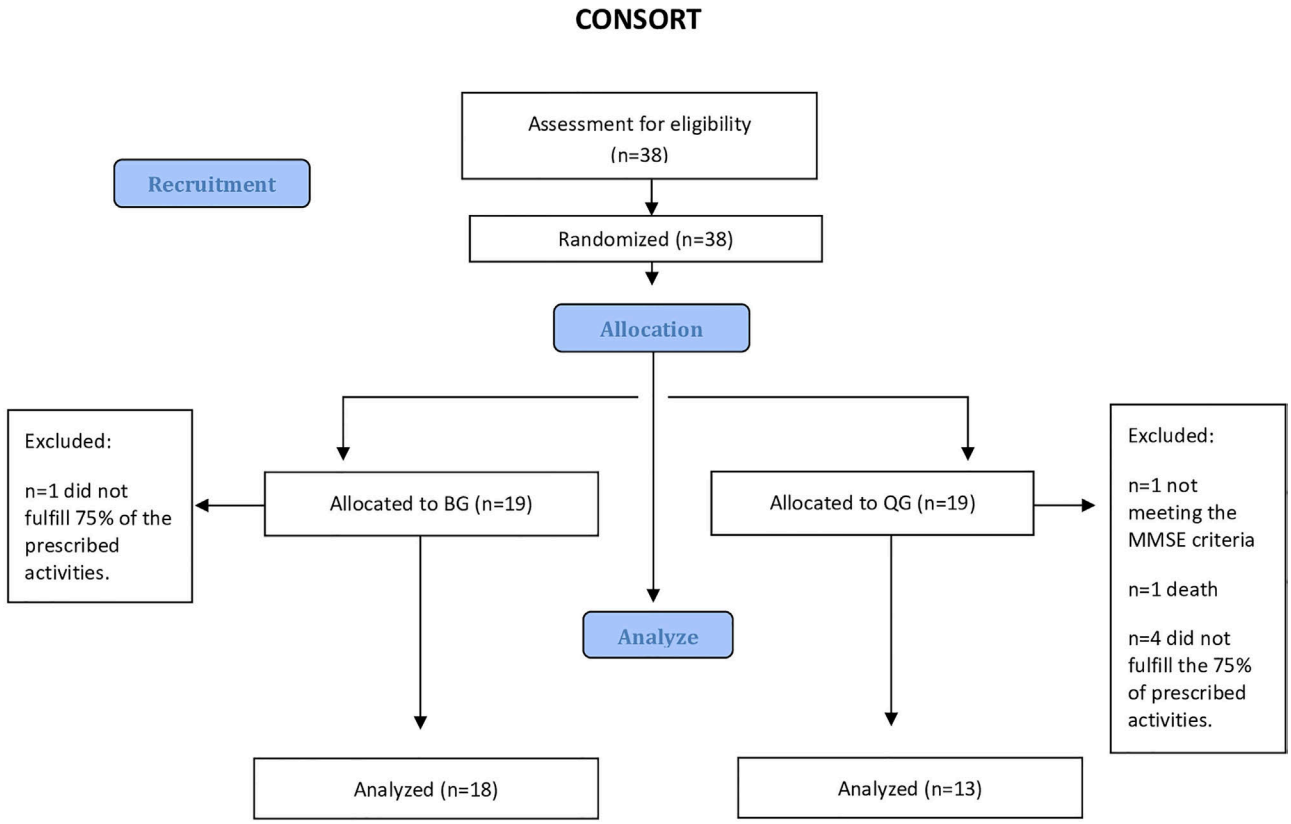

Figure 1 - Flowchart of the participant selection process and protocol steps.

Table 3 - Characteristics of participants according to randomized group (binary and quaternary) (N = 31).

	Total n (%)	Binary group n (%)	Quaternary group n (%)	p*
Sex				0.856
Male	22 (71.0)	13 (72.2)	9 (69.2)	
Female	9 (29.0)	5 (27.8)	4 (30.8)	
Severity of the disease				0.435
Light	13 (42.0)	8 (44.4)	5 (38.5)	
Moderate	17 (54.8)	10 (55.6)	7 (53.8)	
Severe	1 (3.2)	-	1 (7.7)	
Schooling				0.194
Elementary School	18 (58.1)	10(55.6)	8 (61.5)	
High School	9 (29.0)	7 (38.9)	2 (15.4)	
Higher Education	4 (12.9)	1(5.6)	3 (23.1)	
Marital Status				0.597
With Companion	21 (67.7)	12 (66.7)	9 (69.2)	
Without Companion	10 (32.3)	6 (33.3)	4 (30.8)	
Concomitant Diseases				0.394
Not	14 (45.2)	9 (50.0)	5 (38.5)	
Yes	17 (54.8)	9 (50.0)	8 (61.5)	
Initial Manifestation				0.584
Tremor	16 (51.6)	10 (55.6)	6 (56.8)	
Bradykinesia	4 (12.9)	2 (11.1)	2(11.1)	
Rigidity	6 (19.4)	3(16.7)	3(16.7)	
Gait	5 (16.6)	3(16.7)	2(15.4)	
Sleeping medicine				0.583
Not	22 (71.0)	13 (72.2)	9 (69.2)	
Yes	9 (29.0)	5 (27.8)	4 (30.8)	
Medication Use				0.305
Not	2 (6.5)	1(5.6)	1(7.7)	
Yes	29 (93.5)	17(94.4)	12(92.3)	
BMI				0.468
Eutrophic	20 (64.5)	11 (61.1)	9 (69.2)	
Overweight	11 (35.5)	7 (38.9)	4 (30.8)	

Figure 2 shows the average HR and the average BPMs for both groups (BG and QG) during the 12 weeks of intervention. It was found that BG increased HR during the 12 weeks of the intervention, stating that the HR during the intervention increased along with the Bpm's of the songs. In contrast, in the QG there is constant HR fluctuation during the intervention, as in the first weeks the individuals' HR accompanied the increase in the Bpm of the songs, but these values did not remain until the end of the 12 weeks. Also, it is worth mentioning that the binary rhythm increased the maximum HR to 120bpm, while the quaternary rhythm was up to 102bpm maximum.

Table 4 shows the comparison between sleep quality, daytime sleepiness, and fatigue between groups BG and QG, in the pre-and post-intervention periods. In the comparisons between the pre-and post-intervention of BG, we found a significant difference in the sleep quality ($p = 0.002$) and daytime sleepiness ($p = 0.001$), otherwise, non-significant improvement in fatigue was noted for the BG; For QG no differences were found in any of the variables investigated. When comparing BG and QG during the post-intervention period, a significant difference was found in favor of BG on sleep quality ($p = 0.011$), showing a greater increase in the scores for the group that participated in the binary rhythm intervention. When analyzing the variables by effect size, we can notice that the quality of sleep in BG was the only variable to achieve a moderate effect size.

Discussion

The findings of this study are of great relevance, as it is the first study to compare two distinct dance rhythms, that is, binary and quaternary rhythms among individuals with PD. The present study aimed to compare the binary and quaternary rhythm protocols in fatigue, sleep, and daytime sleepiness of individuals with PD. It was evident that after 12 weeks of intervention, the BD demonstrated greater benefits in the sleep quality and daytime sleepiness when compared to the QG. It was also observed that concerning the post-intervention period of the two groups, differences were found in the sleep quality scores of the group that performed the binary rhythm classes. In addition, the HR averages during the intervention period were analyzed, together with the Bpm's of the songs of both groups, in which it was noted that the BG was able to raise

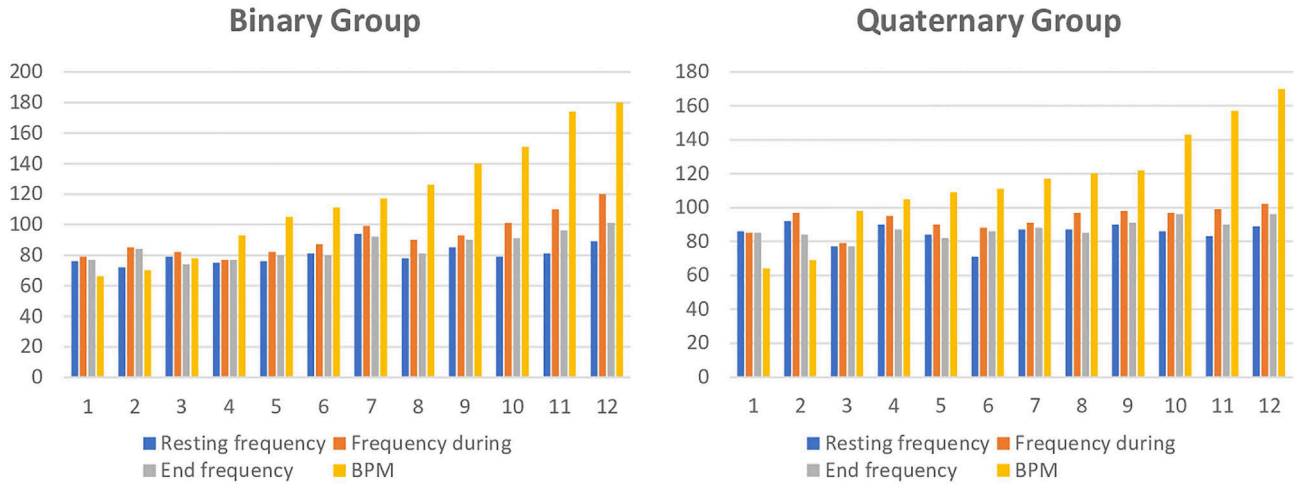

Figure 2 - Mean changes in heart rate during class and BPM of songs over the 12 weeks of intervention.

Table 4 - Comparison of fatigue, sleep quality, and daytime sleepiness between the binary and quaternary groups of the study subjects.

Variables	Binary group mean ± SD				Quaternary group mean ± SD					
	Pré	Post	Intragroup effect p value⋆	d	Pré	Post	Intragroup effect p value⋆	d	Intergroup effect p value#	Interaction effect p value##
Fatigue	28.6 (18.5)	25.5 (13.7)	0.057	0.190	34.0 (17.0)	31.0 (14.7)	0.122	0.188	0.284	0.947
Sleep quality	111.5 (19.9)	122.1 (20.3)	**0.002**	0.527	104.5 (16.8)	101.8 (20.7)	0.459	0.143	**0.011**	**0.008**
Daytime sleepiness	9.72 (5.08)	7.88 (5.00)	**0.001**	0.365	10.61 (6.14)	10.30 (5.17)	0.543	0.054	0.174	0.098

Source: Developed by the authors. SD = Standard Deviation; d = Effect size ⋆p-value for comparison between BG and QG pre- and post-intervention;
#p value for comparison between BG and QG in the post-intervention period;
##p-value of interaction between group versus time. We used the Anova two-way with repeated measures and Bonferroni's correction.

the HR during the 12 weeks of intervention, and these findings were not obtained so effectively in the QG.

Thus, it can be observed that the binary rhythm was more efficient and beneficial in the studied symptoms when compared to the quaternary rhythm. Factors that may have led to these results suggest that the dance modalities studied within the binary rhythm were more attractive and interesting to this population. This can be directly related to the rhythm developed, which has the musical characteristic of marking two times, being considered a simple rhythm, easy to perform, and making the steps more accessible to practitioners. In addition, in the binary rhythm, there is a Brazilian dance modality, namely *forró*, known as a popular rhythm, and practiced throughout Brazil mainly by adults, it is a rhythm danced at traditional parties for the elderly[8,25]. *Forró* is considered a symbol of Brazilian culture, probably favoring the adherence and motivation in binary rhythm classes[8,26].

Some authors point out that the culture of each country should be considered in the dance classes since the classes can be more attractive and motivating when people already know the songs and dance rhythms, so the participants become emotionally involved with the specific memories of their culture[27,28]. This can be seen in a systematic review that analyzed the benefits of different dance rhythms in PD, showing that regardless of the rhythm practiced, dance can be beneficial and end up becoming more accessible and attractive considering where these practitioners come from[29]. That is, understanding the similarities and differences of dance rhythms in PD symptoms, as well as the regionality of its practitioners, can be important to provide better recommendations, which can have a positive impact on symptoms, as well as promote adherence to classes[13,29].

Moreover, binary rhythm interventions improved HR after 12 weeks, it is observed that by increasing the intensity of classes with the BPMs of the songs, the HR also increased. When observing the quaternary rhythm, the results were opposite, where the HR during the 12 weeks remained almost the same, without a progressive increase. It is already clear in the literature that individuals living with PD have a very large HR variability, and in numerous cases, the HR is reduced[30]. Some authors suggested that the practice of physical activity by this population is ideal for raising the HR levels and thus attenuating motor dysfunctions[31]. The study by Delextrat et al meets the results of the binary rhythm where it shows that a dance intervention was able to significantly increase the HR of individuals with Parkinson's disease following the recommendations proposed by the American College of Sports Medicine (ACSM).

Thus, when observing the benefits that dance rhythms bring to PD, this study found controversies in the literature, which shows that the quaternary rhythm (with the tango modality) is the most beneficial for this population in the studied variables[11,15,32]. Regarding sleep quality, it was observed in the present study that the group that performed the binary rhythm classes had an increase in the scores, which demonstrates that the classes improved sleep quality. These findings agree with a study conducted with the "Baduanjin" modality from China, with positive results on sleep quality after 6 months of intervention[33]. However, when analyzing the quaternary group, it is noted that it did not show any alterations after the intervention. In the literature, when observing the quaternary rhythm, it is found that the classes hardly promote benefits on sleep quality in individuals with PD[17,29,34]. Authors claim that sleep is poorly studied in PD because it is a subjective and difficult outcome to measure, and is related to other non-motor symptoms, such as quality of life, fatigue, depression, and cognition[29,35].

Besides, it is known that daytime sleepiness is also a common symptom of individuals with PD, and studies conducted in various parts of the world such as in the Netherlands[36], China[37], and the United States[38] reported a high percentage of daytime sleepiness, which ranged from 45 to 60%, but its causes may be related to medication or poor quality night sleep. Favoring these findings, the results of the present study showed that only binary rhythm classes proved to be effective in combating daytime sleepiness, by causing a decrease in scores after 12 weeks of intervention. Contrary results are found in the literature and indicate that both binary and quaternary rhythm dance interventions can improve daytime sleepiness in individuals with PD[34].

Moreover, it was not possible to observe in this study any improvement in fatigue after the intervention of the two proposed dance rhythms. This finding is not different from other studies presented in the literature such as Elbers, Berendse, and Kwakkel[39] who claim the existence of a barrier in the investigation of fatigue in PD, due to the lack of instruments that can measure the sensation of fatigue, which contributes to the lack of studies with positive results in this variable. In addition, the study by Romenets et al[32] involving the rhythms shows similar results to the present study, where the dance was able to improve non-motor symptoms (quality of life, sleep, cognition, and depression), but failed to benefit the feeling of fatigue. Similar results are also reported in the studies by Xiao and Zhuang[33], and Sturkenboom et al[40] in which dance and exercise interventions were not effective in improving fatigue.

It is noted that a limitation of our study is the lack of a control group to make comparisons with the two experimental groups. In addition, the subjective characteristics of the fatigue assessment instrument were another limiting factor and the fact that our study investigated the participants symptoms improvements while the conventional pharmacological treatment was maintained. Additionally, it was not possible to follow up with the participants over

the months, making the analysis of the lasting effect of the interventions unfeasible. Finally, another limiting factor was the analysis of only the non-motor symptoms of PD.

Conclusion

It was concluded that binary rhythm is more effective in relieving non-motor symptoms, such as quality of night sleep and daytime sleepiness, and in increasing HR when compared to the quaternary rhythm. These results proved the effectiveness of binary rhythm in its use as an adjunct method to the drug treatment of individuals with PD.

References

1. Kalia LV, Lang AE. Parkinson's disease. Lancet. 2015;286:896-912. doi
2. Dickson DW. Neuropathology of Parkinson's disease. Parkinsonism & Related Disord. 2018;46(1):30-3. doi
3. Fox SH, Katzenschlager R, Lim SY, Barton B, de Bie RM, Seppi K. Movement disorder society. evidence based medicine committee. International Parkinson and movement disorder society evidence based medicine review: update on treatments for the motor symptoms of Parkinson's disease. Mov Disord. 2018;33(8):1248-66. doi
4. Crowley EK, Nolan YM, Sullivan AM. Exercise as therapy for Parkinson's? Aging. 2018;10(7):1536-37. doi
5. Kurt EE, Büyükturan B, Büyükturan Ö, Erdem HR, Tuncay F. Effects of Ai Chi on balance, quality of life, functional mobility, and motor impairment in patients with Parkinson's disease. Disabil Rehabil. 2018;40(7):791-7. doi
6. Hulbert S, Ashburn A, Roberts L, Vernheyde G. Dance for Parkinson's - the effects on whole body coordination during turning around. Complem Ther Med. 2017;32:91-7. doi
7. Kalyani, HHN, Sullivan KA, Moyle G, Brauer S, Jeffrey ER, Kerr GK. Impacts of dance on cognition, psychological symptoms and quality of life in Parkinson's disease, NeuroRehabilitation. 2019;45(2):273-83. doi
8. Delabary MS, Monteiro EP, Donida RG, Wolffenbuttel M, Peyré-Tartaruga LA, Haas AN. Can Samba and Forró's Brazilian rhythmic dance be more effective than walking in improving functional mobility and spatiotemporal gait parameters in patients with Parkinson's disease? BMC Neurol. 2020;20(1):305-14. doi
9. Peyré-Tartaruga LA, Martinez FG, Zanardi APJ, Casal MZ, Donida RG, Delabary MS, et al. Samba, deep water, and poles: a framework for exercise prescription in Parkinson's disease. Sport Sci Health. 2022;17:1-9. doi
10. Sharp K, Hewitt J. Dance as an intervention for people with Parkinson's disease: a systematic review and meta-analysis. Neurosci Biobehav Rev. 2014;47:445-56. doi
11. Lotzke D, Ostermann T, Bussing A. Argentine tango in Parkinson disease - a systematic review and meta-analysis. BMC Neurol. 2015;15:226. doi
12. Giménez-Llort L, Castillo-Mariqueo L. PasoDoble, a proposed dance/music for people with Parkinson's disease and their caregivers. Front Neurol. 2020;12(11):1-10. doi
13. Mcneely ME, Duncan RP, Earhart GM. Impacts of dance on non-motor symptoms, participation, and quality of life in Parkinson's disease and healthy older adults. Maturitas. 2015;82(4):336-41. doi
14. Hackney ME, Earhart GM. Recommendations for implementing Tango classes for persons with Parkinson's disease. Am J Dance Ther. 2010;32(1):41-52. doi
15. Hashimoto H, Takabatake S, Miyaguchi H, Nakanishi H, Naitou Y. Effects of dance on motor functions, cognitive functions, and mental symptoms of Parkinson's disease: a quasi-randomized pilot trial. Complem Ther Med. 2015; 23 (2):210-9. doi
16. Earhart GM, Duncan RP, Huang JL, Perlmutter JS, Pickett KA. Comparing interventions and exploring neural mechanisms of exercise in Parkinson's disease: a study protocol for a randomized controlled trial. BMC Neurology. 2015;15:9. doi
17. Tillmann AC, Andrade A, Swarowsky A, Guimarães ACA. Brazilian Samba protocol for individuals with Parkinson's disease: a clinical non-randomized study. JMIR Res Protoc. 2017;6(7):e129. doi
18. Tillmann AC, Swarowsky A, Andrade A, Moratelli J, Boing L, Vieira MCS, et al. The impact of Brazilian samba on Parkinson's disease: analysis by the disease subtypes. Rev Bras Med Esporte. 2020;26(1):25-9. doi
19. Moratelli J, Alexandre KH, Boing L, Swarowsky A, Corrêa CL, Guimarães ACA. Binary dance rhythm or Quaternary dance rhythm which has the greatest effect on non-motor symptoms of individuals with Parkinson's disease? Complement Ther Clin Pract. 2021;43:101348. doi
20. Bertolucci PHF, Brucki SMD, Campacci SR, Juliano Y. The mini-mental state examination in an outpatient population: influence of literacy. Arq Neuro-Psiquiatr. 1994;52(1):1-7. doi
21. Hoehn MM, Yahr MD. Parkinsonism: onset, progression, and mortality. Neurology. 1967;17:427-42.
22. Valderramas S, Feres AC, Melo A. Estudo de confiabilidade e validade de uma versão em português do Brasil da escala de gravidade da fadiga em pacientes com doença de Parkinson. Arq Neuro-psiquiatria. 2012;70(7):497-500.
23. Chaudhuri KR. The Parkinson's disease sleep scale: a new instrument for assessing sleep and nocturnal disability in Parkinson's disease. J Neurol Neurosurg Psychiatry. 2002;73(6):629-35.
24. Bertolazi AN, Fagondes SC, Hoff LS, Pedro VD, Menna Barreto SS, Johns MW. Validação da escala de sonolência de Epworth em português para uso no Brasil. J Bras Pneumologia. 2009;35(9):877-83. doi
25. Marques R. Quem "se garante" no forró eletrônico? Produzindo diferenças em contextos de fronteira e ebulição social. Cadernos Pagu. 2014;43:347-83.
26. Quadros AC, Volp CM. Forró universitário: a tradução do forró nordestino no sudeste brasileiro. Motriz: J Phys Educ. 2005;11(2):127-30.
27. Hannon EE, Soley G, Ullal S. Familiarity overrides complexity in rhythm perception: a cross-cultural comparison of American and Turkish listeners. J Exp Psychol Hum Percept Perform. 2012;38(3):543-8. doi
28. Jensen A, Bonde LO. The use of arts interventions for mental health and wellbeing in health settings. Perspect Public Health. 2018;138(4):209-14. doi

29. Mcneelly ME, Duncan RP, Earhart GM. A comparison of dance interventions in people with Parkinson's disease and older adults. Maturitas. 2015;81(1):10-6. doi
30. Bugalho P, Mendonça M, Lampreia T, Miguel R, Barbosa R, Salavisa M. Heart rate variability in Parkinson disease and idiopathic REM sleep behavior disorder. Clin Autonom Res. 2018; 28(6):557-64. doi
31. Miyasato RS, Silva Batista C, Peçanha T, Low DA, de Mello MT, Piemonte ME, et al. Cardiovascular responses during resistance exercise in patients with Parkinson's disease. PM R. 2018;10:1145-52.
32. Comments SR, Anang J, Fereshtehnejad SM, Pelletier A, Postuma R. Tango for treatment of motor and non-motor manifestations in Parkinson's disease: a randomized control study. Complemen Ther Med. 2015;23(2):175-84.
33. Xiao CM, Zhuang YC. Effect of health Baduanjin Qigong for mild to moderate Parkinson's disease. Geriatr Gerontol Int. 2016;16(8):911-9. doi
34. Cusso ME, Donald KJ, Khoo TK. The impact of physical activity on non-motor symptoms in Parkinson's disease: a systematic review. Front Med (Lausanne). 2016;17(3):1-9. doi
35. Grover S, Somaiya M, Kumar S, Avasthi A. Psychiatric aspects of Parkinson's disease. J Neurosci Rural Pract. 2015;6(1):65-76.
36. Zhu K, van Hilten JJ, Marinus J. Onset and evolution of anxiety in Parkinson's disease. Eur J Neurol. 2017;24 (2):404-11. doi
37. Yu RL, Tan CH, Wu RM. The impact of nocturnal disturbances on daily quality of life in patients with Parkinson's disease. Neuropsychiatr Dis Treat. 2015;11:2005-12. doi
38. Goldman SM, Quinlan PJ, Ross GW, Marras C, Meng C, Bhudhikanok GS, et al. Solvent exposures and Parkinson disease risk in twins. Ann Neurol. 2012;71(6):776-84. doi
39. Elbers RG, Verhoef J, van Wegen EE, Berendse HW, Kwakkel G. Interventions for fatigue in Parkinson's disease. Cochrane Database Syst Rev. 2015;2015(10): CD010925. doi
40. Sturkenboom IH, Graff MJ, Hendriks JC, Veenhuizen Y, Munneke M, Bloem BR, et al. Efficacy of occupational therapy for patients with Parkinson's disease: a randomized controlled trial. Lancet Neurol. 2014;13(6):557-66. doi

Corresponding author

Jéssica Amaro Moratelli, Universidade do Estado de Santa Catarina, Departamento de Educação Física, Programa de Pós-Graduação em Ciências do Movimento Humano, Florianópolis, SC, Brazil. Jessica.moratelli@hotmail.com.

Manuscript received on January 18, 2022
Manuscript accepted on June 15, 2022