

Title: The Effect of Dancing on Parkinson Disease People

The effect of dance intervention on balance, health status and quality of life of elderly living with Parkinson Disease – a quasi-experimental study

Authors: Anaam Soloh¹, Sahar Hammoud², Beatrix Bánkiné Perjés², Viktória Prémusz^{1,2}

Institutions:

¹Institute of Physiotherapy and Sport Science, Faculty of Health Sciences, University of Pécs, Pécs, Hungary. Hungary, H-7621 Pécs, Vörösmarty u. 4.

²Doctoral School of Health Sciences, Faculty of Health Sciences, University of Pécs, Pécs, Hungary, H-7621 Pécs, Vörösmarty u. 4.

Corresponding Author: Anaam Soloh

Address: Hungary, H-7621 Pécs, Vörösmarty u. 4.

Phone Number: 0036 20 489 0097

Email Address: education.enaam3@gmail.com

ABSTRACT

Introduction: Parkinson Disease (PD) is a neurological chronic disorder which can impact the motor and the non-motor functions. It has recently been shown that regular exercises and rhythmic movements can reduce PD symptoms. Thus, we aimed in this study to investigate the effect of dancing on PD patients as a non-pharmacological treatment.

Methods: This was a quasi-experimental, interventional, follow up study. 23 PD patients (The average age was 62.6 ± 8.8 years) were included, where 8 were in the Intervention Group (IG) and 15 in the Control Group (CG). SF-36 and PDQ-39 validated questionnaires were used to collect data about health status and Quality of Life (QoL), as well as, BBT and FSST tests to measure the balance. Data were collected between February 2021 and January 2022. Statistical analysis was performed using IBM SPSS. The significance level was set at $p < 0.05$.

Results: Based on SF-36 only 13.3% of CG and in contrast 37.5% of IG reported very good or good health. However, the difference was not statistically significant ($p = 0.681$). Regarding QoL, the IG had higher mobility ($p = 0.873$), activities of daily living ($p = 0.083$), emotional well-being ($p = 0.082$), cognition ($p = 0.335$), and communication ($p = 0.811$) than the CG but the results were not significant. Concerning FSST, significant balance differences were found in all trails ($p \leq 0.001$, $p = 0.035$, $p \leq 0.001$). BBT also improved but not significantly.

Discussion: Dancing intervention could improve PD's balance according to BBT and FSST. But further studies are needed to prove the effect of dancing on health status and QoL.

Keywords: Parkinson Disease, Dance Therapy, Health Status, QoL, Balance.

ABSZTRAKT

Célkitűzés: A Parkinson-kór (PD) egy krónikus neurológiai rendellenesség, amely hatással lehet a motoros és a nem motoros funkciókra. A közelmúltban kimutatták, hogy a rendszeres gyakorlatok és a ritmikus mozgás csökkenthetik a PD tüneteit. Így ebben a tanulmányban arra törekedtünk, hogy megvizsgáljuk a tánc PD-betegekre gyakorolt hatását, mint nem farmakológiai intervenciót.

Adatok és módszerek: Kvázi-experimentális, intervenciós, követéses vizsgálatot folytattunk. 23 PD-beteget vontunk be, 8-at az intervenciós csoportba (IG) és 15-öt a kontrollcsoportba (CG) soroltunk be. Az SF-36 és PDQ-39 validált kérdőíveket használtuk az egészségi állapotra és az életminőségre (QoL) vonatkozó adatok gyűjtésére, valamint a BBT és FSST teszteket alkalmaztuk egyensúly mérésére. Az adatokat 2021 februárja és 2022 januárja között gyűjtöttük. A statisztikai elemzést IBM SPSS használatával végeztük. A szignifikancia szintet $p < 0,05$ -ben határoztuk meg.

Eredmények: Az SF-36 alapján a CG-nek csak 13.3%-a, ezzel szemben az IG 37.5%-a számolt be nagyon jó, vagy jó egészségről. A különbség azonban statisztikailag nem volt szignifikáns ($p = 0,681$). Ami a QoL-t illeti, az IG nagyobb mobilitásról ($p = 0,873$), mindennapi aktivitásról ($p = 0,083$), érzelmi jóllétről ($p = 0,082$), kognitív készségekről ($p = 0,335$) és kommunikációról ($p = 0,811$) számolt be, mint a CG, de az eredmények nem voltak szignifikánsak. Az FSST-t illetően mindenhárom alkalommal jelentős egyensúlykülönbségeket találtunk ($p \leq 0.001$, $p = 0.035$, $p \leq 0.001$). A BBT is javult, de nem szignifikánsan.

Kulcsszavak: Parkinson-kór, Táncterápia, Egészségi állapot, Életminőség, Egyensúly.

ABBREVIATIONS

PD: Parkinson Disease

QoL: Quality of Life

PA: Physical Activity

COVID-19: Coronavirus Disease 2019

IG: Intervention Group

CG: Control Group

BMI: Body Mass Index

BBT: Balance Berg Test

FSST: Four Square Step Test

SF-36: 36-item Short Form Health Survey

PDQ-39: 39-questions Parkinson Disease Questionnaire

SD: Standard Deviation

MD: Mean Difference

INTRODUCTION

Parkinson Disease (PD) is a neurological disorder which can impact the motor and the non-motor functions, usually commencing over the age of 60. PD is a chronic disease, and it is the second largest neurological disease affecting an estimated 571 per 100,000 people in Europe with raising prevalence due to the aging population. In the United States, there are approximately 1.5 million patients with PD (1). In Hungary, PD deaths were 398 or 0.35% of total deaths in 2020 (2). The main cause of PD is the loss of brain cells called Substantia Nigra which are responsible for producing the dopamine (3,4). PD symptoms can be rigidity, tremor at rest, bradykinesia and postural instability. It can influence the balance and the gait in late stages (5). Balance is a common serious challenge for PD people. Balance dysfunction is identified as one of the causes to have poor Quality of Life (QoL), especially when it comes to difficulty in turning or standing, which may cause falling as a result of postural instability (5,6). PD can also lead to mood disorders such as anxiety, depression and apathy. Almost 45% of PD patients suffer from anxiety (1). In addition, apathy is a frequent psychiatric disturbance that can be obvious even earlier than the motor symptoms of PD (7). The traditional way of the PD curing as a motor disorder is by dopaminergic medication. In the last decades, non-pharmacologic interventions started to be used to treat PD patients (5). It has recently been shown that regular exercises and rhythmic movements can improve bradykinesia symptoms in PD. In addition, physical activity (PA) increases survival and prevents people from chronic diseases (7). According to the literature, the movement therapy improved balance and gait function which led to better QoL on PD patients. While benefits can be obtained with a short dance intervention, longer interventions may prove to be more effective (8). Although PA improves specific aspects of physical fitness such as rehabilitation by using multiple compensatory strategies as therapeutic approach, many questions are still unanswered (9,10). For example, how frequent the exercises should be performed to get the maximal benefit? When should it start? What kind of exercise do the patients need? When we think of exercise, we immediately think about muscle strengthening and cardiovascular condition, but we forget about the main idea of moving. Based on the above presented, we are conducting this study to investigate the effect of dancing on PD patients as a non-pharmacological treatment.

Objectives

The aim of this research was to determine the effect of dancing on PD patients as a non-pharmacological treatment, by evaluating general and specific health status, and QoL of PD patients and by measuring balance at baseline and after 10 weeks of participating in dance classes.

MATERIALS AND METHODS

Research Design and Setting

This was a quasi-experimental, interventional, follow up study using validated questionnaires and clinical tests. The research took place in Vasutas Művelődési Ház (Dance and civilised meetings Studio) Pécs, Hungary. After the pandemic, the location was changed to one of the buildings of the University of Pécs, dance studio in cooperation with Parkinson Dance Group of the Parkinson Association in Pécs.

Sample and Data Collection

In the research we targeted the PD patients, the estimated number of participants in the Intervention Group (IG) was 20, but due to Coronavirus Disease 2019 (COVID-19) we had difficulty to keep in contact with the patients. We started with collecting data from 11 participants in the IG who agreed to participate but only 8 participants could take part in the research until the end. Due to COVID-19, some participants were not able to attend the dancing class. While the Control Group (CG) included 15 patients. Data were collected between February 2021 and January 2022.

Inclusion and Exclusion Criteria

Adults over 18 years with the diagnosis of PD between stages of 1-4 were eligible to participate if they had one of the following symptoms tremor, freezing, and slow down. Patients with a Body Mass Index (BMI) higher than 35 and those with any physical and mobility impairments were excluded. Additionally, we would have been excluded patients with verbal and written communication impairments. But this was not a case.

Sampling Technique

Non-random, consecutive sampling was used in this study. 23 patients participated in the research. The sample of the IG was 8 patients, and 15 patients in the CG. All patients had similar symptoms, tremor, freezing, and slowdown.

Intervention

The IG took part in dance classes, however the CG did not. Each class was held for one hour once per week. Few dancing classes were switched to online due to COVID-19 restrictions. Each dance class focused on a particular limb and had a different goal. For instance, Ballet dancing type concentrated on the body posture and on coordination. Other classes focused on Salsa moves, this type provided a lot of flexibility and length steps by the assistance of the music and following a specific rhythm. The dancing training was structured of 4 parts using the chair as a core support. The most common exercise was breathing training during the warm-up and during every movement they used to do. First part was the warm-up while seated in circle with the group, started with flexion, extension and rotation combined with dance moves. The second part was done in partnered exercises in standing position, PD participants created their own moves at the same rhythm of the music. In the third part, the PD participants were asked to dance Tango following each other, meanwhile the instructor was noticing for how long they could walk unsupported, checked on the posture of their body and the gait cycle. The fourth part was the relaxing part, it was an important part for PD participants to calm down (11). The IG had a physical examination; Balance Berg Test (BBT) and Four Square Step Test (FSST). Both groups filled 4 validated questionnaires.

Data Collection Tools

1. Sociodemographic Questions and Short Anamnesis: the questionnaire gave us more detailed information about the PD participants. It included age, gender, marital status, education level, employment status and current activity. Additionally, patients were asked about their height and weight for BMI measurements, in addition to the walking aids usage.
2. Lifestyle Questions: this form focused on the PD participant's lifestyle before and after 5 years. Answering the questions gave us specific information about coffee and alcohol consumption, smoking habits, in addition to eating habits.
3. 36-item Short Form Health Survey (SF-36), consisted of 36 questions to tell us about each participant thought of his/her own health. Each questions had 5 different options of answer. The PD participants were asked to describe their usual activities related to 8 sub-scales; physical and social functioning, physical and emotional role limitations, mental health, energy, pain, and general health perceptions, and a physical and mental summary score can be obtained from these. This could help us to evaluate the health status of our participants (11). The maximum score of 100 reflected the best possible health status.

4. 39-questions Parkinson Disease Questionnaire (PDQ-39): consisted of 39 questions with 5 different options of answer related to the frequency of the disease manifestation. The answers referred to impact of the illness on the patient's life in the previous month, it had 8 dimensions: mobility, activities of daily life, emotional well-being, stigma, social support, cognition, communication, and bodily discomfort. The PDQ-39SI was derived by the sum of the 8 PDQ-39 sub-scale scores divided by 8 (the number of sub-scales), which yielded a score between 0 and 100. This was equivalent to expressing the sum of all 39 item responses as a percentage score. The final score was the result of the following equation: the sum of each question score divided by the result times 4 (the maximal score for each question), divided by the total number of questions. The higher score was the worst. This result was multiplied by 100. Each dimension score ranged from 0 to 100 in a linear scale (12).
5. FSST: in this test we measured the balance of each PD participant in the IG only. We performed this test twice. The first test was on 7th of October 2021 and second test was on 16th of December 2021. The main idea of the measurement was to check how fast the head and the spine can provide balance for the core muscles strength while moving and changing positions with bending forward and backward. This test could inform us about the PD's balance ratio. In FSST there were 4 squares the PD participant was instructed to stand on square 1 facing the square 2. Participants were asked to try to step the 4 squares as fast as possible without touching the sticks in the following sequence: 2, 3, 4, 1, 4, 3, 2. Both feet must make contact with the floor in each square. The participant was instructed to try to step forward, backward, and sideway to the right and left the sequences as fast as possible. Equipment required for FSST were a stopwatch and 4 sticks (13,14).
6. BBT: in this test we measured how much effort the PD participant needed to correct or change the posture which led us to evaluate the balance while moving. The test included 14 tasks. The instructions were well received. We could also examine the unsupported movement ability and the body coordination of each participant in the IG. We performed this test twice (15,16).

Translation of Data Collection Tools

Since the official language in Hungary is Hungarian, it was impossible to distribute the questionnaires in English. The SF-36 questionnaire was already validated in Hungarian

language. Concerning the PDQ-39 and the life style questionnaires, they were both in English. Both questionnaires were translated to Hungarian and then content validity was checked by panel of experts. Permission to use all questionnaires was granted. Additionally, the instructions of BBT and FSST tests were in Hungarian language.

Data Analysis

SPSS version 26 was used to analyze the data. For descriptive statistics, frequencies and percentages were used for categorical variables, and mean and Standard Deviation (SD) for continuous variables. The Kolmogorov–Smirnov test was used to check the normal distribution of the data. For variance analysis of categorical variables, the Chi-square (χ^2) test or Fisher's exact test was used to compare the variance in the dependent variable across the independent variable. While for numerical variables (mobility, FSST, BBT), Wilcoxon-test, Mann-Whitney-U test, paired sample T-test and One way ANOVA tests were used to conduct the variance analysis. The significance level was set at $p < 0.05$.

Ethical Considerations

Participants were informed about the research's aim and methods before signing the informed consent form. The investigation conformed to the principles outlined in the Declaration of Helsinki. Voluntary participation and ability to withdraw from or leave the study at any point without a reason and without feeling an obligation to continue. Anonymity and confidentiality were provided for the participants. All possible sources of harm to participants were considered and reduced. To provide the safety of the participants a trained dance rehabilitation instructor was present during the intervention sessions sometimes an expert neurologist was there. The study was approved by the Regional Research Ethics Committee (Record number: 8838).

RESULTS

Demographics

Within the IG, 37.5% were males, 50% had additional illness and 37.5% used walking aids. While in the CG, 60% were males, 46.7% had additional illness and 13.3% used walking aids. The average age and the BMI of the IG were higher than that of the CG. The detailed demographics of both groups are presented in Table 1 and Table 2.

Life Style

No change in coffee consumption habits of participants of both groups (IG and CG) was observed between the last 5 years and the current month. Concerning sleeping quality, we noticed a higher difficulty of sleeping in participants of both groups of the current month compared to that of 5 years ago. The details of life style questions are presented in Table 3.

Health Status (SF-36)

60.9% of the PD participants reported bearable, 17.4% reported bad, 13.0% reported good and 8.7% very good health status. As shown in Table 4, 13.3% of CG and 37.5% of IG reported a good and very good health description although it was not significant ($p=0.681$). Bad health status was reported by 20.0% of the CG and 12.5% of IG. More than half of the PD participants stated to do less than what they wanted due to PD. 12.5% of the IG stated that their health status is much worse than a year ago compared to 20% in the CG. See Appendix A.

QoL (PDQ-39)

The IG participants had higher mobility ($p=0.873$), activities of daily living ($p=0.083$), emotional well-being ($p=0.082$), cognition ($p=0.335$), and communication ($p=0.811$) than those of CG but the results were not significant. The details of the 8 sub-scales of the PDQ-39 are shown in Table 5.

Participants in the CG had strong and very strong physical pain reports, while those in the IG had not. Additionally, 73.3 % of the CG reported a little bit restrictive pain, while only 37.5% reported that in IG. Participants in the IG were worried about falling in public more often than those in CG, although few IG participants never felt worried of falling in public. According to our results the IG had more participants who cooked by their own more often than the CG. However, the IG participants had PD symptoms more frequent than the CG participants.

Regarding the variance analysis, IG participants had significantly higher writing problems ($p=0.044$) and feelings of anger ($p=0.015$) in the last month. There was a significant difference in feelings of isolation across gender of the CG participants ($p=0.015$). Additionally, there were significant differences in basic life activities such as cooking and dressing across age groups

of CG participants ($p=0.008$, $p=0.048$ respectively). Participants of CG with higher BMI needed more to be accompanied than those with lower BMI ($p=0.01$) in CG. To be confined to home significantly varied among different age categories ($p=0.036$) in IG.

Since there was not any significant difference in age and BMI between the IG and CG PD participants ($p=0.092$, $p=0.401$ respectively) we estimated some difference in relation to PDQ-39, but we were only able to describe significant difference based on One-way ANOVA test by the mobility subscale ($F= 3.463$, $p=0.029$) related to age categories but no significant difference was found related to BMI categories ($F= 1.875$, $p=0.179$).

BBT

Based on the results of the Kolmogorov-Smirnova normality test, BBT data showed to be non-normally distributed. Thus, the Wilcoxon signed rank test, a non-parametric test, was used to compare data, as an alternative to the paired T-test. Significant difference was not found based on Wilcoxon test for the 14 BBT tasks. However, some differences were found by the personal data comparing the baseline and follow up results of the 14 BBT task. The hardest tasks were the last 4 tasks, such as when the participants were asked to stand on one leg which was a big challenge. After the 10th week BBT results assessed an improvement in each PD dancer, they could do almost all the tasks with a good score (3-4). IG participants could perform the BBT tasks more confidently and independently. The instructions and the results of the BBT of the IG are presented in Appendices B and C.

FSST

During the first week, the participants could not do the task properly from the first trail, where they were able to do it from the second trail. After 10 weeks, the participants could do the task from the first trial. Additionally, the second trail was faster than that of the first week. As shown in Figure 1, there were significant differences between the FSST results of the first ($p\leq0.001$), second ($p=0.035$), and third ($p\leq0.001$) trials between pre and post intervention measurements, where the participants were faster in the post intervention measurements especially in the first and third trials where the difference in time was greater than that in the second trial. For more details about the FSST instructions and test results, see Appendices D, E and F.

DISCUSSION

Even though there is no cure for PD, medication, surgery, or reassuring care can relieve symptoms. Pharmacological treatment can hardly influence balance dysfunction. But still as many studies showed that the movement therapy for PD who had balance dysfunction increased awareness and positive potential which led to better QoL and health status (6). Thus, this study was conducted to investigate the effect of dancing on PD patients as a non-pharmacological treatment.

The average age of the IG was higher than that of the CG, as a result PD participants in IG had more challenges and difficulties than CG due to age differences (17,18). We realized that the IG needed support while moving in order to perform better and secured motion while dancing. When we decided to compare the two groups, we kept in mind that the IG had less participants compared to the CG. In addition, they were older and had much more co-morbidities than the CG participants. This could be a main reason for joining the dance classes and trying to reach the best prevention they could get from the physical movements every week.

Getting in more advanced age leads to water loss which may lead to several changes, starting from bone structure due to loss of bone density, following muscles weakness due to muscle mass reduction (sarcopaenia) and increasing body and visceral fat, all this changes could increase prospect of fractures (18). Our findings showed that participants in the IG reported a better health status than those in the CG though, the difference was not significant. This could reach our aim of the dancing classes program which helped to motivate and increase tolerance and balance for each PD participant (5,19). The results further showed that there were depart for PD participants to do activities due to their health condition. Feeling calm or full of energy question was relative because PD patients usually change their mood frequently depending on their strength (7,20). Additionally, PD medications can lead to depression or anxiety (18) that can affect the patients' activities and limit their movement. Dancing classes can build gradually a good way for accepting and respecting each other's problems. The PD participants may talk, share their thoughts and laugh, which may improve their social life (20,21). Our results support this, where the IG showed a higher communication scores than the CG. During our research, the attendance was almost complete, where participants showed interest and were motivated to participate. Many studies showed evidence that PD patients attended dance classes for social and emotional benefits as well (22).

As the person gets old the weight increases due to health condition and mainly loss of physical activity, here comes the idea of dance classes to fill this gap and work on physical and mental health together (7). Participants in the IG were worried about falling in public more often than those in CG, although few IG participants never felt worried of falling in public. The main idea of practicing dancing was to increase confidence and reduce the fear of falling down. It could also reduce the embarrassment of having the PD generally (23). Few studies have shown that when PD participants focused on improvement and independence achievements that they have got from the dance classes, they forget about their chronic disease and their symptoms (7,24) such as difficulties in sleeping and writing problems. Our results are contradicting to these finding, where the IG participants had more writing and sleeping problems, but our findings showed that the IG had a higher activities of daily living, such as cooking and dressing than the CG.

Studies have shown that movement therapy can increase awareness and positive potential for PD with balance dysfunction which enhance QoL (5). Our IG participants felt less angry during the last month compared to CG. There was a significant difference in feelings of isolation across gender of the CG participants ($p=0.015$). Gender could be a reason for having a better or a worst health status which lead to better or poor QoL, depending on the society structure and the common rules. For instance, females are more likely to work at health care institution, as a result they can care more about themselves due to their knowledge. While males work in different fields and have less knowledge about health. Females also generally are more likely to do check-ups due to their body hormones, during pregnancy, after menopause or maturation period (25).

All dance classes started with warm-up and breathing following standing and walking which could improve stabilization of PD patients in IG after 10 weeks of dance participation. Based on some researches, age can lead to a high BMI which limits movement and decreases balance (4). The first week of BBT results clarified that IG participants had already good posture, we assumed that the reason could be because the PD dancing group in Pécs started 3 years ago. According to this, BBT tasks were not hard for most of them. Regarding BBT outputs of IG participants after 10 weeks, their gait and posture qualities became natural and smooth. Their balance was shifted to the center and to all directions equally which led to a good performance in the FSST task. They were not afraid to fall as they were 10 weeks before. According to our evaluation, dance classes could greatly improve their ability while standing on one leg for example which was the last and the hardest task for all IG participants (26).

Concerning the FSST results, IG participants needed time to analyze the moves and to arrange the order before starting the task, which was normal for their age (27). Dancing affects the motor system and makes a major change in the brain stimulation (5,6,26,28). We assumed that dance activity could improve the participant's motor and maintain a good stimulation as a result of avoiding the PD symptom such as tremor and keep going with the rhythm of the music. This could lead their body to a different mind-set and new way of thinking. Our results support this, where after 10 weeks, the participants could do the task from the first trial. There were significant differences between the FSST results of the first, second, and third trials between pre and post intervention measurements, where the participants were faster in the post intervention measurements.

Limitations

Our study has some limitations. First, we excluded patients with communication problems and those with inappropriate mobility. Second, we could not control the participants' medication pre and post dancing class. Third, the physical tests were performed before or after the dancing class depending on the participants' preferences. Fourth, few dancing classes were held online due to COVID-19 restrictions which might lead to less effective intervention due to poor monitoring of participants. Finally, the small sample size. Only 8 participants out of the 11 who agreed, were included in the IG due to COVID-19 restrictions thus, there is a need for additional research including a larger sample size to examine the potential long-term effects of dance on PD patients.

Conclusion

To sum up, we assumed that dancing, as a non-pharmacological treatment can be beneficial for health status of people with PD. Our SF-36 results showed that IG had better health status than the CG but the difference was not statistically significant. Thus, we could not prove our hypothesis. We also assumed that QoL will be better in PD patients who are part of a dancing program than the patients who are not. Our findings showed that the IG had higher mobility, activities of daily living, emotional well-being, cognition, and communication, as well as, lower stigma and bodily discomfort than the CG but, the results were not significant. Finally, we assumed that the balance improves in PD patients due to the dancing intervention. Our

findings showed improvement in BBT results after 10 weeks of intervention within the IG but the results were not significant. However, our results showed significant improvements in FSST results in all trails before and after 10 weeks of intervention. Thus, our hypothesis was confirmed. More research is needed to examine the potential long-term effects of dance on PD patients.

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TABLES

Table 1 Demographics of PD participants

Characteristic	Intervention group (N= 8) n (%)	Control group (N= 15) n (%)
Gender		
Male	3 (37.5)	9 (60.0)
Female	5 (62.5)	6 (30.0)
Residence		
City	3 (37.5)	7 (46.7)
Countryside	4 (50.0)	1 (6.7)
Capital	0 (0.0)	4 (26.7)
Village	1 (12.5)	3 (20.0)
Education		
Vocational training	2 (25.0)	4 (26.7)
High school	1 (12.5)	3 (20.0)
University	5 (62.5)	8 (53.3)
Employment status		
Employed	0 (0)	5 (33.3)
Retired	8 (100.0)	8 (53.3)
Unemployed	0 (0)	2 (13.3)
Additional illness	4 (50.0)	7 (46.7)
Using walking aids	3 (37.5)	2 (13.3)

Table 2 Demographics of PD participants

Characteristics	Intervention group (N= 8) Mean ± SD	Control group (N= 15) Mean ± SD	Z value	P-value
Age (years)	67.2 ± 9.5	60.1 ± 7.5	-1.683	0.092
Height (cm)	164.7 ± 6.7	172.8 ± 7.6	-2.177	0.029
Weight (kg)	76.1 ± 14.4	79.2 ± 10.7	-0.68	0.497
BMI (kg/m ²)	28.0 ± 4.7	26.6 ± 3.9	-0.839	0.401

Table 3 Life style questionnaire results of participants

Characteristics	OoL last 5 years		OoL this month	
	IG (N= 8) n (%)	CG (N= 15) n (%)	IG (N= 8) n (%)	CG (N= 15) n (%)
Smoking regularly	1 (12.5)	1 (6.7)	0 (0.0)	1 (6.7)
Cigarettes (amount/day)	> 10	1-5	0	1-5
Coffee drinking				
Never	1 (12.5)	2 (13.3)	2 (25)	3 (20.0)
Occasionally	3 (37.5)	4 (26.7)	3 (37.5)	4 (26.7)
1-2 cup/ day	4 (50.0)	8 (53.3)	3 (37.5)	8 (53.3)
3-5 cups/ day	0 (0.0)	1 (6.7)	0 (0.0)	0 (0.0)
Alcohol drinking				
Weekly	2 (25.0)	5 (33.3)	0 (0.0)	4 (26.7)
Never	3 (37.5)	4 (26.7)	4 (50.0)	5 (33.3)
Rarely	3 (37.5)	6 (40.0)	4 (50.0)	6 (40.0)
Paying attention to healthy eating				
Not really paying attention	2 (25.0)	2 (13.3)	1 (12.5)	2 (13.3)
Paying some attention	5 (62.5)	9 (60.0)	6 (75.0)	9 (60.0)
Paying close attention	1 (12.5)	4 (26.7)	1 (12.5)	4 (26.7)
Sleep quality description				
Get up early, can't sleep back	2 (25.0)	1 (6.7)	3 (37.5)	4 (26.7)
Often get up for longer period	0 (0.0)	6 (40.0)	0 (0.0)	4 (26.7)
Hard time to fall asleep	2 (25.0)	1 (6.7)	2 (25.0)	1 (6.7)
Falling asleep easily	4 (50.0)	7 (46.7)	3 (37.5)	6 (40.0)

OoL, quality of life; IG, intervention group; CG, control group.

Table 4 Health Status of PD participants

Health Status	Intervention group (N= 8)	Control group (N= 15)	P-value
	n (%)	n (%)	
Very good	1 (12.5)	1 (6.7)	0.682
Good	2 (25.0)	1 (6.7)	
Bearable	4 (50.0)	10 (66.7)	
Bad	1 (12.5)	3 (20.0)	
Total	8 (100.0)	15 (100.0)	

Fisher's exact test was used for the comparison.

Table 5 PDQ-39 questionnaire results of participants

	Group	N	Mean	SD	P-value	MD
Mobility	CG	15	23.5	18.9	0.873	-18.0
	IG	8	41.5	22.3		-18.0
Activities of daily living (ADL)	CG	15	18.7	14.8	0.083	-22.6
	IG	8	41.3	25.6		-22.6
Emotional well-being	CG	15	26.5	13.3	0.082	-12.3
	IG	8	38.8	19.0		-12.3
Stigma	CG	15	22.1	21.4	0.65	0.4
	IG	8	21.8	25.2		0.4
Social Support	CG	15	14.9	16.1	0.301	4.4
	IG	8	10.5	11.6		4.4
Cognition	CG	15	18.9	14.5	0.335	-17.1
	IG	8	36.0	16.8		-17.1
Communication	CG	15	16.0	18.3	0.811	-7.9
	IG	8	23.9	17.6		-7.9
Bodily Discomfort	CG	15	41.2	35.6	0.187	2.6
	IG	8	38.6	22.0		2.6
PDQ-39 Summary Index	CG	15	22.7	13.1	0.71	-8.8
	IG	8	31.5	12.1		-8.8

CG, control group; IG, intervention group; MD, mean difference

FIGURES

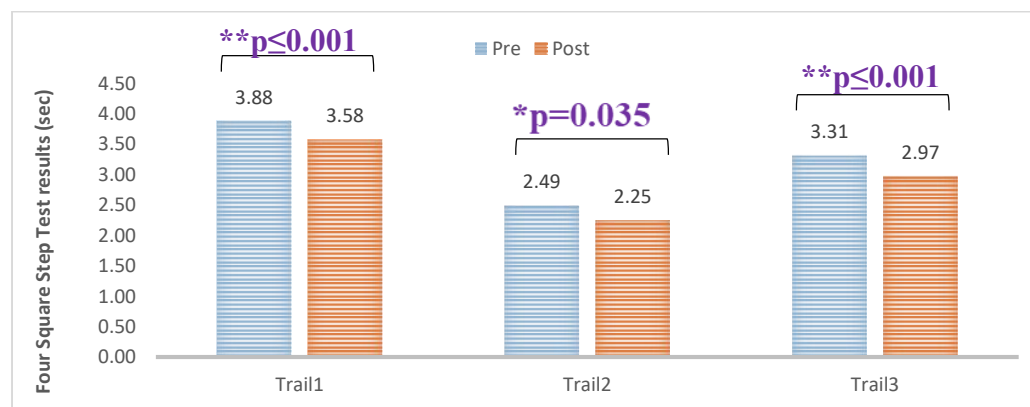


Figure 1 FSST results of the IG participants pre and post intervention measurements (N= 8)

APPENDIX

Appendix A

Health status now compared to year ago for both groups of Parkinson disease's (N=23).

Health status compared to a year ago	Frequency	Percentage
It's much better than a year ago	1	4.3%
Now a little better than a year ago	1	4.3%
It's pretty good than a year ago	8	34.8%
It's a little worse than it was a year ago	9	39.1%
It's much worse than it was a year ago	4	17.4%
Total	23	100.0%

Appendix B

Physical examinations- BBT

The BBT Instructions

1. Sitting to standing: Try to not use your hands for support.
2. Standing unsupported: Please stand for 2 min without holding.
3. Sitting with back unsupported but feet are supported on the floor: please sit with arms folded for 2 min.
4. Standing to sitting.
5. Transverse: Arrange chairs for transvers.
6. Standing with eyes closed: Please close your eyes and stand still for 10 seconds.
7. Standing with foot together: Stand without holding closed feet.
8. Reaching forward without stretched arm while standing raise one arm to 90 degrees: Fist your fingers and try to reach forward as far as you can, without leaning your body forward.
9. Pick up object from the floor: start from standing position pick up a slipper or a shoes, which is placed in front of your foot.
10. Turning and look behind toward your left and right shoulders while standing.
11. Turn 360: Turn completely around yourself in a circle and repeat to the other direction the same procedure.

12. Alternate foot on step: While standing unsupported place each foot alternately on the step stool. Continue until each foot touch it 4 times.
13. Standing one foot in front unsupported: One foot placed directly in front of the other.
14. Standing on one leg stand on one leg as long as you can without holding.

Appendix C

BBT test results of IG participants (N= 8)

Characteristics		Mean	SD	P-value
Pair 1	Pre	3.83	0.41	0.317
	Post	4.00	0.00	
Pair 2	Pre	3.83	0.41	0.317
	Post	4.00	0.00	
Pair 3	Pre	4.00	0.00	1.000
	Post	4.00	0.00	
Pair 4	Pre	3.67	0.52	0.157
	Post	4.00	0.00	
Pair 5	Pre	3.67	0.52	1.157
	Post	4.00	0.00	
Pair 6	Pre	4.00	0.00	1.000
	Post	4.00	0.00	
Pair 7	Pre	4.00	0.00	1.000
	Post	4.00	0.00	
Pair 8	Pre	3.67	0.52	0.157
	Post	4.00	0.00	
Pair 9	Pre	3.67	0.82	0.157
	Post	4.00	0.00	
Pair 10	Pre	3.50	0.55	1.157
	Post	3.83	0.41	
Pair 11	Pre	3.67	0.52	1.000
	Post	3.67	0.52	

Pair 12	Pre	3.67	0.82	0.157
	Post	4.00	0.00	
Pair 13	Pre	3.33	0.52	0.083
	Post	3.83	0.41	
Pair 14	Pre	3.17	0.75	1.083
	Post	3.67	0.52	

Pre: before 10 weeks, Post: after 10 weeks.

Appendix D

Physical examinations- FFST

FFST included two trails:

Trial 1: the total score is the best time of two FSST.

Trial 2: Stopwatch started when the first foot contacted the floor in square 2, write down the time when the right foot contacted the floor in the square.

Trial 3: Stopwatch stop when the last foot came back to touch the floor in square 1. Repeat the trail if the participant fails to complete the sequences successfully.

Four Step Square Test (FSST)

Name: _____

Assistive Device and/or Bracing Used: _____

Date: _____

Trial 1 _____ sec. Trial 1 _____ sec.

FSST Score (best timed trial): _____ sec.

Date: _____

Trial 1 _____ sec. Trial 1 _____ sec.

FSST Score (best timed trial): _____ sec.

Date: _____

Trial 1 _____ sec. Trial 1 _____ sec.

FSST Score (best timed trial): _____ sec.

Appendix E

FSST outcomes after first week of the dance classes for the IG (N= 8)

participant number/ Instructions	Trail number	1	2	3	4	5	6
Total test score	1	3.9	3.2	4.8	4.7	3.5	2.9
First foot touch the 2nd square	2	2.6	2.5	3.8	2.6	2.1	1.1
Last step back to the 1st square	3	3	2.9	4.5	3.9	3.2	2.2
Any walking aids		-	-	Cane	-	-	-

Appendix F

FSST outcomes after 10 weeks of the dance classes for the IG (N= 8)

participant number/ Instructions	Trail number	1	2	3	4	5	6
Total test score	1	3.8	3.0	4.2	4.3	3.3	2.7
First foot touch the 2nd square	2	2.6	2.1	3.4	2.2	1.3	1.8
Last step back to the 1st square	3	2.8	2.7	3.72	3.5	2.81	2.3
Any walking aids		-	-	-	-	-	-

Appendix G

The pictures were allowed to be taken by the permission of the participants.

