

## Introduction

The main goal of this thesis is to prove the positive effect of the dance and movement activity for patients with Parkinson's disease (PD). Another goal is to evaluate effects of long-term dance activity and find out which symptoms are influenced the most after five-month intensive activity.

The aim is to evaluate the effectiveness of dance classes in the frame of influence on a wide range of motor and non-motor symptoms of PD. Therapy effectiveness is assessed on 12 probands (participants of the research). Eventual changes of their problems are evaluated after five-month period of dance classes. To evaluate the effectiveness we used modified Movement Disorder Society - Unified Parkinson's Disease Rating Scale (MDS – UPDRS). Measurements and dance lessons are done in cooperation with Prague branch of organization Parkinson-Help, z.s. and participant of dance movement classes in Turnov. The findings are presented by statistical functions in tables and graphs below and described in text.

## Characteristics of the group

Although in the beginning of the study we had 20 patients tested for the evaluation, eight of them could not undergo the outcome testing because of illness or another personal reasons. Finally we had to evaluate just 12 patients (5 women and 7 men) with the same late-onset form of PD. Most of the patients (10 of 12) were older than 60 years old. All 12 patients, using Levodopa as a pharmacotherapy, were assessed in the same time of the day in an ON state. Every patient has different Levodopa dosage. Just one of the participants has undergone invasive treatment with Deep Brain Stimulation, however his results do not affect the homogeneity of the overall evaluation.

## Investigative material and processing

For the evaluation and objective assessment of the PD's wide range symptoms we used modified version of MDS-UPDRS rating scale. For our use, there was patient's questionnaire added. For deeper assessment of some symptoms and skills this material was enriched by some Berg Balance Scale tests and some other gait tests. As a basis we used Czech version of MDS-UPDRS, which unfortunately has not been validated yet. Scoring is similar as in the MDS-UPDRS (0-4; 0 - normal, 4 - severe). In the material we have finally assessed 55 PD's motor and non-motor symptoms and skills.

Processing was done in MS Excel by using tables, functions and charts. We were focused on mapping condition of patients before their dance activity and compare it with situation after 5 month of intensive dance classes twice a week. For the statistical objectification histograms and statistical hypothesis tests were used. All of 12 patients have assigned the number (1. - 12.).

## Results of the study

There are overall study results presented in the tables below.

The **Table 1** shows the income material with data about patient's state before the dance movement activities. The table shows all assessed symptoms and skills. Scores of each patient are in the vertical colons. Table is supplemented by the colon "Arithmetic average" which shows the average of score in

every observed symptom. Colon "Standard deviation" has its statistical importance. Using the colour range clearly indicates which symptoms developed amongst the probands the most severely and the least (darker colour means higher severity of disability). The last horizontal colon "Total score of every patient" shows the total MDS-UPDRS score useful for comparison. The Table 1 is complemented by a bar **Chart 1 - Histogram before** where is a clear overview of distribution for every degree of severity (0-4).

The **Table 2** shows the same attributes as the Table 1 however in situation after finishing dance movement classes (5 month intensive treatment). This outcome evaluation was let with the same criteria as the income one. Colour range is used with the same rules as before. Table 2 is supplemented by **Chart 2 - Histogram after**. By comparing both of Histograms you can see, that the distribution is in the same resolution in both cases. Both Histograms shows that monitored quantity does not match the Gaussian normal distribution.

Chart 1

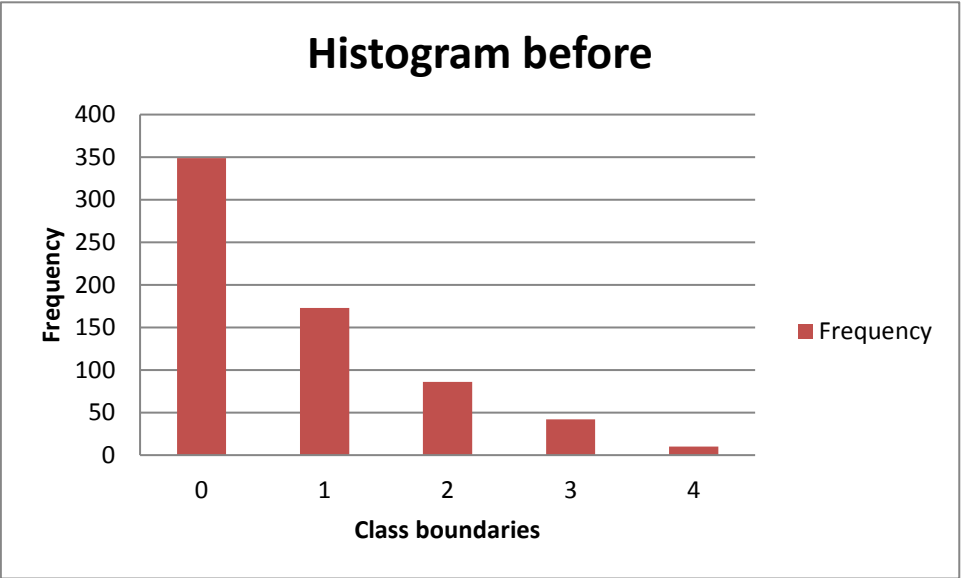


Chart 2

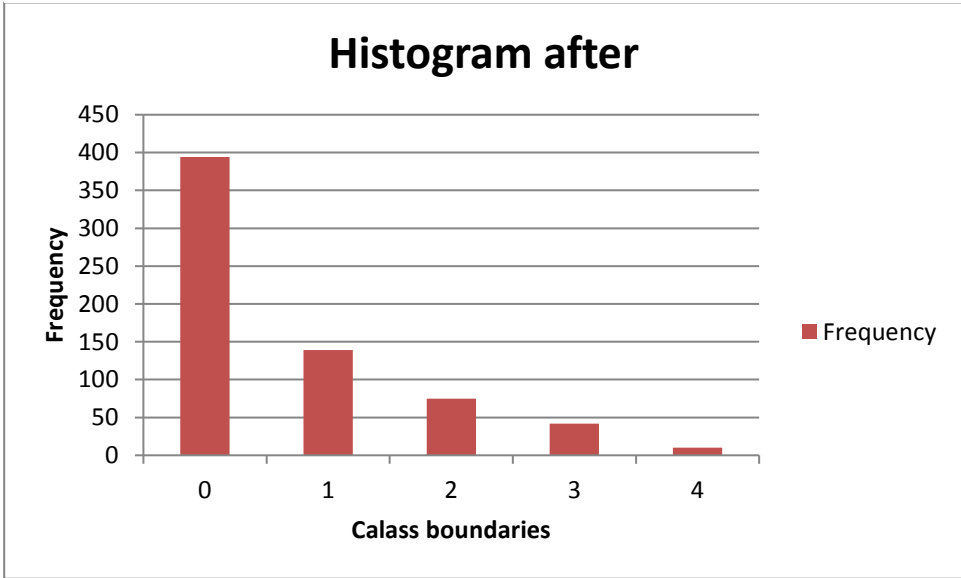


Table 1

Situation before	Severity of symptoms												Arithmetic average	Standard deviation
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.		
Cognitive impairment	0	1	3	1	0	1	0	2	1	1	2	3	1,25	1,010362971
Hallucinations and psychosis	0	1	2	0	0	0	0	0	0	0	0	0	0,25	0,595119036
Depressed mood	0	1	2	0	0	0	1	0	0	0	2	3	0,75	1,010362971
Anxious mood	0	1	1	0	1	0	0	0	0	0	2	3	0,67	0,942809042
Apathy	0	1	3	0	1	0	1	0	0	0	2	3	0,92	1,114924013
Features of DDS	0	0	0	1	0	0	0	1	0	1	2	0	0,42	0,640095479
Sleep problems	0	2	0	1	1	0	0	1	3	0	1	0	0,75	0,924211376
Daytime sleepiness	3	2	2	2	1	2	0	0	4	1	3	2	1,83	1,1426091
Pain and other sensations	2	0	0	0	1	0	0	0	1	1	3	1	0,75	0,924211376
Light headedness on standing	0	2	0	0	0	0	0	2	1	1	0	2	0,67	0,849836586
Fatigue	2	1	3	1	0	1	1	3	0	1	2	2	1,42	0,953793595
Speech	0	0	0	4	2	0	1	3	2	0	2	2	1,33	1,312334646
Chewing nad swallowing	1	0	0	0	0	0	0	2	0	0	1	1	0,42	0,640095479
Eating difficulties	0	1	0	0	1	3	0	3	0	0	1	1	0,83	1,067187373
Dressing	0	1	1	0	1	0	1	2	1	1	1	2	0,92	0,640095479
Hygiene	1	1	0	0	1	0	1	3	0	1	1	2	0,92	0,862006703
Handwriting	0	1	0	4	1	4	2	3	1	1	3	1	1,75	1,361677887
Doing hobbies and other activities	1	1	0	0	4	0	1	3	0	0	2	2	1,17	1,280190958
Turning in bed	0	1	0	0	1	0	2	3	1	0	2	0	0,83	0,986013297
Tremor	2	0	0	0	2	2	1	1	0	2	1	1	1,00	0,816496581
Getting out of bed	0	1	0	0	2	0	1	4	1	1	1	2	1,08	1,114924013
Walking and balance	2	1	0	0	1	0	1	4	2	1	1	2	1,25	1,089724736
Freezing	0	0	1	0	0	0	1	3	0	0	1	1	0,58	0,862006703
Falls in realtion to freezing	0	0	1	0	1	0	0	4	2	0	1	1	0,83	1,1426091
Speech	1	0	0	3	1	0	0	2	1	0	0	3	0,92	1,114924013
Facial expression	1	1	0	3	1	0	1	2	0	1	0	2	1,00	0,912870929
Rigidity	0	1	2	1	2	2	2	3	2	1	0	3	1,58	0,953793595
Finger tapping	0	0	0	2	2	1	0	3	1	1	0	3	1,08	1,114924013
Hand movements	0	1	0	1	2	2	0	3	1	1	1	2	1,17	0,897527468
Pronation- supination movements	0	0	1	2	2	2	0	2	2	2	1	2	1,33	0,849836586
Toe tapping	0	0	1	1	2	1	1	3	1	0	1	3	1,17	0,986013297
Leg agility	0	0	0	1	1	1	1	2	0	0	1	3	0,83	0,897527468
Arising from chair	2	0	0	0	1	0	0	3	0	0	0	3	0,75	1,16368667
Sitting down on the chair	1	0	0	0	0	0	0	2	0	0	0	3	0,50	0,957427108
Transfers	0	0	0	0	0	0	0	1	0	0	0	1	0,17	0,372677996
Standing with eyes closed	0	0	0	0	0	0	0	1	0	0	0	1	0,17	0,372677996
Standing on a narrow base	0	0	0	1	2	0	0	3	0	0	0	2	0,67	1,027402334
Rotation 360°	0	0	0	0	2	0	0	2	0	0	3	2	0,75	1,089724736

One leg stand	0	1	1	1	3	0	0	4	1	1	0	3	<b>1,25</b>	1,299038106
Gait	1	0	0	1	1	0	0	2	0	0	0	2	<b>0,58</b>	0,759202798
Freezing of gait	0	0	0	0	0	0	0	1	0	0	0	1	<b>0,17</b>	0,372677996
Postural stability	0	0	0	0	1	0	0	4	1	0	0	1	<b>0,58</b>	1,114924013
Posture	2	1	1	1	2	1	3	2	3	0	1	1	<b>1,50</b>	0,866025404
Global spontaneity of movement	0	1	1	1	2	1	1	1	1	1	0	2	<b>1,00</b>	0,577350269
Postural tremor	0	1	0	0	0	1	0	1	0	1	1	1	<b>0,50</b>	0,5
Kinetic tremor	0	0	1	0	0	2	0	2	0	0	0	0	<b>0,42</b>	0,759202798
Rest tremor amplitude	0	1	0	0	0	1	0	1	0	0	1	0	<b>0,33</b>	0,471404521
Constancy of the rest tremor	0	1	0	0	0	1	0	2	0	0	2	0	<b>0,50</b>	0,763762616
Number of dyskinesias	0	0	0	2	0	0	0	0	1	0	2	0	<b>0,42</b>	0,759202798
Functional impact of dyskinesias	0	0	0	1	0	0	0	0	0	0	3	0	<b>0,33</b>	0,849836586
Painful dyskinesias	0	0	0	0	0	0	0	0	0	0	0	0	<b>0,00</b>	0
Time spent in the OFF state	0	0	0	0	0	0	1	0	1	0	0	0	<b>0,17</b>	0,372677996
Functional impact of fluctuations	0	0	0	0	0	0	1	0	0	0	0	0	<b>0,08</b>	0,276385399
Severity of motor fluctuations	0	0	0	0	0	0	0	0	0	0	0	0	<b>0,00</b>	0
Painful OFF-state dystonia	0	0	0	0	0	0	1	0	0	0	0	0	<b>0,08</b>	0,276385399
<b>Totoal score of every patient</b>	<b>22</b>	<b>29</b>	<b>27</b>	<b>36</b>	<b>49</b>	<b>29</b>	<b>27</b>	<b>99</b>	<b>36</b>	<b>22</b>	<b>54</b>	<b>81</b>		

Table 2

Situation after	Severity of symptoms												Arithmetic average	Standard deviation	
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.			
Patient															
Cognitive impairment	0	1	1	0	0	1	0	0	0	2	1	3	<b>0,75</b>	0,924211376	
Hallucinations and psychosis	0	0	0	0	0	0	0	0	0	0	0	3	<b>0,25</b>	0,829156198	
Depressed mood	0	1	0	1	0	0	0	0	0	1	1	3	<b>0,58</b>	0,862006703	
Anxious mood	0	1	1	0	1	0	0	0	1	2	2	3	<b>0,92</b>	0,953793595	
Apathy	0	0	0	0	0	0	0	0	1	1	0	3	<b>0,42</b>	0,862006703	
Features of DDS	0	0	0	0	0	0	0	0	1	2	0	0	<b>0,25</b>	0,595119036	
Sleep problems	0	2	0	0	2	0	0	0	2	1	1	1	<b>0,75</b>	0,829156198	
Daytime sleepiness	3	3	2	0	0	0	0	0	2	3	1	3	<b>1,42</b>	1,320248293	
Pain and other sensations	0	0	0	0	2	0	0	0	1	1	1	0	<b>0,42</b>	0,640095479	
Light headedness on standing	0	0	0	0	1	0	0	3	1	2	1	2	<b>0,83</b>	0,986013297	
Fatigue	0	1	1	0	0	0	1	1	1	2	1	2	<b>0,83</b>	0,687184271	
Speech	0	0	0	3	3	0	1	3	2	1	0	3	<b>1,33</b>	1,312334646	
Chewing nad swallowing	0	0	0	0	0	0	0	2	0	1	0	2	<b>0,42</b>	0,759202798	
Eating difficulties	0	0	0	0	0	0	0	2	0	2	0	2	<b>0,50</b>	0,866025404	
Dressing	1	1	2	0	1	0	1	3	1	1	1	3	<b>1,25</b>	0,924211376	
Hygiene	0	1	0	0	1	0	1	2	0	1	1	2	<b>0,75</b>	0,721687836	
Handwriting	0	0	4	4	3	4	2	4	1	3	1	3	<b>2,42</b>	1,497683396	

Doing hobbies and other activities	0	1	0	4	2	0	1	3	1	2	1	3	1,50	1,258305739
Turning in bed	0	0	0	0	1	0	2	2	1	1	1	1	0,75	0,721687836
Tremor	1	1	3	0	2	2	0	2	0	1	2	2	1,33	0,942809042
Getting out of bed	0	1	1	0	2	0	1	2	1	3	1	3	1,25	1,010362971
Walking and balance	0	0	2	1	3	0	1	3	3	2	1	4	1,67	1,312334646
Freezing	0	0	3	1	1	0	1	3	0	2	0	4	1,25	1,361677887
Falls in realtion to freezing	0	0	2	0	0	0	0	2	2	1	0	0	0,58	0,862006703
Speech	0	0	0	4	1	0	0	3	0	0	0	4	1,00	1,58113883
Facial expression	0	0	0	2	0	0	0	2	1	0	0	3	0,67	1,027402334
Rigidity	0	2	1	1	1	0	3	2	2	1	1	3	1,42	0,953793595
Finger tapping	0	2	0	0	0	0	0	1	0	0	2	2	0,58	0,862006703
Hand movements	0	2	0	0	0	0	1	1	0	1	0	0	0,42	0,640095479
Pronation- supination movements	0	1	0	0	1	0	0	0	1	1	1	1	0,50	0,5
Toe tapping	1	1	0	0	2	0	2	2	0	0	1	3	1,00	1
Leg agility	0	0	0	1	2	0	0	2	0	0	0	2	0,58	0,862006703
Arising from chair	0	0	0	0	0	0	0	2	0	0	0	1	0,25	0,595119036
Sitting down on the chair	0	0	0	0	0	0	0	0	0	0	0	0	0,00	0
Transfers	0	0	0	0	0	0	0	1	0	0	0	0	0,08	0,276385399
Standing with eyes closed	0	0	0	0	0	0	0	0	0	0	0	0	0,00	0
Standing on a narrow base	0	0	0	0	1	0	0	0	0	1	0	0	0,17	0,372677996
Rotation 360°	0	0	2	0	2	0	0	2	0	0	0	2	0,67	0,942809042
One leg stand	0	2	0	0	3	0	0	4	0	2	0	2	1,08	1,381926996
Gait	0	0	0	0	0	0	0	1	0	0	0	1	0,17	0,372677996
Freezing of gait	0	0	0	0	0	0	0	0	0	0	0	1	0,08	0,276385399
Postural stability	0	0	0	2	0	0	0	1	0	1	0	0	0,33	0,623609564
Posture	2	0	1	1	1	0	1	2	1	1	1	2	1,08	0,640095479
Global spontaneity of movement	1	1	0	1	2	0	1	3	1	1	0	3	1,17	0,986013297
Postural tremor	0	0	0	0	0	2	1	1	0	0	1	1	0,50	0,645497224
Kinetic tremor	0	0	0	0	1	2	0	0	0	0	1	2	0,50	0,763762616
Rest tremor amplitude	0	1	0	1	0	1	0	1	0	0	1	0	0,42	0,493006649
Constancy of the rest tremor	0	1	0	1	0	1	0	1	0	0	3	0	0,58	0,862006703
Number of dyskinesis	0	0	0	0	1	0	0	0	1	2	0	2	0,50	0,763762616
Functional impact of dyskinesias	0	0	0	0	0	0	0	0	0	3	0	2	0,42	0,953793595
Painful dyskinesis	0	0	0	0	0	0	0	0	0	0	0	0	0,00	0
Time spent in the OFF state	0	0	0	0	0	0	1	0	0	1	0	3	0,42	0,862006703
Functional impact of fluctuations	0	0	0	0	0	0	1	0	0	1	0	3	0,42	0,862006703
Severity of motor fluctuations	0	0	0	0	0	0	1	0	1	1	0	3	0,50	0,866025404
Painful OFF-state dystonia	0	0	0	0	0	0	0	0	0	0	0	0	0,00	0
<b>Totoal score of every patient</b>	<b>9</b>	<b>27</b>	<b>26</b>	<b>28</b>	<b>43</b>	<b>13</b>	<b>24</b>	<b>69</b>	<b>30</b>	<b>55</b>	<b>30</b>	<b>101</b>		

In **Table 3**, there are results compared from input (Table 1) and output (Table 2) scores collected and again accompanied by colour gradation for clarity. The column "Subtraction" in this table shows the mathematical subtraction of arithmetic averages from input and output testing. This column provides an objective assessment of which symptoms have improved and which has worsened after the dance lessons. For clarity, the table is complemented by the colour range. Green colour means improvement and red colour means worsening, white colour means without difference. The column "Statistical hypothesis test" shows the difference between two sets of data. When the number is closer to "1" the difference is lower.

The results from the Table 3 are supplemented by bar **Chart 3** showing all improved and worsened symptoms, based on the calculated difference. For symptoms that have positive values in the column above the zero axis, has improved. In those columns which have a peak below the zero axis are worsened. The total percentage of improvement / worsening of symptoms is shown in **Chart 4**.

**Table 3**

Comparison	Before avg.	After avg.	Subtraction	Statistical hypothesis test
Cognitive impairment	1,25	0,75	0,50	0,081864229
Hallucinations and psychosis	0,25	0,25	0,00	1
Depressed mood	0,75	0,58	0,17	0,503545906
Anxious mood	0,67	0,92	-0,25	0,191054298
Apathy	0,92	0,42	0,50	0,166086814
Features of DDS	0,42	0,25	0,17	0,503545906
Sleep problems	0,75	0,75	0,00	1
Daytime sleepiness	1,83	1,42	0,42	0,317685405
Pain and other sensations	0,75	0,42	0,33	0,219887843
Light headedness on standing	0,67	0,83	-0,17	0,503545906
Fatigue	1,42	0,83	0,58	0,089093574
Speech	1,33	1,33	0,00	1
Chewing nad swallowing	0,42	0,42	0,00	1
Eating difficulties	0,83	0,50	0,33	0,368342595
Dressing	0,92	1,25	-0,33	0,038814091
Hygiene	0,92	0,75	0,17	0,166086814
Handwriting	1,75	2,42	-0,67	0,180342916
Doing hobbies and other activities	1,17	1,50	-0,33	0,473854509
Turning in bed	0,83	0,75	0,08	0,674237238
Tremor	1,00	1,33	-0,33	0,338800696
Getting out of bed	1,08	1,25	-0,17	0,550503716
Walking and balance	1,25	1,67	-0,42	0,294547057
Freezing	0,58	1,25	-0,67	0,070803954
Falls in realtion to freezing	0,83	0,58	0,25	0,338800696
Speech	0,92	1,00	-0,08	0,674237238
Facial expression	1,00	0,67	0,33	0,166086814

Rigidity	1,58	1,42	0,17	0,550503716
Finger tapping	1,08	0,58	0,50	0,235988132
Hand movements	1,17	0,42	0,75	0,043333321
Pronation- supination movements	1,33	0,50	0,83	0,010482361
Toe tapping	1,17	1,00	0,17	0,503545906
Leg agility	0,83	0,58	0,25	0,191054298
Arising from chair	0,75	0,25	0,50	0,052663145
Sitting down on the chair	0,50	0,00	0,50	0,111172951
Transfers	0,17	0,08	0,08	0,338800696
Standing with eyes closed	0,17	0,00	0,17	0,166086814
Standing on a narrow base	0,67	0,17	0,50	0,139409977
Rotation 360°	0,75	0,67	0,08	0,794860451
One leg stand	1,25	1,08	0,17	0,438205899
Gait	0,58	0,17	0,42	0,017180487
Freezing of gait	0,17	0,08	0,08	0,338800696
Postural stability	0,58	0,33	0,25	0,490977434
Posture	1,50	1,08	0,42	0,175273647
Global spontaneity of movement	1,00	1,17	-0,17	0,503545906
Postural tremor	0,50	0,50	0,00	1
Kinetic tremor	0,42	0,50	-0,08	0,777377692
Rest tremor amplitude	0,33	0,42	-0,08	0,338800696
Constancy of the rest tremor	0,50	0,58	-0,08	0,586299307
Number of dyskinesias	0,42	0,50	-0,08	0,820205739
Functional impact of dyskinesias	0,33	0,42	-0,08	0,845130009
Painful dyskinesias	0,00	0,00	0,00	1
Time spent in the OFF state	0,17	0,42	-0,25	0,388852328
Functional impact of fluctuations	0,08	0,42	-0,33	0,219887843
Severity of motor fluctuations	0,00	0,50	-0,50	0,081864229
Painful OFF-state dystonia	0,08	0,00	0,08	0,338800696

Chart 3

## Improvement/deterioration of symptoms

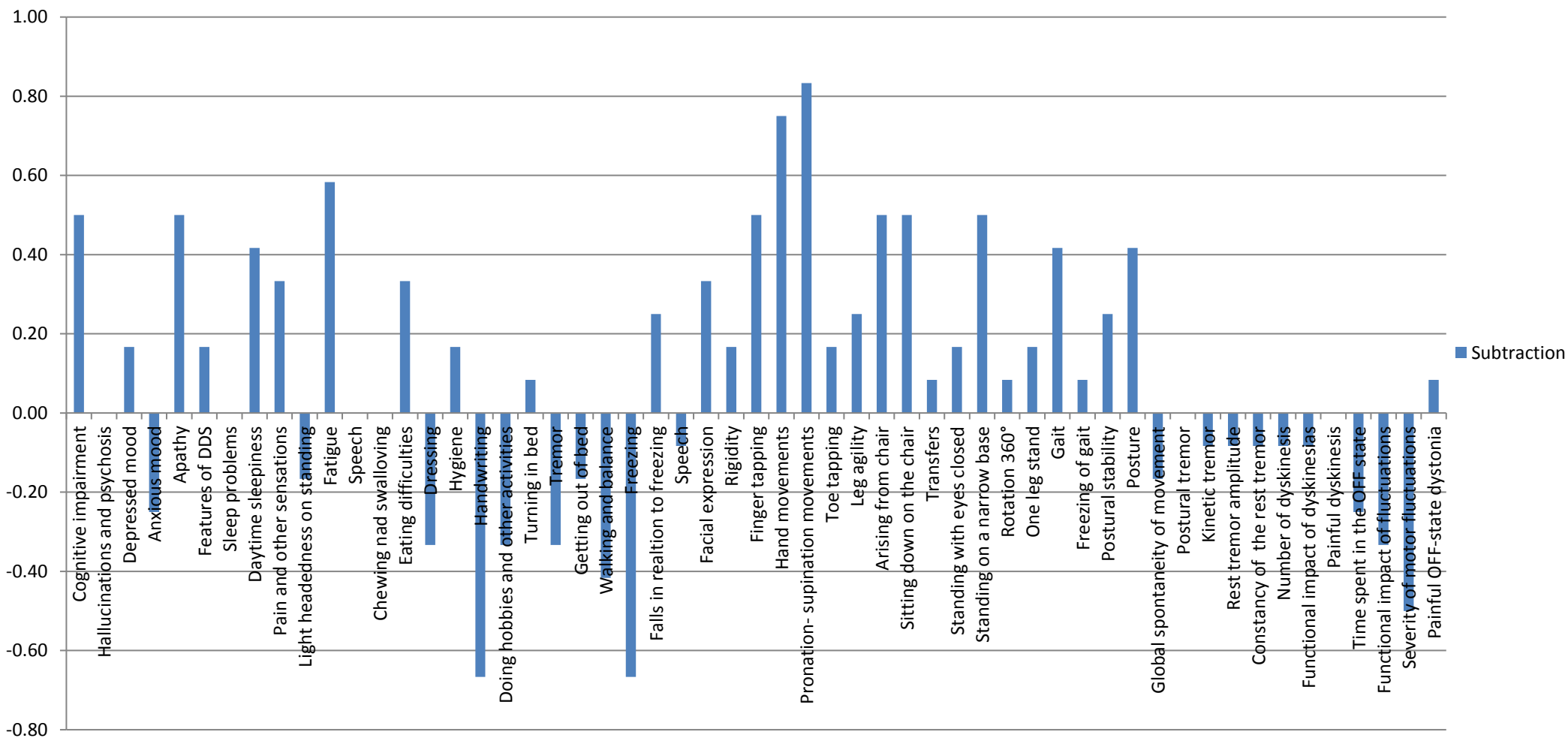
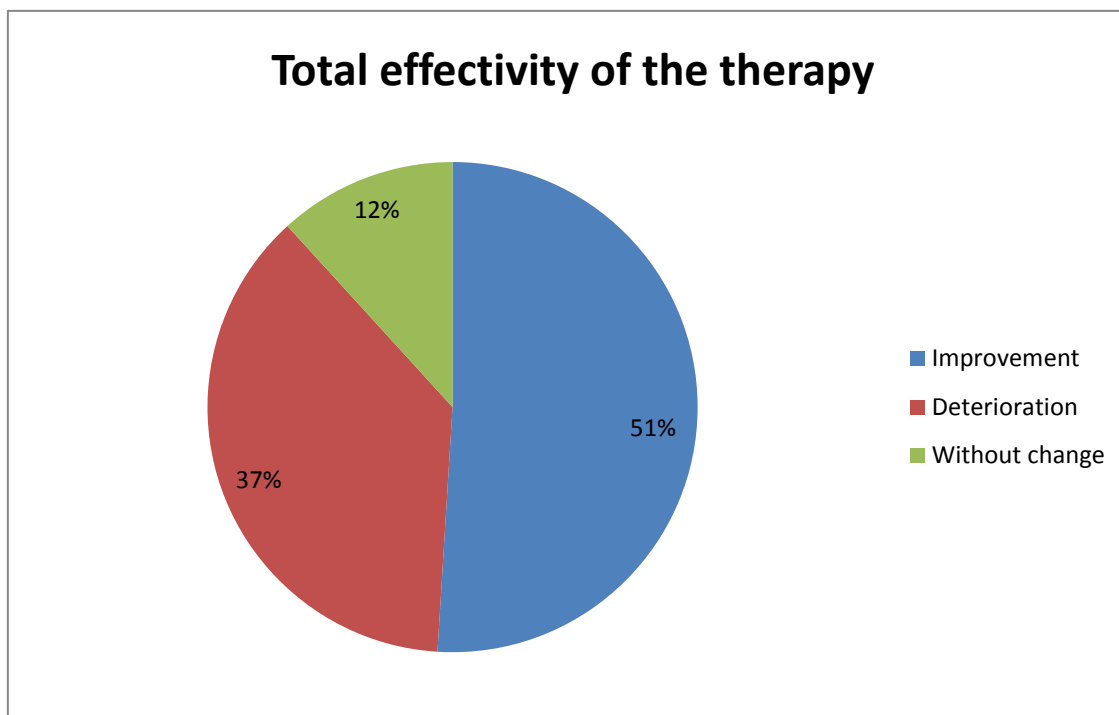




Chart 4

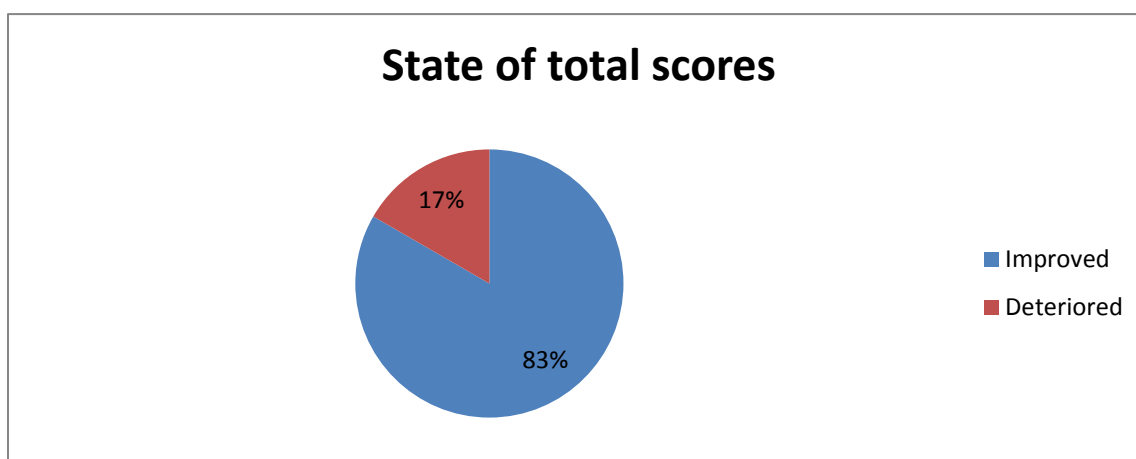


Finally in **Table 4** we have compared situation *before* and *after* for every patient separately. We have compared their total MDS-UPDRS scores and count their subtraction. This data has not statistic importance, but shows the result for individual patient. We can see that the results are for most of the patients very positive. Green colour shows the improved MDS-UPDRS scores and red colour the deteriorated ones. Situation in Table 4 is marked in the **Chart 5**.

Table 4

Patient number	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Total patient's score before	22	29	27	36	49	29	27	99	36	22	54	81
Total patient's score after	9	27	26	28	43	13	24	69	30	55	30	101
Subtraction	13	2	1	8	6	16	3	30	6	-33	24	-20

Chart 5



## Conclusion

This research was conducted in the Czech Republic for the second time and realization of this study was supported by the Duncan Centre Conservatory in Prague who has decided to provide dance / movement classes for PD patients as a part of a comprehensive curative program. This study is the first step in objectification of curative effect of the long-term treatment by dance movement activity. Previous studies were mapping much shorter duration of the treatment, so we can compare effectiveness of this therapeutic approach in dependence on time.

After the five month therapy the study brought some pleasing results and findings. As you could see in the tables and charts, there are several improvements registered. This study proved that 51% of assessed symptoms have improved. The comparison of the objective assessment of modified version MDS-UPDRS with subjective feelings of patients expressed in the second part is interesting. As we can see from Table 3 and Chart 3, the most of worsened symptoms are from subjective rated part of the rating material. It collides with our objective assessment, where the most of symptoms are improved or without change.

The greatest improvement among all patients was registered in symptoms connected to bradykinesia on upper and lower extremities as "Hand movements" and "Pronation-supination movements" and postural stability. Each of observed tests, added to Berg Balance Scale, focused on postural stability were much better after the period of the dance activity. Dance also brought positive effect on rigidity, gait and some of mental skills like "Cognitive impairment" or "Apathy" as you can see in Table 3.

On the other hand we have found some deterioration in tremor symptoms. These results are quite surprising because in previous study we have found the positive effect of the dance movement therapy on tremor difficulties. Each of these results could be influenced by the actual state of each of patients easily. The rating scale is not too sensitive to register every change of patient's habit or medication during the examined period.

From Chart 5 we can see that 83% of patients gained the better MDS-UPDRS score after the therapy then before, which is in itself positive. Results gained from this study are clear proof that the dance and movement activity should have its space in the non-pharmacological treatment for PD patients and should not be underestimated.