# Feasibility of home exercises to enhance the benefits of tango dancing in people with Parkinson's disease

Giovanni Albani[a,*], Giuseppe Veneziano[b], Clara Lunardon[c], Calogero Vinci[a], Alessandra Daniele[a], Federico Cossa[d], Alessandro Mauro[a,e]

[a] Department of Neurology and Neurorehabilitation, Istituto Auxologico Italiano, IRCCS, Piancavallo, Verbania, Italy
[b] Clinica Le Terrazze, Cunardo, Varese, Italy
[c] Department of Translational Medicine, Section of Neurology, University of Eastern Piedmont "Amedeo Avogadro", Novara, Italy
[d] Fondazione Maugeri, Turin, Italy
[e] University of Turin, "Rita Levi Montalcini, Department", Italy

## ARTICLE INFO

## ABSTRACT

*Background:* A style of dance called tango translates clinical practice into a new philosophy and rehabilitative approach for individuals with Parkinson's disease (PD). The style of dance mixes music, self-generated and external cued strategies and social and emotional recovery. In recent years, there has been an increase in the number of studies reporting health benefits for people diagnosed with PD who dance tango. However, there are some organisational limitations to people participating in dance classes, including having trained Tango teachers, an appropriate space for dancing, and schedule that allows for participants with motor inabilities.
*Methods:* This pilot study involved the observation of PD patients who completed four days of home exercise plus a tango dance lesson each week for five weeks.
*Results:* Ten PD patients improved their quality of life, their motor score on the Unified Parkinson's Disease Rating Scale and their kinematic performances.
*Conclusions:* We propose a protocol of exercises that has been derived from the tango dance and that can be performed in a patient's home.

## 1. Introduction

### 1.1. A new concept of rehabilitation for people with Parkinson's disease

The utility of rehabilitation for patients with Parkinson's disease (PD) has not been clear untill almost 15 years ago. In the early 2000, a contemporary review of all rehabilitative approaches for patients with PD reported that the goals of rehabilitative treatment are not always reached[1] Later, by acknowledging the efficacy of external cues,[2] rehabilitation approaches began to focus on associated cortical areas in an effort to compensate for deficits in dopaminergic and non-dopaminergic pathways and to positively influence gait quality. Thus, in more recent years, the scientific community has been changing the concept of rehabilitation for PD patients, moving from approaches with uncertain benefits to indispensable approaches based on cued strategies and cognition. Last step through this road was to find out the importance of combining goal-direct physical activity, with emotional recovery, thus opening the doors to the use of non-conventional approaches, such as

tai-chi[3] Nordic walking[4] theatre therapy[5] and tango.[6]

### 1.2. A rationale for dancing tango in patients with Parkinson's disease

Tango dancing may address each of the key areas that have been identified as being important for an exercise programme designed for individuals with PD[7] First, dance is an activity performed with music, which can act as an external cue to improve the start and the quality of movement, a crucial part of a PD rehabilitation programme. Second, individuals have to focus on the partner's movements, whole-body co-ordination, stepping strategies and aesthetic qualities of movement[8] A systematic review and meta-analysis that investigated tango and PD[9] revealed significant overall beneficial effects on motor severity, which was measured by the Unified Parkinson's Disease Rating Scale (UPDRS), and on balance and gait, which was measured by the Mini-BESTest or Berg Balance Scale and the Timed Up and Go test. One of the possible ways in which tango improves postural strategies in PD patients may be attributed to the activation of supplementary motor areas by means of a

* Corresponding author at: Department of Neurology and Neurorehabilitation, Istituto Auxologico Italiano, IRCCS, Piancavallo, Verbania, Via Cadorna 96, Italy.
*E-mail address:* g.albani@auxologico.it (G. Albani).

| 10 patients (6 males and 3 females) with mild-moderate PD ( Hoehn & Yahr stages II,III) were recruited |

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| T0     Start of study: Gait Analysis, UPDRS, PDQ-39,Reaction Time Study |

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| T1          Reaction Time Study after the first single lesson |

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| 5 weeks of  home exercises (1 hour/4 days/week) and 2 hour of tango group lesson (1 day/week) |

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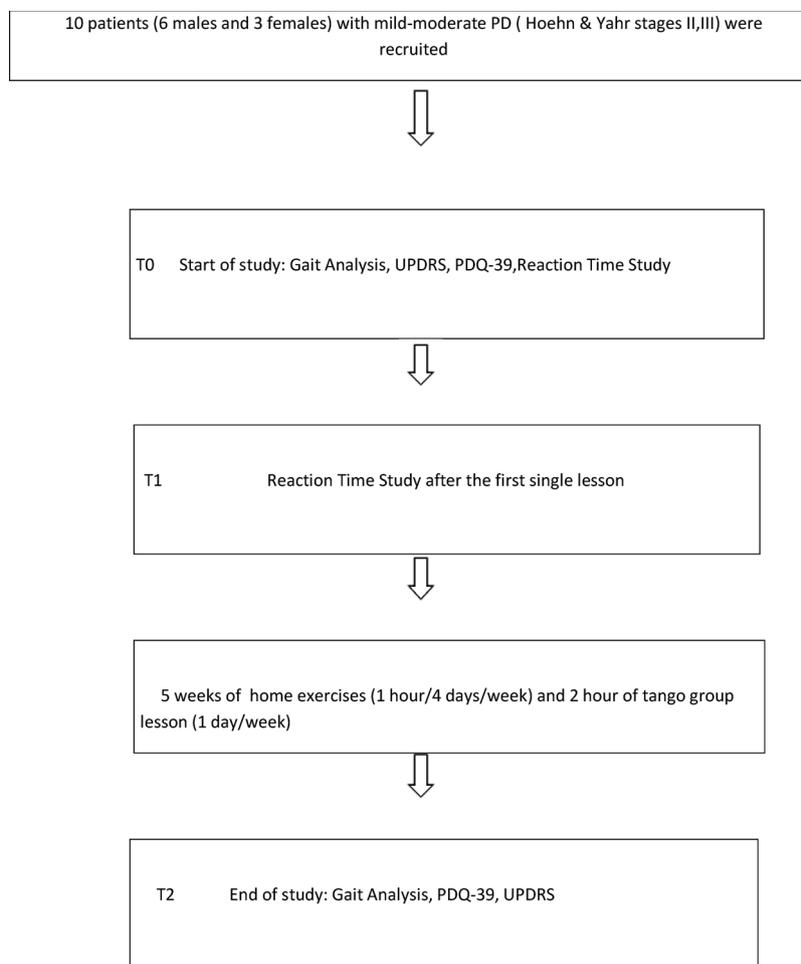| T2       End of study: Gait Analysis, PDQ-39, UPDRS |

**Fig. 1.** Synopsis of the study.

motor imagery effect, so that, just training to image tango dance, determines an expansion of active bilateral motor areas during locomotor imagery.[10] Moreover, tango dancing allows PD patients to develop a plan and then execute new dancing schemes, which harmonises movements between their trunk and limbs, leading to a recovery of the executive cortico-subcortical output.[11]

### 1.3. Rehabilitation at home for Parkinson's disease

Tango dancing may encounter some of the following organisational challenges: training tango teachers to work in a clinical context, finding an appropriate space for dancing, scheduling an optimal time for all participants to attend and tolerating possible time delays because of the motor disabilities of the participants. A convenient solution to reduce the limitations described above would be to develop a programme that could be undertaken in a home setting that would produce similar benefits. By performing motor activities at home following standardised protocols, the continuity of the rehabilitation programme could be continued, resulting in reduced national health costs. Following this view, other physical-therapy approaches have been proposed with "at-home" protocols for PD patients, such as a six-month community exercise programme[12] a kinetic-based physiotherapy[13] and an individualised occupational therapy programme[14] All of these approaches have been shown to be safe and lead to an improvement in self-perceived performance in daily activities.

### 1.4. Aim of the present study

The principal aim of this pilot study was to evaluate the feasibility

and clinical effects of a protocol that was undertaken at home and that included tango exercises. However, a home protocol for any dance, including tango, has some limitations, such as needing to have a partner or a caregiver available to do the dance and dedicated space in the home. Furthermore, if the patient was a beginner, they may have had some uncertainties about correct dancing movement. For these reasons, the study protocol also included four days per week of the home protocol and one day of "real" tango lesson together with teachers and other patients.

In this exploratory study, the clinical scores may not have been sufficiently convincing in and of themselves. Thus, to evaluate the benefit of this protocol, all patients also performed a gait analysis.

Kinematic data, such as spatiotemporal variables, have been widely used to describe the pathological features of gait[15] but they may only represent a part of the pathophysiology underlying parkinsonian gait, specifically the part under the highest-level control centres, as confirmed by the sensitivity of these parameters to attentional strategies.[16] Also, they may be not be sensitive enough to define the biomechanical changes of the trunk and pelvis, which play a fundamental role in tango dancing. For these reasons, the present study considered both spatiotemporal parameters as well as biomechanical indices of pelvic movements.[17]

A secondary aim was to evaluate the immediate effects of tango on motor performances. The rationale of this goal was suggested by the fact that some patients, who are used to dancing tango, acquired an immediate benefit after a single evening of dancing. The benefit was reported to involve not only gait and posture, but also other tasks involving upper limbs, such as writing. Consequently, the third aim of this study was to evaluate the immediate effects of tango dance on motor

tasks other than gait and posture, such as reaction times of hands.

## 2. Materials and Methods

### 2.1. Feasibility and clinical effects of home tango exercises

In this pilot study, we recruited 10 PD patients (6 males and 4 females; mean age = 63.1 years, standard deviation [SD] = 9.25). The selection criteria were as follows: (a) never danced tango before, (b) no clear signs of dementia (Mini-Mental State Examination [MMSE] score > 24; Mini Mental State Examination Score, MMSE,[18] and (c) an absence of relevant hip disturbances. All patients gave their informed consent. Patients were evaluated before and after the first single lesson (immediate effect) and after a five-week period of tango-based home exercises. Patients were tested with the motor part of the UPDRS (that is, UPDRS III) and the Parkinson's Disease Quality of Life (PDQ-39) questionnaire at the beginning and at the end of the study (see Fig. 1). This five-week pilot study included four sessions per week of home exercises, each one lasting one hour, and a weekly group session lasting two hours. Group sessions were held under the guidance of two masters of Argentine Tango, a neurologist and a physiotherapist. Home exercise instructions and a dedicated DVD were given to every patient and their caregiver. Home exercises were carefully chosen by tango masters, neurologists and physiotherapists, by translating the dance movements into home exercises that could be performed at home (see Figs. 2–4 and the enclosed dvd). Clinical and gait evaluations were performed within three hours of their first L-dopa intake of the day (in a range of 8 a.m. to 11 a.m.).

### 2.2. Gait analysis

The gait analysis was performed before the study and after a month of beginning the study by an optoelectronic system (Vicon, Oxford Metric, United Kingdom) that was equipped with two Kistler platforms. To allow for the analysis of overground gait, the participants were required to walk along an eight-meter walkway. Six trials were recorded while the participants walked at their preferred speed. Data were collected for each trial using a six-camera Vicon motion analysis system with reflective markers that were placed according to the standard Vicon Plug-in Gait marker set[19] and two force platforms (Kistler, CH) that were used for gait event detection. Data were normalised as the percent of the gait cycle.

Over the evaluation of spatiotemporal parameters, as we think pelvic movements may play a crucial role in this protocol, we analysed also the mean PT (Pelvic Tilt, that is, the mean value of the pelvic joint plotted in the sagittal plane during the gait cycle) and the PT ROM (Pelvic Tilt, Range of Motion, that is, the range of motion at the pelvic joint in the sagittal plane during the gait cycle, calculated as the difference between the maximum and minimum values of the plot).

### 2.3. Reaction times after a single tango lesson: evaluation of tango effects on upper limb performances

We tested the reaction times of hand movements immediately after the first session of tango. The test was performed according to the protocol adopted by Jahanshahi and colleagues.[20] A box with six circular one-inch diameter buttons constituted the response apparatus. The two central buttons were black and were placed one on the left and one on the right. They performed the function of "home" keys. Four inches above the "home" keys were two red buttons. Two green buttons were placed at the same distance below the "home" keys. We examined the effects of different stimuli (that is, a warning signal, temporal cue and movement parameter cue) presented at variable time intervals before the command to push the buttons. The subject sat in front of a visual display unit and was instructed to press and hold down one or both of the black "home" buttons with the index finger of the right, left
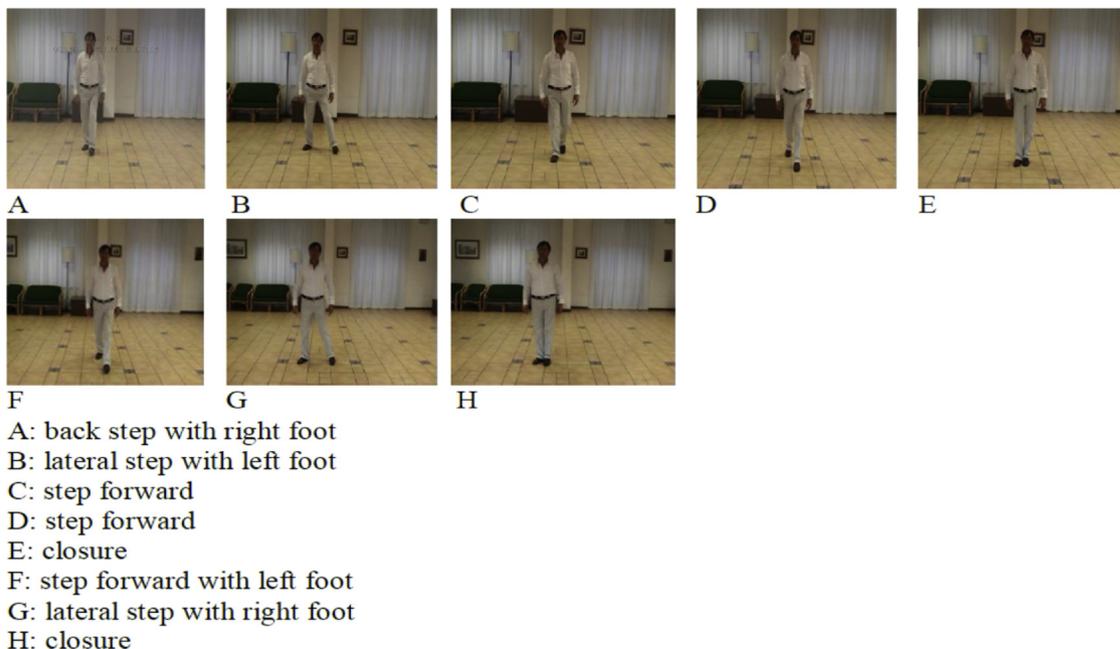


A: back step with right foot
B: lateral step with left foot
C: step forward
D: step forward
E: closure
F: step forward with left foot
G: lateral step with right foot
H: closure

**Fig. 2.** Basic Tango steps for Male.
A: back step with right foot
B: lateral step with left foot
C: step forward
D: step forward
E: closure
F: step forward with left foot
G: lateral step with right foot
H: closure

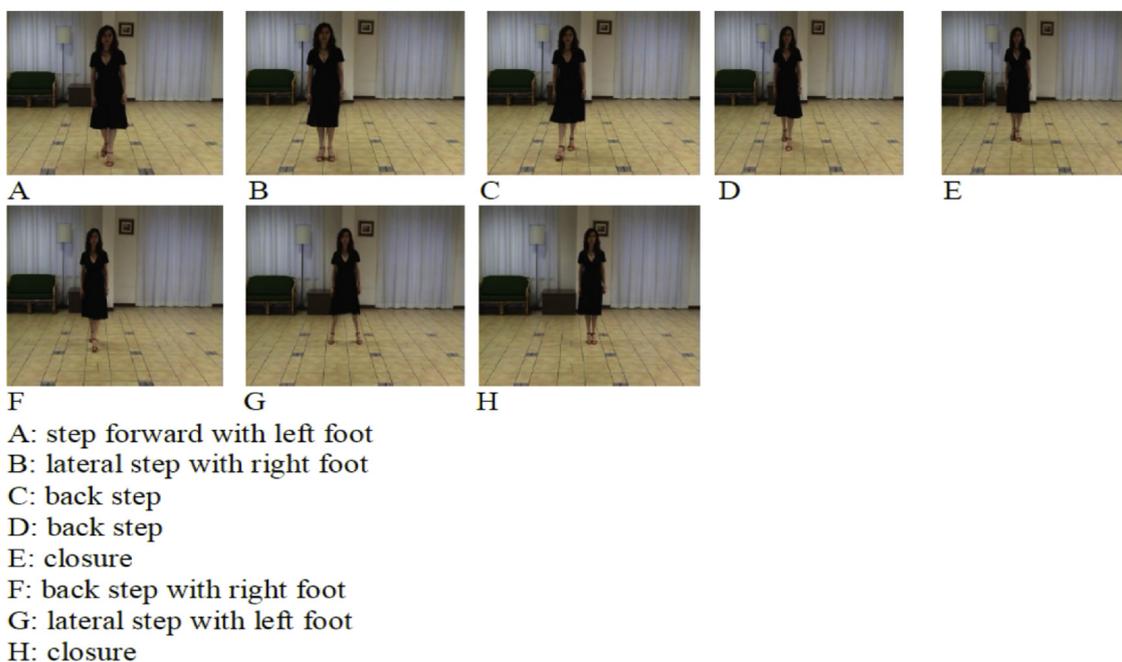A: step forward with left foot
B: lateral step with right foot
C: back step
D: back step
E: closure
F: back step with right foot
G: lateral step with left foot
H: closure

**Fig. 3.** Basic Tango steps for Female.
A: step forward with left foot
B: lateral step with right foot
C: back step
D: back step
E: closure
F: back step with right foot
G: lateral step with left foot
H: closure

or both hands, depending on the condition. Patients performed a simple reaction-time task, an un-cued task, two partially cued tasks (cueing either the direction of movement or the left or right hand) and a fully cued visual four-choice reaction-time tasks.

## 3. Statistical analysis

The significance level for the two-tailed Student's *t*-test was set at $\alpha = 0.05$. The type 1 error was maintained at 5% using the Bonferroni–Hochberg procedure. The P-values are presented as un-adjusted values, unless specified otherwise.

## 4. Results

### 4.1. Reaction times after the first tango session

An improvement was observed in basal UPDRS III scores motor scale subset ($p < 0.01$) between baseline (mean = 28.67; SD = 8.84) and after the first session of Argentine Tango (mean = 24.44; SD = 8.5). On the other hand, simple and cued reaction-time tasks did not change significantly (Table 1).

### 4.2. Clinical effects after five weeks of home tango practice

Scores improved after five weeks of home tango practice (Table 2). Comparisons between basal UPDRS scores (mean = 28.67; SD = 8.84)



**Fig. 4.** Basic Tango for a couple.

**Table 1**
Global motor function and reaction times of upper limbs after the first tango lesson.

| UPDRS III basal | UPDRS III T1 | Simple RT (ms) basal | Simple RT (ms) T1 | Cued RT (ms) basal | Cued RT (ms) T1 |
|---|---|---|---|---|---|
| 28.6 | 24.4 (p < 0.01) | 583.2 | 585.8 (ns) | 427.2 | 477.3 (NS) |

Abbreviations: ms millisecond; nsnot significant; RT reaction time; UPDRS Unified Parkinson's Disease Rating Scale.

**Table 2**
Effects of home tango lessons.

| UPDRS III Basal | UPDRS III T2 | PDQ-39 basal | PDQ-39 T2 |
|---|---|---|---|
| 28.6 | 25.1 (p < 0.01) | 24.4 | 21.1 (p < 0.05) |

Abbreviations: PDQ-39, Parkinson's Disease Quality of Life questionnaire; UPDRS, Unified Parkinson's Disease Rating Scale.

and UPDRS scores at the end of study (mean = 25.1; SD = 8.99) showed a significant improvement (p < 0.01) (Table 2). Comparisons between basal PDQ-39 scores (mean = 24.44; SD = 16.82) and PDQ-39 scores at the end of study (mean = 21.11; SD = 16.61) also showed a significant improvement (p < 0.05) (Table 2).

### 4.3. Kinematic effects after five weeks of home tango practice

Kinematic analysis showed in stride cadence (Table 3). The cadence mean was 106.19 ± -0.07 steps/minute at the beginning of the study and 110.78 ± -1.19 steps/minute at the end of the follow-up period (p < 0.05). No significant differences were found for the percentage of stance. In three of the ten patients, we observed an improvement in pelvic position in the sagittal plane in association with a reduction in the ability of the pelvis to bend forward during gait (Fig. 5).

### 5. Discussion

The present pilot study provides the first evidence that exercises adapted from tango dancing and performed at home are beneficial for PD patients because they improve motor status and quality of life. In particular, we found in improvement in patient posture, gait, speech and UPDRS items, which supports the idea that this kind of dance may influence axial symptoms, in particular, in PD. The benefits perceived by this home programme are similar to those reported after conventional tango lessons[21] and they may be correlated with the effects of the specific rhythm of music[22] to the generation of motor strategies during dancing[23] and to social and emotional effects.[24] The strongest point of this study is the proposal of a home-based protocol aimed at enhancing

or eventually substituting tango classes outside of the patient's home. This may have great impacts on future strategies of scientific and health communities, which are working hard to find better home health-care solutions for monitoring patients and simultaneously reducing health costs.
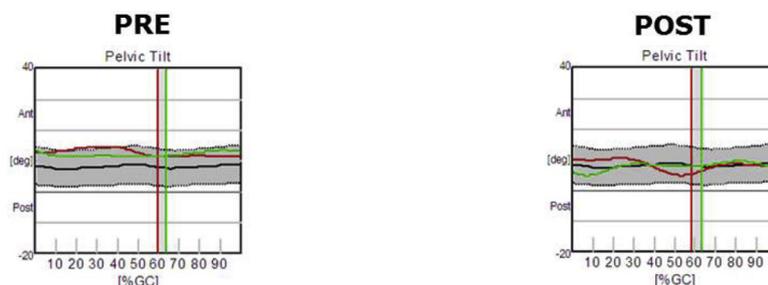
In the present study, we described an immediate beneficial effect of tango in PD patients, which presented itself as an immediate improvement in the motor status of the patients. Although the reaction times did not change, probably due to the small sample size or the inadequacy of the proposed methodology, we cannot exclude the possibility that tango improves lower-limb function and global motor function, without influencing hands movements.

Our findings are the first to report of an immediate benefit from tango dancing in PD patients, even if an improvement in vigilance immediately after dancing has been described in healthy people[25] On the other hand, the literature does not report studies about the immediate effects of tango dancing in patients with PD, except for a single case study of transcranial direct-current stimulation effects during tango dancing, which reported an improvement in trunk movements and gait.[26]

With regard to the kinematic findings, to our knowledge, there are not any studies that describe the effects of tango training on gait performances in healthy people. Similarly, most of the studies on PD patients reported semi-quantitative scores from dedicated rating scales (for example, the Berg Balance Scale and the Timed Up and Go test), and very few studies used three-dimensional gait analysis. Hackney et al. described an improvement in the percentage of time spent in stance during forward walking[11] and cadence,[8] as in our findings. Thus, the cadence seems to be the most sensitive measure for assessing tango influence among all spatiotemporal parameters, which was probably due to the effect of the musical rhythm.

With regard to the biomechanical findings, there are a lack of data in the literature that is due to the fact that despite the use of kinematic parameters, biomechanical parameters have only recently been proposed on a list of reference index data for PD patients.[17] With this consideration in mind, among all of the biomechanical changes that were detected after one month, the most interesting was the improvement in pelvic rotation that was reported in three of ten patients. The improvement may be correlated with the imposed erected posture during tango dancing.

In conclusion, our results suggest the feasibility of a home-exercise tango protocol, and they add new information to support the potential use of tango for the improvement of motor control in people with PD. Home-based exercises may not be a suitable substitute for some aspects of a live class, such as group dynamics and touch and motor feedback from another person, but a home-based physiotherapy approach using tango could be applied with positive effects on posture and gait[27] as well as a reduction of the economic burden of PD. The various components of the tested protocol (that is, home exercises, home classes, reaction time and gait analysis) may, in part, explain the greatest limitation of this exploratory study: the small sample size. The small

**Table 3**
Changes in kinematic parameters after the study.

| | PRE mean | | POST mean | | NORMATIVE RANGE[a] | statistic |
|---|---|---|---|---|---|---|
| | Right | Left | Right | Left | | |
| % stance (% gc) | 64.15 ± 0.01 | 59.84 ± 0.43 | 64.25 ± 0.01 | 60.32 ± 1.50 | 61.60 + 2.39 | NS |
| Step length (m) | 0.42 ± 0.04 | 0.54 ± 0.02 | 0.44 ± 0.001 | 0.47 ± 0.04 | 0.62 + 0.08 | NS |
| Cadence (step/min) | 106.19 ± 0.07 | | 110.78 ± 1.19 | | 113 + 12.4 | p < 0.05 |
| Walking velocity (m/s) | 0.88 ± 0.01 | | 0.86 ± 0.01 | | 1.17 + 0.23 | NS |

Abbreviations: m, meter; min, minute; NS, not significant; POST mean, mean values after the study was complete; PRE mean, mean values before the study began; s, second.

[a] These values are the normative range values of our gait lab obtained in a group of 52 health controls in the age range of 60–65 years old.

**PRE**

Pelvic Tilt

**POST**

Pelvic Tilt

There was a significant improvement of pelvis position in sagittal plane, together with the reduction of pelvis bending forward during gait.

|  | PRE | | POST | | NORMATIVE RANGE |
|---|---|---|---|---|---|
|  | Right | Left | Right | Left |  |
| *Mean pelvic Tilt (°)* | 12.00 ± 0.66 | 11.63±0.52 | 9.52 ± 1.29* | 9.15±0.66* | 6.53±6.97 |
| *Pelvic Tilt at IC (°)* | 13.09±0.96 | 12.54±0.77 | 7.61±1.74* | 10.51±0.44 | 8.81±4.35 |
| *ROM Pelvic Tilt (°)* | 2.62±0.67 | 3.30±0.03 | 4.75±0.34 | 5.05±1.31 | 1.60±3.62 |

*= p< 0.05, PRE vs. POST

**Fig. 5.** Example case of Pelvic joint changes after 1 month of Tango Excersises.

sample size resulted in an inability to create subgroups for testing and comparative analysis, such as a subgroup of people who only performed the exercises in a home setting or a subgroup or people in tango classes that focused on different effects on motor control. Much more the opportunity to have convincing significance by the kinematic findings and, finally, to have also clinical additional information such as the impact on motor fluctuations and on the so called non-motor manifestations. The goal of this exploratory study was simply to propose an innovative approach and to provide support for further research that would include a larger population and a control group, which would hopefully provide more insights.

## Author contributions

All authors contributed equally to the conception and design of the study and the acquisition and analysis of the data. The critical revisions of the manuscript were conducted by all authors, who also approved the final submitted version of the paper.

## Conflicts of interest

None.

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