

# Community-based group exercise for persons with Parkinson disease: A randomized controlled trial

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**Abstract.** The purpose of this study was to compare group boxing training to traditional group exercise on function and quality of life in persons with Parkinson disease (PD). A convenience sample of adults with PD ( $n=31$ ) were randomly assigned to boxing training or traditional exercise for 24–36 sessions, each lasting 90 minutes, over 12 weeks. Boxing training included: stretching, boxing (e.g. lateral foot work, punching bags), resistance exercises, and aerobic training. Traditional exercise included: stretching, resistance exercises, aerobic training, and balance activities. Participants were tested before and after completion of training on balance, balance confidence, mobility, gait velocity, gait endurance, and quality of life. The traditional exercise group demonstrated significantly greater gains in balance confidence than the boxing group ( $p<0.025$ ). Only the boxing group demonstrated significant improvements in gait velocity and endurance over time with a medium between-group effect size for the gait endurance ( $d=0.65$ ). Both groups demonstrated significant improvements with the balance, mobility, and quality of life with large within-group effect sizes ( $d\geq 0.80$ ). While groups significantly differed in balance confidence after training, both groups demonstrated improvements in most outcome measures. Supporting options for long-term community-based group exercise for persons with PD will be an important future consideration for rehabilitation professionals.

Keywords: Parkinson disease, boxing, balance confidence, exercise, quality of life

## 1. Introduction

Persons with Parkinson disease (PD) demonstrate a decline in functional outcomes in the time period after completing conventional rehabilitation (Kwakkel, de Goede, & van Wegen, 2007). Community-based group exercise programs are offered as a long-term option for exercise beyond conventional rehabilitation, and show promise for improving outcomes in people with disability (Stuart, Chard, Benvenuti, & Steinwachs, 2009).

Persons with PD have expressed a desire for participating in these types of community programs, particularly ones that are specifically designed for people with PD (O'Brien, Dodd, & Bilney, 2008). Therefore, exploring the various types of community-based programs that are available for people with PD will improve our understanding of their impact on function and health-related quality of life.

Traditional exercise incorporates stretching, strengthening, aerobic activity, and balance training (Ashburn et al., 2007; Bridgewater, 1996; Caglar, Gurses, Mutluay, & Kiziltan, 2005; Dibble et al., 2006). Many traditional-based exercise programs are beneficial in increasing endurance (Bridgewater, 1996; Schenkman,

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Hall, Kumar, & Kohrt, 2008), balance (Hirsch, Toole, Maitland, & Rider, 2003; Schenkman et al., 2008), and mobility (Dibble et al., 2006) in persons with PD. However, these studies have been conducted primarily within home-based or research-based settings limiting long-term access to services. While community-based traditional group exercise programs do exist, limited evidence was found regarding the effectiveness of these types of programs for persons with PD (Stuart et al., 2009).

Non-traditional exercise programs generally incorporate traditional exercise concepts, but apply them in an alternative manner. Non-traditional forms of exercise such as Nordic walking (van Eijkeren et al., 2008), tango (dance) (Hackney, Kantorovich, Levin, & Earhart, 2007), tai chi (Hackney & Earhart, 2008; Li et al., 2007), qigong (Schmitz-Hubsch et al., 2006), and taiji (Klein & Rivers, 2006), have shown improvements in balance (Hackney & Earhart, 2008; Hackney et al., 2007; Klein & Rivers, 2006; Li et al., 2007), mobility (Hackney & Earhart, 2008; van Eijkeren et al., 2008), and gait velocity (van Eijkeren et al., 2008), as well as psychological and social abilities (Klein & Rivers, 2006). Another non-traditional form of exercise for persons with PD is community-based group boxing training, which was reported to be a safe and feasible exercise option in a case report including seven persons with PD (Combs et al., 2011). For the patients, boxing training resulted in immediate and long-term improvements in balance, mobility, endurance, and quality of life. Given these preliminary findings and the alternative nature of the boxing training that encourages participants to increase boxing repetitions and intensity of training with each bout as tolerated, it is possible that this non-traditional form of exercise may provide greater potential for improvements in function and perceived quality of life than traditional exercise. Therefore, the purpose of this study was to compare the effects of non-traditional group boxing training to traditional group exercise on balance, mobility, and health-related quality of life outcomes in persons with PD.

## 2. Methods

### 2.1. Design

A prospective, single-blind, randomized controlled trial was conducted. The study was approved by Institutional Review Board and all participants signed an informed consent prior to enrollment.

### 2.2. Participants

Thirty-one participants were consecutively recruited via local clinicians, newspaper advertisements, and flyers distributed at PD support groups and symposiums throughout. Participants were included if they: 1) reported a clinical diagnosis of PD; 2) were 21 years of age or older; 3) currently were not receiving physical therapy services; 4) were independently ambulatory in the home setting with or without the use of an assistive device; 5) were able to follow at least three-step verbal commands; 6) were available for the entire period of the study; 7) had transportation to and from study-related sessions. Participants were excluded if they had: 1) pre-existing neurological condition(s) other than PD; 2) current musculoskeletal or cardiovascular condition(s) that would limit participation in either training program; 3) orthopedic surgery within the past six months, 4) past brain surgery or brain stimulator implant; 5) current known pregnancy.

### 2.3. Randomization and interventions

Following screening by study investigators, participants were randomly assigned using a concealed block randomization procedure to either the boxing training group (BOX) or the traditional exercise group (EX). Participants attended 24–36 sessions, 90 minutes each, over a 12 week period of their assigned program. All participants, irrespective of their assigned training arm, were allowed to pace themselves and take rest breaks if needed throughout the training session.

Each traditional group exercise session began with a 15-minute warm-up period consisting of various seated exercises such as multi-planar axial and extremity active range of motion and stretching. The next hour consisted of strengthening exercises, endurance training, and balance activities. Strength training included resistance-based exercises for large muscle groups within the upper and lower extremities. Upper extremity motions were performed with dumbbells at self-selected weights (5–8 pounds) and lower extremity exercises were performed with body weight resistance. Participants were encouraged to move through the full range of available motion with all resistance exercises. Endurance activities included walking in- or out-doors at a self-selected pace and stair climbing. Static and dynamic standing balance activities were performed on different support surfaces, with various bases of support and visual input (eyes open and closed). Examples of balance activities performed include multidirectional

reaching, static and dynamic standing balance on discs and rocker boards, and negotiating an obstacle course. Each session ended with a 15 minute seated cool-down similar to the warm-up plus breathing exercises for relaxation. The traditional exercise classes were held on a university campus continuously over a 15 month period. Sessions were led by two physical therapy students under the supervision of a licensed physical therapist.

Participants in the BOX group began each session with a warm-up similar to that performed by the EX group. They were then led through a series of boxing-specific activities via a circuit training regimen, as well as general endurance activities, all of which have been described in a previous report (Combs et al., 2011). Activities were self progressed by encouraging participants to train as intensely as they could tolerate and by striving to complete more repetitions during each training bout. Participants wore boxing gloves and hit boxing-specific punching bags, but did not make contact with other people while boxing. The boxing training program was led by one or two personal trainers certified by the National Academy of Sports Medicine. The study investigators were not involved in the design or implementation of the boxing training program. Participants assigned to the boxing program joined pre-existing classes offered by a community program.

#### 2.4. Outcome measures

Data were collected within one-week prior to the implementation of either the boxing training or traditional exercise training (pre-test) and within one-week after completion of the assigned 12-week training program (post-test). Outcomes included the following: Berg Balance Scale (BBS), Activities-specific Balance Confidence Scale (ABC), Timed Up and Go (TUG), Dual-task Timed Up and Go (dTUG), gait velocity, 6-Minute Walk Test (6MWT), and Parkinson's disease Quality of Life scale (PDQL). Measurements were conducted in random order to reduce potential effects of test order bias. When applicable, participants were tested one hour after taking PD-related medications. Participants did not wear orthoses or use assistive devices during testing and were guarded by an examiner, if needed. The examiners, masked to group assignment, were trained to conduct all study outcome measures. Intra-rater and inter-rater reliability for the BBS was established prior to initiating the study (ICC = 0.99; ICC = 0.98 respectively).

The BBS is a 14-item scale with a maximal score of 56 used to measure changes in functional standing balance over time (Steffen & Seney, 2008). High test-retest reliability has been established for BBS with persons with PD (ICC = 0.94), and the minimal detectable change (MDC) is five points (Steffen & Seney, 2008).

The ABC was designed to measure participants' self-perceived confidence in completing activities of daily living. It is a 16-item questionnaire with mean responses ranging from 0 to 100% (Powell & Myers, 1995). High test-retest reliability has been established for the ABC with persons with PD (ICC = 0.94), and the MDC is 13% (Steffen & Seney, 2008).

Mobility was assessed with the TUG and dTUG. Participants were timed as they stood up, walked forward three meters, turned around a target on the floor, and returned to sitting. During the dTUG participants simultaneously counted backwards from 100 by three's in order to assess their mobility while engaging in a cognitive activity (Hofheinz & Schusterschitz 2010). The average of three trials of each test was reported. High test-retest reliability of the TUG and dTUG for patients with PD has been reported (ICC = 0.85, ICC = 0.98 respectively) (Steffen & Seney, 2008). The MDC for the TUG has been reported as 3.5 seconds for persons with PD (Huang et al., 2011). The MDC for the dTUG has not been reported to date; therefore, we calculated its MDC at the 95% confidence interval using the three pre-test trials (MDC = 2.84 seconds).

Gait velocity was collected using the GaitRite Walkway System (CIR Systems Inc, Havertown, PA, USA). Participants were instructed to walk at a self-selected pace across the 4.88 m walkway. Participants began and ended each trial 1.5 m beyond the edge of the walkway to prevent the recording of acceleration and deceleration. The mean of five trials was reported. High test-retest reliability of self-selected gait velocity has been established for persons with PD (ICC = 0.96) and the MDC is 0.18 m/s (Steffen & Seney, 2008).

The 6MWT was used to determine walking endurance (Steffen & Seney, 2008). Participants were instructed to walk as far as they could during the six-minute time interval around a 60-meter course. High test-retest reliability of the 6MWT has been established with persons with PD (ICC = 0.96) and the MDC is 82 meters (Steffen & Seney, 2008).

The PDQL is a 37-item self-administered quality-of-life survey (Hobson, Holden, & Meara, 1999). Total scores can range from 37–185 with higher scores suggesting higher perceived quality of life. High test-retest reliability has been established for the total score of

the PQDL (ICC = 0.94) in persons with PD (de Boer, Wijker, Speelman, & de Haes, 1996). MDC has not been established for the PDQL.

### 2.5. Data analysis

An intention-to-treat analysis was used by carrying forward the previous score for participants lost to follow up. Data did not meet the assumptions for use of parametric statistics; therefore, non-parametric tests were employed. Descriptive statistics including median and ranges were calculated for all demographic variables and outcome measures. The Mann-Whitney *U* test was conducted to determine between-group differences and the Wilcoxon signed rank test was used to determine within-group differences across time. Between group differences after training were determined using change scores (post-test minus pre-test). Alpha was set at  $p \leq 0.025$ . Between group and within group effect sizes were calculated using z-scores for Cohen's *d* (small effect  $d=0.2$ , medium effect  $d=0.5$ , and large effect  $d=0.8$ ) (Cohen, 1992). Also, the number of participants who met or exceeded the MDC for each outcome measure was calculated. The Statistical Package for the Social Sciences version 16.0 (SPSS, Inc., Chicago, IL, USA) was used for data analysis.

## 3. Results

Fifty-two potential participants were screened for inclusion in the study with 31 meeting the criteria to be enrolled in the study (Fig. 1). Nine participants dropped out prior to completing the intervention with the majority from the boxing training group. Pre-test scores for the participants who withdrew from the study were carried forward at post-test. Two participants from the boxing training group did not complete the minimum number (24) of training sessions; however, their post-test scores were used for analysis. There were no statistically significant differences between groups in demographic variables (Table 1) or any of the outcome measures at pre-test. Due to the large number of participants who did not complete the study, demographic variables and pre-test scores were compared between those who dropped out or did not complete the minimum number of training sessions and those who completed all phases of the study. No significant differences were found between these groups for any variables.

A statistically significant difference was found between groups for the ABC (Table 2), indicating that the EX group perceived a greater improvement in balance confidence after training. This finding was confirmed with a large between group effect size of 0.97 based on change scores (Table 3). Also, only the EX group demonstrated a significant improvement in the ABC from pre- to post-test ( $p=0.022$ ). While no other outcome measures demonstrated statistically significant between group differences, a trend toward a difference in gait endurance with the 6MWT was observed via a medium between group effect size ( $d=0.65$ ). After training the BOX group demonstrated a statistically significant increase in median distance walked ( $p=0.013$ ), while the EX group demonstrated a decrease in distance walked during the 6MWT.

Both groups demonstrated statistically significant improvements over time ( $p \leq 0.025$ ) and large effect sizes ( $>0.80$ ) with the BBS, TUG, dTUG, and PDQL (Tables 2 and 3). Only the BOX group showed a statistically significant improvement ( $p=0.001$ ) and large effect size in gait velocity from pre- to post-test (Tables 2 and 3). Figure 2 summarizes the number of participants in each group who were able to meet or exceed the established MDC for each measure at post-test.

## 4. Discussion

In this study, we hypothesized that both boxing training and traditional exercise would improve function and health-related quality of life over time, but that non-traditional group boxing training would lead to larger improvements than traditional group exercise. However, the only significant difference between groups was the greater improvement in balance confidence on the ABC reported by the EX group, refuting our hypothesis. While the exercise programs in this study were matched for time and duration, there were differences in several types of exercises delivered by each program. The balance activities within the traditional exercise program were employed in a way that it was likely apparent to the participants that they were working on balance. For example, participants in this group practiced various static and dynamic standing activities such as single-leg stance, as well as balance tasks that often mimicked real-world activities (e.g. reaching into cabinets and standing on uneven surfaces). Conversely, the boxing training program indirectly addressed balance through boxing-related activities. While both groups

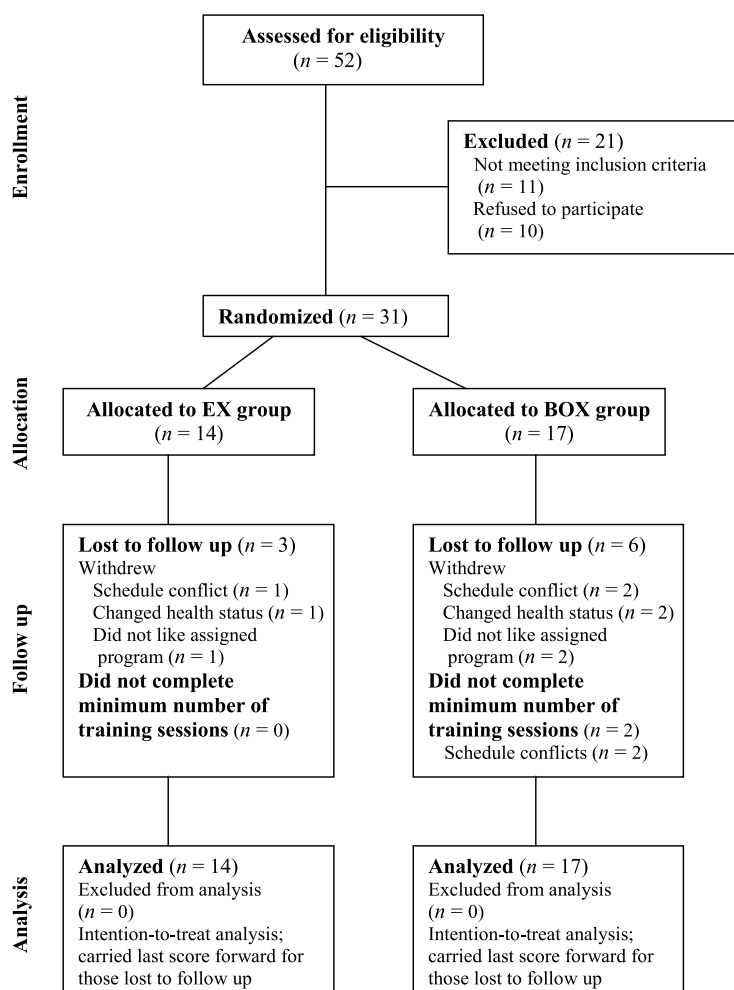


Fig. 1. CONSORT diagram.

significantly increased balance via the BBS, only the EX group perceived a significant improvement in balance confidence with their change in balance. And a greater number of participants in the EX group exceeded the MDC for the ABC. This may be related to the aspect that the participants in the EX group knew they had been practicing specific tasks aimed at improving their balance. In all, these findings support previous literature that suggests that task-specific practice can optimize performance of those activities practiced (Kwakkel et al., 2007; Mak & Hui-Chan, 2008). In this study, participants in the EX group may have made more gains in balance confidence because that program was directly focused on retraining balance skills.

Alternatively, only the BOX group demonstrated statistically significant improvements from pre- to post-test in gait velocity and gait endurance on the 6MWT.

While these changes were not significant between groups, a medium effect size was found between groups for the 6MWT, indicating the magnitude of change in gait endurance after training was greater for the BOX group (Cohen, 1992). This may have been due to the circuit training regimen conducted in the boxing program where participants were encouraged to train as intensely as tolerated and to increase repetitions during each three-minute training interval. In comparison, participants in the traditional exercise program were instructed to train at a self-selected pace during all activities. No previous studies were found that incorporated circuit-based or interval-based training for persons with PD; however, Schenkman et al. (2008) reported that functional capacity was improved in two of three participants with PD following an endurance training program of progressive intensity. These results support

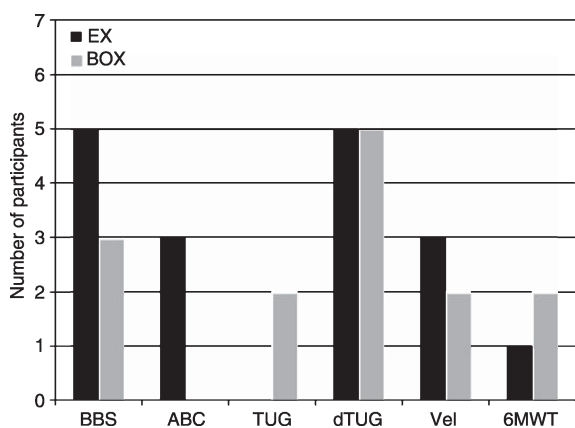


Fig. 2. The number of participants in the EX group (black bars) and the BOX group (gray bars) who met or exceeded the established MDC for each outcome measure. BBS = Berg Balance Scale; ABC = Activities Specific Balance Confidence Scale; TUG = Timed Up and Go Test; dTUG = Dual Timed Up and Go; Gait Vel = Gait Velocity; 6MWT = Six-Minute Walk Test; EX group = traditional exercise group; BOX group = Boxing training group; MDC = minimal detectable change.

the idea that encouraging patients with PD to exercise beyond self-selected levels is feasible (Ridgel, Vitek, & Alberts, 2009) and can have a positive impact on functional mobility and disease progression (Ahlskog, 2011).

Both groups showed significant improvements over time and large within group effect sizes in balance (BBS), mobility (TUG, dTUG), and quality of life (PDQL) indicating that perhaps regardless of the type of exercise, community-based group exercise can improve function and perceived quality of life for persons with PD. Five participants in each group exceeded the MDC of the dTUG signifying that the participants improved their ability to process cognitive information during concurrent motor tasks (Hofheinz & Schuster-

Table 1  
Demographic data

Variable	EX (n = 14)	BOX (n = 17)	p
Age (years)	68.0 (31.0)	66.5 (28.0)	0.69
Months since diagnosis	50.0 (99.0)	41.5 (182.0)	0.66
Hoehn & Yahr Score	2.0 (3.0)	2.0 (3.0)	0.95
Gender*	10M: 4F	11M: 6F	1.0

Median (Range) reported for each demographic variable. M = males; F = Females; \*indicates Fisher's Exact test.

schitz, 2010). Dual-task training of gait along with concomitant physical or cognitive tasks has been found to improve gait performance (Brauer & Morris, 2010). Although dual-task training was not deliberately intended as part of either training program in this study, inherent features of the programs may have promoted this type of practice. For example, both exercise programs played music in the background, encouraged participants to count out their exercise repetitions, and required participants to divide attention between exercise tasks and listening to trainer directions. Additionally, the group nature of the programs created busy environments in which participants had to navigate and focus their attention.

While a Hawthorne effect cannot be ruled out, the increased perception of quality of life reported by both groups is intriguing in light of the consistent group environments (O'Brien et al., 2008). Throughout the period of the study, we observed participants in both groups building relationships with other exercisers. Interestingly, this happened regardless of group size (EX = 4–8 per session; BOX = ≥15–20 per session) or longevity of program existence (EX = new at start of study; BOX = pre-existing since 2006). Improvements in quality of life have also been reported after group-based physical therapy for persons with PD (Ellis et al., 2005). These potential psychosocial benefits of group

Table 2  
Balance, balance confidence, mobility, and health-related quality of life outcomes

Variables	EX (n = 14)			BOX (n = 17)			Between group p
	Pre-Test	Post-Test	p	Pre-Test	Post-Test	p	
BBS (total)	49.0 (17.0)	54.0 (12.0)	<b>0.005</b>	49.0 (49.0)	53.0 (45.0)	<b>0.005</b>	0.439
ABC (%)	85.0 (56.9)	93.3 (33.8)	<b>0.022</b>	83.1 (60.6)	85.3 (60.6)	0.624	<b>0.015</b>
TUG (sec)	7.64 (7.39)	7.12 (5.47)	<b>0.021</b>	8.05 (15.12)	7.12 (14.62)	<b>0.003</b>	0.809
dTUG (sec)	10.33 (16.09)	8.89 (7.64)	<b>0.010</b>	11.32 (26.23)	8.16 (18.24)	<b>0.003</b>	0.841
Gait Vel. (m/s)	1.15 (0.72)	1.22 (0.64)	0.140	1.06 (1.08)	1.10 (1.10)	<b>0.001</b>	0.439
6MWT (m)	484.4 (301.2)	478.7 (183.9)	0.807	405.0 (549.1)	457.0 (669.7)	<b>0.013</b>	0.087
PDQL (total)	125.5 (84.0)	149.5 (79.0)	<b>0.022</b>	128.0 (61.0)	132.0 (63.0)	<b>0.012</b>	0.670

Median (Range) is presented for each outcome measure; statistically significant differences are indicated in bold ( $p < .025$ ); Within group differences calculated with Wilcoxon Signed Rank; Between group differences in change scores calculated with Mann-Whitney U; BBS = Berg Balance Scale; ABC = Activities Specific Balance Confidence Scale; TUG = Timed Up and Go Test; dTUG = Dual Timed Up and Go; Gait Vel = Gait Velocity; 6MWT = Six-Minute Walk Test; PDQL = Parkinson's disease Quality of Life Scale.

Table 3  
Summary of effect sizes

	Effect Size (Cohen's <i>d</i> )		Between group
	Within group		
	Pre-test to post-test		
	EX ( <i>n</i> = 14)	BOX ( <i>n</i> = 17)	
BBS	<b>1.25</b>	<b>1.10</b>	0.28
ABC	<b>0.96</b>	0.17	<b>0.97</b>
TUG	<b>0.97</b>	<b>1.16</b>	0.09
dTUG	<b>1.12</b>	<b>1.16</b>	0.07
Gait Vel	0.58	<b>1.46</b>	0.28
6MWT	0.09	<b>0.94</b>	0.65
PDQL	<b>0.96</b>	<b>0.95</b>	0.15

Large effect sizes are indicated in bold; (small effect  $d=0.2$ , medium effect  $d=0.5$ , and large effect  $d=0.8$ ); BBS = Berg Balance Scale; ABC = Activities Specific Balance Confidence Scale; TUG = Timed Up and Go Test; dTUG = Dual Timed Up and Go; Gait Vel = Gait Velocity; 6MWT = Six-Minute Walk Test; PDQL = Parkinson's disease Quality of Life Scale.

exercise warrant further investigation (de Goede, Keus, Kwakkel, & Wagenaar, 2001).

#### 4.1. Study limitations

The lack of a second follow-up limited our ability to determine the long-term effects of these training programs. Our original intention was to conduct follow-up testing three-months following completion of the assigned exercise program to determine retention of changes after a period of no exercise. However, many of the participants desired to continue exercising, either with their group or with another exercise program following the immediate post-test, and in light of this ethical consideration, we discontinued the retention test.

The results of this study may be limited due to the greater than expected attrition rate of 29% (Fig. 1). Higher attrition and lower compliance were found within the BOX group indicating that this non-traditional form of exercise may not have been a preferred type of exercise for some participants. While the community-based boxing training program in Indianapolis, Indiana has become a popular option for exercise for over 100 members with PD, two of our participants who dropped out of this group cited dislike for the boxing and intensity of training aspects of the program. However, during informal interviews, most of the participants in the BOX group expressed that they enjoyed the boxing training and were happy to have the opportunity to join a PD specific exercise group within their community. Further investigation to determine preference for type of exercise among persons with PD will be important future work.

## 5. Conclusions

This is the first clinical trial to compare group-based boxing training to traditional exercise in persons with PD. In conclusion, traditional group exercise led to significantly greater improvements in balance confidence than group boxing training. While both groups demonstrated improvements over time, group boxing training appears to be a promising non-traditional alternative to long-term community-based exercise for improving gait endurance for persons with PD. In consideration that people with PD experience a decline in function in the time period after completing an intervention (Kwakkel et al., 2007), supporting options for long-term community-based exercise is an important issue for rehabilitation professionals.

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