Original Research

A Community-based Boxing Program is Associated with Improved Balance in Individuals with Parkinson's Disease

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ABSTRACT

International Journal of Exercise Science 14(3): 876-884, 2021. In alignment with efforts to mitigate the negative health consequences of Parkinson's Disease (PD), the purpose of this investigation was to examine if participation in a community-based boxing program (CBP) was associated with improvements in balance and fall risk reduction among individuals with PD. In this retrospective cross-sectional study, de-identified data from 12 individuals with PD participating in a CBP was examined. Participants included those with a Hoehn and Yahr stage between 1 and 3, averaging 2.8 ± 0.8 CBP sessions per week for 6.1 ± 0.8 months between testing. Baseline and re-evaluation testing included the Fullerton Advanced Balance (FAB) Scale and Timed Up and Go (TUG) to quantify balance and fall risk. Sessions were 90-minutes in length involving a warm-up, boxing drills, strength and endurance exercises, and cool down. Sessions included multiple bouts of 30-60 second high-intensity exercise intervals (RPE between 15/20 to 17/20). Paired t-tests were used to determine if differences existed between the FAB and TUG from baseline to re-evaluation, with statistical significance accepted at $p < 0.05$ and > 0.8 interpreted as a large effect using Cohen's *d*. Results indicated a statistically significant increase and large effect in FAB performance, with a mean increase in score above previously reported minimal detectable change (MDC). While participation in CBP was associated with a statistically significant improvement and medium effect in the TUG, this did not demonstrate a population specific MDC. This study found that participation in a CBP was associated with improved balance among clients with PD.

KEY WORDS: Boxing training, community exercise, Rock Steady Boxing, physical therapy

INTRODUCTION

Parkinson's disease (PD), a chronic and progressive neurological disorder, is estimated to impact approximately 930,000 individuals in the United States in 2020 (20). Regrettably, PD results in complications including but not limited to impaired balance and increased risk of falls, with 65% of individuals with PD reporting to have had a fall and 39% of those being recurrent (2, 11, 30). Reducing an individual's risk of falls is crucial, as falls are associated with adverse

health consequences such as traumatic injury, prolonged periods of immobilization, and decreased life expectancy (11). Consequently, investigating strategies to improve balance and mitigate the risk of falls in those with PD are necessary.

While impaired balance and an increased risk of falls among those with PD is multifaceted (32), participation in routine exercise is linked to improvements in gait, balance, and fall risk reduction (24, 26). Due to PD's chronic and progressive nature, exercise program adherence has been deemed critical to optimize short and long-term health outcomes (31). Unfortunately, barriers to involvement in community-based exercise programs among individuals diagnosed with PD include perceptions of low outcome expectations, a lack of time, and fear of falling (10). As a result, increased attention has been given to the development of engaging and evidence-informed community-based exercise programs for clients with PD (7, 14). Fortunately, emerging evidence points to the potential therapeutic benefits of high-intensive exercise training protocols for those with PD, including gains in balance and strength (16). Subsequently, community-based boxing programs (CBP), leveraging the principles of high-intensity exercise training and balance training, have become increasingly popular for individuals diagnosed with PD (8, 9, 14). This includes the integration of short-bouts of high-intensity exercise at a rate of perceived exertion (RPE) between 'hard' and 'very hard' or 15/20 to 17/20.

As highlighted by Borrero and colleagues' (5), individuals with PD participating in CBP have also reported improved social connectedness with others diagnosed with PD, an enhanced sense of purpose, and increased determination and confidence. These findings are encouraging for concepts including but not limited to program adherence as well as social self-perceptions. Unfortunately, while CBP for individuals with PD have become increasingly prevalent, the number of quantitative studies examining changes in critical health outcomes such as balance and fall risk measures are sparse and have yielded conflicting results. Consequently, investigators have raised a call for additional investigations examining the associated benefits of participating in a CBP among clients diagnosed with PD (22).

Therefore, guided by the importance of exploring strategies to enhance balance and reduce risk of falls among those with PD, the purpose of this study was to examine if participation in a CBP was associated with improvements in balance and fall risk reduction among individuals with PD. The investigators hypothesize that participating in a CBP will be associated with increased balance and decreased risk of falls, as measured by improved FAB and TUG performance, among individuals with PD.

METHODS

Participants
A power analysis conducted with G*POWER 3.1 (Universitat Kiel, Germany) determined that 12 participants were needed in this retrospective, cross-sectional study for a power of 0.80, with an effect size of 0.8 and $\alpha = 0.05$. De-identified data was collected retrospectively from a convenience sample of 12 individuals diagnosed with PD [mean age = 67.0 ± 6.1 years; female *n* = 3, male *n* = 9), who had participated in a CBP for approximately 6-months. Participants had

been previously assessed by their referring physician using the Hoehn and Yahr scale, with all participants staged at a 3 or lower. Inclusion criteria included participants being 21 years or older, a community-dwelling adult with a formal diagnosis of PD, physician clearance to participate in a CBP, and capable of independent ambulation with or without an assistive device. Exclusion criteria included individuals who had undergone surgery in the past 6 months, lacked transportation to and from the facility, had received physical or occupational therapy services at the time of the investigation or in the past 6 months, and those identifying as pregnant. This research was carried out in full accordance to the ethical standards of the International Journal of Exercise Science (23), being reviewed and approved by the University of Missouri Institutional Review Board (#229321).

Protocol
Individuals meeting the inclusion criteria had participated in a university-sponsored CBP, informed by the design and development of Rock Steady Boxing and the work of Combs and colleagues (7, 8). Participants averaged 2.8 ± 0.8 sessions per week for 6.1 ± 0.8 months between baseline and re-evaluation. All participants completed the baseline assessment upon program entry as a component of new membership. Individual sessions were led by the same individual, being a certified Rock Steady Boxing instructor and personal trainer through the American College of Sports Medicine. Sessions were approximately 90-minutes in length and included a 15-minute warm-up, 30-minutes of boxing drills, 15-minutes of strength and endurance exercises, 15-minutes of activities focused on fine motor skills, and a 15-minute cool-down. Sessions averaged 15 participants per class. Classes included a mix of participants with a reported range between 1 to 3 on the Hoehn and Yahr scale. If an individual required additional assistance or monitoring for safety, an outside community or family member supported the client throughout the session.

Warm-up periods included various supine as well as standing flexibility and coordination activities. Notably, warm-up activities focused on multi-planar active range of motion movements of the extremities and trunk. Boxing drills, including jabs, hooks, and uppercuts, were coupled with cognitive and memory training activities such as linking movement patterns with assigned colors, numbers, or letters. Similar to previously outlined protocols (7), participants wore boxing gloves and struck boxing-specific punching bags but did not contact others. Following initial completion of boxing drills with a target RPE of somewhat hard (13/20), participants were instructed to perform 3-5 rounds of 30-60 second drills at a rate of perceived exertion (RPE) between hard (15/20) to very hard (17/20). Similarly, strength and endurance exercises were initially performed at a target RPE of somewhat hard (13/20), but also included high-intensity circuit training with 3-5 rounds of 30-60 second bouts of activity at a target RPE between hard to very hard. Movement patterns within the strength and endurance portion included bodyweight squats, punching a speed bag, and ball slams. This was followed by fine motor activities focused on improving upper extremity dexterity, such as tying shoes, picking up small objects from the ground, and stringing beads. Finally, sessions concluded with a cool-down similar to whole-body, active range of motion movement patterns as done in the warm-up.

Participants were encouraged to self-monitor their activity level and incorporate rest-breaks and exercise modifications as needed. Also, sessions included additional staff, family, and volunteers to ensure client safety and tolerance as required. Participants' balance was assessed using the reliable and valid Fullerton Advanced Balance (FAB) Scale and Timed Up and Go (TUG) test according to standardized guidelines and instructions (13, 15). The same physical therapist, with 10-years of clinical experience, performed baseline and re-evaluation assessments. The physical therapist did not lead any RSB sessions, although she did have access to participant baseline performance when completing reassessments. Baseline and re-evaluation assessments included completing the FAB to provide an overall balance score as well as a three-trial average of the TUG.

The FAB is designed to assess the subtle and multidimensional changes in balance and resultant fall risk among higher-functioning older adults (25). Specifically, the FAB includes 10 static and dynamic balance activities on a performance-based 5-point Likert scale (0 to 4) to provide an overall score with a 40/40 demonstrating the highest level of ability, an increased risk of falls for those scoring 25 or less, and a reported minimal detectable change (MDC) of 2.33 (13, 33). Items within the FAB include 1) standing with feet together and eyes closed, 2) forward reaching to retrieve an object, 3) turning 360 degrees in right and left directions, 4) stepping onto and over a 6-inch bench, 5) tandem walking, 6) standing on one leg, 7) standing on foam with eyes closed, 8) two-footed jump for distance (pending performance on item 4 and safety considerations), 9) walking with head turns, and 10) reactive postural control. The FAB has been validated for clients diagnosed with PD and has exhibited high test-retest reliability (0.96) intra- (0.92-1.00) and inter-rater reliability (0.91-0.95) (18).

The TUG is a well-established assessment of fall risk, balance and mobility with previously established validity and high test-retest reliability (3, 15, 27). The TUG assesses the time required for participants to rise from a chair, walk forward 3 meters, turn around and walk back, and return to a sitting position. Use of an ambulation aid is permitted. Reductions in the time required are interpreted as positive improvements in performance. Population-specific cut-offs scores for clients with PD include those requiring greater than 11.5 seconds to be at an elevated risk for falls and an MDC of 3.5 seconds (15).

Statistical Analysis
Upon meeting assumptions of normality including skewness, kurtosis and the Shapiro-Wilk test, paired t-tests were used to determine if differences existed between FAB and TUG scores at baseline and re-evaluation. Statistical significance was accepted at $p < 0.05$. Cohen's *d* was utilized to calculate effect size with 0.2 representing a small effect, 0.5 representing a medium effect, and greater than or equal to 0.8 representing a large effect (6, 29). All statistical analyses were completed using SPSS Statistics version 26.0 (Armonk, NY: IBM Corp).

RESULTS

Results indicated a statistically significant increase in the FAB between baseline and re-evaluation (FAB-Baseline: 33.8 ± 4.3, FAB-ReEval: 36.3 ± 2.6, $p = 0.004$), demonstrating a large

effect (d = 0.82) with a mean increase in score (2.5 ± 2.7) above previously reported MDC (33). Although there was a statistically significant decrease in time required to complete the TUG (TUG-Baseline: 8.2 ± 1.8 sec, TUG-ReEval: 7.3 ± 1.7 sec, p < 0.001) and a medium effect (d = 0.62), the mean reduction in time (0.9 ± 0.7 sec) did not demonstrate an MDC for individuals with PD (15). Participation scores can be found in Table 1. Additionally, while classes averaged 15 participants, multiple individuals did not return for their re-evaluation session with the physical therapist. As a result, only 12 individuals with complete baseline and re-evaluation FAB and TUG scores were included.

Table 1. Baseline and Re-Evaluation FAB and TUG Scores

Participant	Age (years)	FAB Score Baseline	FAB Score Re-Evaluation	TUG Baseline (sec)	TUG Re-Evaluation (sec)
1	63	39	40	7	6.2
2	70	34	38	8	7.5
3	74	25	33	7	6
4	71	30	34	9.8	8
5	69	35	39	9	6.7
6	69	34	35	12.5	12
7	68	32	35	6.4	6
8	72	28	32	9.4	8.5
9	62	37	38	8	6
10	57	37	39	6.5	6.6
11	77	37	38	6.7	6.3
12	59	38	35	8.5	8.1
Average (± SD)	67.6 ± 6.1	33.8 ± 4.3	36.3 ± 2.6	8.2 ± 1.8	7.3 ± 1.7

FAB = Fullerton Advanced Balance Scale. TUG = Timed Up and Go. SD = standard deviation.

DISCUSSION

The primary purpose of this investigation was to examine if participation in a CBP was associated with improvements in balance and fall risk reduction among individuals with PD. Findings indicated that following approximately 6-months of participation in a CBP, individuals with PD demonstrated a statistically significant increase in FAB performance with a large effect and improvement between baseline and re-evaluation scores above previously reported MDC values. Thus, improvements in balance were observed although investigators were unable to observe a reduction in fall risk due to the average FAB at baseline being above 25/40. In contrast, while TUG performance demonstrated a statistically significant improvement and medium effect, the mean difference did not represent a population-specific MDC.

These findings are encouraging, with results indicating that CBP participation was associated with improvements in the FAB's more subtle and multidimensional assessment of balance (25). Consistent with a higher-level of baseline functioning, both initial FAB and TUG scores were found to be above previously established thresholds for an increased risk of falls (13, 15). Furthermore, although a significant improvement in TUG performance was found, concerns of

a ceiling effect should be considered due to the high TUG performance at baseline of 8.2 ± 1.8 sec. Specifically, a TUG score of 8.0 ± 2 seconds has been reported as the average performance of health community-dwelling older adults between 60-69 years of age (28). Thus, the ability of this group of individuals with PD to demonstrate a population-specific MDC of 3.5 seconds is reduced.

Due to the limited and conflicting research on the benefits of CBP among individuals with PD (7, 8, 22), the investigators believe this study offers useful contributions exploring strategies to enhance the health of individuals with chronic and progressive neuromuscular disease. As outlined by Kelly et al. (16), the application of high-intensity exercise training among clients with PD has demonstrated favorable improvements in skeletal muscle and enhancements in physical capacity, motor function, and perception of fatigue. These findings are supported by Combs and colleagues (7), who found that participation in a CBP was associated with improved gait velocity and endurance. Although facility-based clinic sessions led by a physical therapist have demonstrated improved results regarding mitigation of neurologic and musculoskeletal impairments associated with PD as compared to community-based programs (11, 19), community-based exercise programs are positioned as a crucial link in the continuation of formalized and supervised exercise intervention for long-term health benefits.

This sentiment is reinforced by Bezner and colleagues' (4) call for physical therapists to increase the incorporation of health and wellness educational strategies into existing plans of care. Importantly, such efforts may extend progress made during the typically shorter time periods or limited visit allocation for individually prescribed physical therapy services. Supporting the need for transitional care options that provide safe and adequately dosed exercise for clients with PD, Domingos et al. (9) highlight the importance of improving interprofessional collaboration practice. In efforts to optimize client safety and efficacy, investigators developed education resources and provided practical workshops for participants and instructors of CBP before program initiation. This intentional and collaborative approach resulted in participants and instructors being very satisfied with the program as well as an increased number of participants at an 18-month follow-up. Furthermore, as providers create environments to promote positive behavioral change to improve short and long-term health outcomes, utilizing client-centered education strategies is vital (21). Suggested frameworks include leveraging the transtheoretical model of change, a psychological construct that describes the stages of behavioral change, demonstrating positive associations with increased physical activity among older adults (1, 12).

Limitations: Although this investigation has clinically useful implications, it is necessary to acknowledge several important limitations. Specifically, the study was retrospective and cross-sectional in nature only, limiting the amount of available participant specific information. Useful information that would have enhanced the study includes but is not limited to the presence of additional pre-existing conditions, PD progression according to the Hoehn and Yahr rating scale for each participant, or variations in medication and assistive device management during the study period. Moreover, although a large effect was observed with improved FAB scores, the investigation's small sample size limits its generalizability coupled with a suspected ceiling

effect in baseline TUG scores. Additionally, while improvements in balance were observed, linking this impairment level outcome to higher functional measures or rate of falls cannot be assumed. Similarly, it is important to underscore that this study identified an MDC in FAB, not a minimally clinically important difference (MCID). Thus, while differences between baseline and re-evaluation FAB scores are considered to be a change outside of measurement error, this study lacks greater associations linking CBP participation with clients' perception of meaningful and beneficial change. Furthermore, this study did not include a properly randomized control and intervention group to investigate the impact of CBP participation more adequately on balance and fall risk in those with PD, warranting additional investigations with a more robust study design.

While this study has multiple limitations as indicated above, participation in a CBP was associated with improved balance as measured by the FAB in clients with PD. Moreover, in contrast to most PD interventions that aim to slow the progression of PD by maintaining current functional abilities (17), participation in a CBP was associated with improved functional outcomes after attending sessions for approximately 6 months at 3 visits per week. Such findings reinforce the importance of community-based exercise programs as a valuable resource for clients navigating the challenges of chronic and progressive disease, although additional studies that explore the efficacy of CBP for clients with PD are warranted. Similarly, further investigations examining optimal exercise dose and intervention practices, strategies to ensure participant safety, and techniques to enhance interprofessional collaboration when implementing CBP for clients with PD are required.

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