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# The Lived Experience of Persons with Parkinson's Disease in Non-Contact Boxing Programs

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A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Health and Rehabilitation Sciences

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## Abstract

We conducted a scoping review to identify articles examining non-contact boxing programs for persons with Parkinson's disease (PwP). Results suggested that gait, mobility, balance, and quality-of-life were the most-studied outcomes. Many qualitative articles explored the experience within in-person boxing programs, but no articles explored experiences within virtual boxing programs. We followed this review with an interpretative phenomenological analysis aimed at addressing this research gap and interviewed six PwP who had engaged with both virtual and in-person Rock Steady Boxing programming. Results suggested that although the virtual setting improved elements of the individual experience, the physical and social aspects were better experienced in person. Results also suggest that in-person programming better supported autonomy, competence, and relatedness, which predicts better intrinsic motivation according to the Self-Determination theory. Virtual programming may have potential for individuals requiring remote exercise but would benefit from better access to home boxing equipment, and improved socialization during workouts.

## Keywords

Rock Steady Boxing, Parkinson's disease, Scoping review, Interpretive Phenomenological Analysis, Self-Determination Theory, qualitative, autonomy, competence, relatedness, psychological needs, virtual rehabilitation, virtual boxing

## Summary for Lay Audience

Parkinson's disease (PD) is a progressive neurological disease largely impacting motor function by inducing slow movements, rigidity in muscles, resting tremors, and balance. Non-motor related issues also surface impacting mental health, cognition, and sleep. This is a result of dopamine-producing brain cells depleting in the midbrain. Despite pharmaceutical and surgical advancements, treatment can only manage symptoms. However, physical activity is a widely recognized adjunctive therapy, playing a role in slowing progression and symptom manifestation. Non-contact boxing programs, like Rock Steady Boxing (RSB), are an increasingly popular exercise for person's with Parkinson's disease (PwP) to increase their physical activity with.

We conducted a scoping review to understand the extent to which the impact of non-contact boxing interventions on PD symptoms have been explored in research. Our search results included a total of 51 published journal articles, conference proceedings and graduate student projects. Many studies investigated the impact on mobility, gait, balance, and quality of life. Mental health, cognition, and sleep were less commonly studied. Our review also showed that current qualitative literature has examined the experience of in-person boxing settings, describing aspects which promote autonomous motivation to engage in physical activity. A behaviour that is autonomously motivated is described by the Self-Determination theory as being longer lasting and can promote wellness. An environment that fosters the psychological needs of autonomy, competence and relatedness supports autonomous motivation. The qualitative literature thus far has described in-person boxing programs for PwP to be need-supportive environments.

The experience of virtual boxing programs in comparison to in-person settings and how this environmental change impacts motivation is yet to be explored. Therefore, we conducted an interpretive phenomenological analysis to address these gaps. Through interviews with six PwP, we examined three aspects of their experience: the individual, the physical and the social experience. The virtual setting impacts the individual experience by improving accessibility and convenience, however physical intensity and socialization lacked. Additionally, autonomy,

competence and relatedness were better supported in the in-person setting. Future programs should consider ways to improve accessibility to boxing equipment at home and social connection in the virtual setting.

## Co-Authorship Statement

The following chapters were written by Laura Mulder, edited by Dr. Andrew Johnson, and reviewed by Dr. Jefferey Holmes and Dr. Mary Jenkins. For the scoping review, determination of the search strategy, inclusion/exclusion criteria, relevant databases, screening, and extraction of the results was conducted by Laura Mulder. A second reviewer, Larissa Mailhot, also engaged in independent database searching, title and abstract screening and article extraction. Dr. Andrew Johnson provided guidance, editing, and mediated disagreements between the reviewers. Drs. Holmes and Jenkins reviewed, critiqued, and advised the drafts. For the qualitative study, development of the proposal and interview guide was led by Laura Mulder, and reviewed by Dr. Andrew Johnson. The Ethics Review Board application was conducted by Laura Mulder and reviewed by Dr. Andrew Johnson and Larissa Mailhot. Recruitment and interviews were led by Dr. Johnson and Laura Mulder. Interview transcription, analysis and examination of the results was conducted by Laura Mulder and reviewed by Drs. Johnson, Jenkins, and Holmes.

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## List of Abbreviations

IPA – Interpretive Phenomenological Analysis

PD – Parkinson’s Disease

PwP – Person’s with Parkinson’s Disease

RSB – Rock Steady Boxing

SDT – Self Determination Theory

vRSB – Virtual Rock Steady Boxing

# Chapter 1

## Introduction

### 1.1 Parkinson's Disease

Parkinson's disease (PD) is a progressive neurological condition that typically manifests in older adults and severely impairs mobility and cognitive function (Guttman et al., 2003; Schapira et al., 2017). These impairments are the result of severe losses of dopaminergic neurons in the substantia nigra leading to decreased dopamine levels in the striatum; a centre for motor control (Guttman et al., 2003). The four cardinal motor impairments in PD include bradykinesia, postural instability, rigidity, and a resting tremor. The decline in balance and mobility is especially problematic as it greatly increases the risk and frequency of falling, possibly leading to subsequent hospitalizations and symptom exacerbation (Creaby & Cole, 2018; Nimwegen et al., 2011; Speelman et al., 2011). Not only is motor control impacted, but non-motor symptoms can also manifest and reduce one's quality of life by impairing sleep, cognition, mood, vision, and smell (Halliday & McCann, 2010; Schapira et al., 2017).

Motor and non-motor symptoms are commonly managed with medications such as dopaminergic agents and cholinesterase inhibitors, and surgical procedures such as deep brain stimulation (Guttman et al., 2003). Despite these pharmaceutical and surgical advancements in the management of PD, there is no cure for this disease (Guttman et al., 2003). Furthermore, many of these treatment options are costly and present unwanted side effects such as resting tremors, sleep disturbances, psychosis, and impaired cognition (Guttman et al., 2003). Currently, exercise as an adjunctive treatment is being extensively explored in research as it has been shown to improve motor and non-motor symptoms in addition to being less invasive and more cost-effective than other available treatments (Feng et al., 2020).

### 1.2 Impact of traditional and alternative exercise on symptoms of PD

Traditional exercises such as aerobic, endurance, and strength training have particularly been the focus in current literature and have been shown to improve gait, balance, cognition, depression, fall risk, and quality of life, although larger and more longitudinal trials are still needed (Emig et al., 2021; Fayyaz et al., 2018; Feng et al., 2020; Schootemeijer et al., 2020).

This is significant as gait and balance are difficult to treat pharmaceutically (van der Kolk & King, 2013) and mood disorder treatments come with their own complications (Fayyaz et al., 2018). Exercise programs that incorporate multiple exercise modalities and which can be tailored to suit individual needs are of particular importance, as PD symptoms manifest uniquely in each individual (Ellis & Rochester, 2018; van der Kolk & King, 2013). These types of exercise programs are commonly seen with alternative exercises such as boxing, dance, Nordic walking, tai chi, and qigong (Ellis & Rochester, 2018; Emig et al., 2021; Feng et al., 2020; van der Kolk & King, 2013). Not only do alternative programs integrate different exercise modalities, but they are typically enjoyable, and incorporate social interaction and camaraderie into their practice (Alves Da Rocha et al., 2015; Ellis & Rochester, 2018). Social environments and camaraderie have been identified as motivators to exercise and are a consistently highlighted feature in non-contact boxing programs (Borrero et al., 2022; Brunet et al., 2022; Combs et al., 2011; Humphrey et al., 2020; Hunter et al., 2019; Johnson et al., 2018; MacCosham et al., 2019; Rossi et al., 2018).

Until recently, PD was associated with boxing as a consequence of repetitive pugilistic head trauma, with Muhammad Ali held out as a famous example of the risk factor (Eugene & Nelson, 2017; Jafari et al., 2013). Since 2006, however, non-contact boxing programs for PD, and in particular Rock Steady Boxing programs, have been increasing in demand (Morris et al., 2019; Rock Steady Boxing, n.d.). The highly-intense nature of non-contact boxing exercises focus on training explosive power movements while maintaining balance, posture, core strength, and agile footwork, similar to professional boxing workout regimes (Chaabène et al., 2015; Filimonov et al., 1985; Finlay et al., 2021; Rock Steady Boxing, n.d.). RSB programs are described as using boxing equipment such as focus mitts, heavy bags, speed bags, and jump rope to train their participants (Rock Steady Boxing, n.d.). Each coach is trained to have a deep understanding of PD in addition to their boxing knowledge. Through this education the coaches are better equipped to provide effective and encouraging instruction while being cognizant of the variety of abilities impacted by PD.

In one review, Petzinger et al. (2013) noted that goal-directed exercises that were cognitively engaging could be important for improving motor circuitry in persons with Parkinson's disease (PwP). Boxing was used as an example of an exercise program that incorporates these features. Thus far, researchers have demonstrated that individuals experience

improvements in gait, mobility, walking speed, balance, quality of life, and sleep after 6-12 weeks of boxing training (Combs et al., 2011, 2013; Dawson et al., 2020; Hermanns et al., 2021; Urrutia et al., 2020). In light of these benefits, understanding the barriers and facilitators to participation in boxing programs is crucial (Schootemeijer et al., 2020).

### 1.3 Barriers and Facilitators to Exercise

PwP face many challenges that hinder participation in exercise programs as their disease progresses. Some of these challenges include physical weakness, or complications that are both PD and non-PD related (Ene et al., 2011; Johnson et al., 2018), low outcome expectation (Schootemeijer et al., 2020), social comparisons with other PwP (Hunter et al., 2019), fear of falling (Ellis et al., 2013; Johnson et al., 2018) and travel and weather related concerns (Ellis et al., 2013; Johnson et al., 2018; Schootemeijer et al., 2020). Although exercise program studies tend to have good compliance throughout the program, some studies suggest that adherence to an exercise routine post-intervention can be challenging (Ene et al., 2011; Rowsell et al., 2022). Rowsell et al. (2022) interviewed PwP who had participated in an at-home exercise program during which they received weekly physiotherapist support for six months. By interviewing PwP six months after the supervision portion of the program ended, Rowsell and colleagues (2022) found that participants experienced difficulty in maintaining intensity in their workouts when the accountability ceased. Similarly, Ene et al. (2011) noted from interviewing 15 participants who graduated from a 16 month supervised exercise program that their daily activity levels decreased. Many reasons for this involved physical decline and increased rigidity, however, one third of the reasons included time constraints and amotivation to continue.

Facilitators of exercise are important to uncover to better encourage continued participation in physical activity for PwP (Schootemeijer et al., 2020). Many social, personal and environmental factors have been identified to help facilitate physical activity within the lives of PwP. Social factors commonly identified include exercising with other individuals who are also impacted by PD, and exercising under the supervision of knowledgeable, caring and professional instructors (Crizzle & Newhouse, 2012; Johnson et al., 2018; O'Brien et al., 2016; Schootemeijer et al., 2020). Information, relatable experiences, and camaraderie can be shared amongst the participants and the instructors, which serves to encourage PwP to continue with their exercise program, and further increases compliance and maintenance. Exercise within these types of



social environments can also stimulate feelings of belonging, and being understood (Crizzle & Newhouse, 2012; O'Brien et al., 2016; Schootemeijer et al., 2020). Personal factors such as feelings of control, progress, confidence, and self-efficacy are prominent promoters for exercise among this population (Ellis et al., 2013; Quinn et al., 2010; Ravenek & Schneider, 2009; Schootemeijer et al., 2020). Finally, environmental factors typically involve program features such as location, cost, scheduling, and the audience towards which the programs are tailored (Ene et al., 2011; Johnson et al., 2018; Paul et al., 2021; Schootemeijer et al., 2020).

#### 1.4 The Self-Determination Theory

Motivation is a crucial facilitator for continued participation in any activity. Drs. Edward Deci and Richard Ryan are prominent psychology researchers who created Self-Determination theory (SDT) as a way of describing factors that motivate long-term behaviour. This theory postulates that motivation to do an activity can either be autonomous or controlled (Ryan et al., 2009), with autonomously motivated behaviour leading to more positive outcomes in well-being and adherence. The most autonomous form of motivation was termed intrinsic motivation and refers to an individual undertaking a task out of enjoyment and interest. In other words, intrinsically motivated activities are the reward itself (Ryan et al., 2009). Interesting and enjoyable activities are not, however, the only factors that influence intrinsic motivation. Deci and Ryan (2008) determined three basic psychological needs that must be satisfied by the activity, environment, or social context in order to promote optimal motivation for long-term behaviour.

These psychological needs were identified as autonomy, competence, and relatedness. Autonomy refers to when an individual's actions are self-determined, or when an individual feels an internal locus of control. This feeling of autonomy must be complemented by a strong sense of self-efficacy or competency, which is generally cultivated through positive feedback and appropriate challenges. The influence of these factors, however, only apply to activities and behaviours that an individual is personally interested in – in other words, activities or behaviours to which an individual relates (Ryan & Deci, 2000). For activities that do not hold any type of value or interest for an individual, autonomy and competence will not influence intrinsic motivation. However, relatedness can help facilitate individuals to internalize the value or interest of an activity through experiencing the value that others express for it (Deci & Ryan,

2015; Gagné et al., 2014). This process of internalization can be result of feeling belonging, connection or in other words, relatedness to other individuals or a group (Ryan & Deci, 2000). Altogether, when the needs of autonomy, competence and relatedness are met, then intrinsic motivation can develop resulting in longer lasting behaviour change.

For activities that do not foster all three basic psychological needs or are not personally enjoyable and interesting, extrinsic motivation plays a larger role. External regulators promote outcomes that are separate from the activity itself and are thus not intrinsically motivating. Ryan and Deci (2008) identified several regulators that range from being more controlled to being more autonomously motivated. The most controlled regulator is external regulation, in which an activity is done to achieve an external reward or avoid an external punishment. Subsequently, introjected regulators influence action based on internal punishments and rewards relating more to self-image and ego. For example, one might want to become physically active to achieve admiration from others or want to avoid feelings of low self-esteem. Identified regulation is comparatively more autonomous, as an individual acts based on their personal value for the outcome. For example, individuals may exercise because they personally value fitness and health. Finally, the second most autonomous extrinsic regulator is integrated regulation. Integrated regulation involves a process of assimilation of identified regulators. Although closely linked to intrinsic motivation, the reward for integrated regulation is still placed outside the activity itself, whereas for intrinsic motivation, the activity is the reward.

Research has underlined the importance of promoting intrinsic motivation through support of the basic psychological needs to influence long-term physical activity compliance for PwP (Hunter et al., 2019; Schootemeijer et al., 2020; Wilson et al., 2008). With particular attention to boxing, Brunet et al. (2022) used an SDT lens to qualitatively examine the influences on participant motivation to attend boxing classes. Autonomy was experienced in subtle ways as the participants were given control over the workout music and their input and feedback was received and incorporated. The boxers followed tailored workouts to embrace the individuality of the disease and its impact on physical abilities. As the boxers accomplished their individualized workout strategies, their feelings of competency grew. Relatedness was also identified as playing a crucial role in encouraging motivation. Boxers felt encouraged, and emotionally and instructionally supported by both the coaches and each other. Furthermore,

working alongside other boxers who face similar challenges inspired them to work harder and push through difficult segments of the workout, demonstrating the impact of relatedness.

Other authors within the qualitative boxing literature have also outlined similar themes from their participant experiences (Borrero et al., 2022; Hermanns et al., 2021; Humphrey et al., 2020; MacCosham et al., 2019; Sheehy et al., 2017). Participants have described experiences of camaraderie, familiarity and belonging when they are intensively training alongside others impacted by PD. Coaches have also been shown to impact the boxing experience by enhancing the participant's confidence, autonomy, and sense of accomplishment through positive verbal feedback and by adapting the workouts towards their individual strengths (Borrero et al., 2022; Brunet et al., 2022; MacCosham et al., 2019; Sheehy et al., 2017). By demonstrating a high degree of empathy and understanding towards those with PD, coaches have also built supportive and encouraging social environments for the participants, making them feel understood and cared for (Borrero et al., 2022). Overall, these personal experiences of autonomy, competence, and relatedness, together with their physical improvements, impact how PwP come to value boxing classes, and this is reflected in their continued attendance.

The experience of environmental facilitators has not been the focus within these qualitative studies, but it is likely that feelings of autonomy and participation frequency can be enhanced by addressing factors such as accessibility in terms of travel time and cost. By offering boxing programs in the virtual setting, accessibility issues related to these factors can be improved.

## 1.5 Home-Based Virtual Exercise Programs

During the COVID-19 pandemic, virtual home-based exercise programs increased substantively in popularity. With advancements in telerehabilitation technologies, there are a number of tools under study that PwP can use to engage in exercise at home such as virtual reality (Teo et al., 2016; Truijen et al., 2022), exergaming programs (Holmes et al., 2013; Souza et al., 2018; van der Kolk et al., 2019; Vellata et al., 2021), videoconferencing with a trainer (Cornejo Thumm et al., 2021), accessories and apps to track progress (Langer et al., 2021), self-managing exercise programs (Langer et al., 2021), and routine phone calls from instructors (Light et al., 2016). Studies have also shown that the impact of home-based exercise programs on motor and non-motor symptoms can be comparable to in-person training (Isernia et al., 2020;

van der Kolk et al., 2019). Outside emergency remote exercise programming during a pandemic, remote exercise may be of additional benefit to PwP residing in Canada in the winter, as the cold seasons add extra travel concerns and can further exacerbate imbalance, tremors, and increase one's fear of falling (Ellis et al., 2013; Guttman et al., 2003). Additionally, virtual exercise programs may provide individuals more autonomy and control within their schedule (Langer et al., 2021; Maresca et al., 2020).

Some evidence suggests that PwP's symptoms worsen in the absence of structured exercise programs (Domingos et al., 2022; Horbinski et al., 2021). Both Domingos et al. (2022) and Horbinski et al. (2021) conducted longitudinal studies measuring PD severity or falls in PwP who experienced interruptions in their structured exercise programs due to COVID-19 lockdowns. Domingos et al. (2022) found that in Portugal, PwP declined in health two months after the lockdowns stopped their exercise programs, regardless if they maintained an active lifestyle or not. Similarly, Horbinski et al. (2021) found that when their boxing program was interrupted by COVID-19 restrictions, the risk of falling increased by 84% and 49% in females and males, respectively. They later found that when the boxing program resumed, the risk of falls decreased by 24% and 18% in females and males, respectively. Interestingly, Lai et al. (2020) conducted a pilot study to examine adherence in both tele-coached and self-coached home based exercise programs. Participants were randomly assigned to either a tele-coach assisted exercise group in which participants met with coaches virtually every session, or to a self-regulated exercise group in which tablets were provided with software containing their daily exercise regime with an exercise journal. Participants were to exercise three times a week for eight weeks in both groups. While the results showed that the self-regulated group participated less and had less time exercising at a moderate intensity level, and in exercising overall, the remotely supervised group showed attendance rates of 99.2% adherence throughout the exercise program with a few participants going beyond the prescribed exercises, and comparatively greater times in exercising. Some reasons for the lack of compliance in the self-regulated group consisted of technology difficulties, and a lack of support and socialization. Taken together, these studies suggest that virtual exercise programming can provide avenues to increase physical activity at home, but there is a need for the programs to be externally structured.

## 1.6 Interpretive Phenomenological Analysis

Interpretive phenomenological analysis (IPA) is a type of qualitative methodology that seeks to understand an individual's lived experience of a phenomenon and to understand how they have made sense of that experience (Smith et al., 2021). This type of qualitative work was developed by Jonathon A. Smith in 1996 as a way of better incorporating phenomenological research into the field of psychology (Smith, 1996). IPA centres itself on three main influences; phenomenology, hermeneutics, and idiography.

Phenomenology is a philosophically influenced approach to qualitative research. Husserlian phenomenology, the earliest established branch of this methodology, focuses on understanding the core essence of a phenomena with the ultimate goal of understanding consciousness itself (Dowling, 2007). This involves a process of phenomenological reduction, in which the researcher attempts to achieve a completely pre-reflective understanding of a phenomenon and the specific essences that form it (Dowling, 2007). As a part of this, researchers must make themselves consciously aware of their preconceptions and interpretations and adequately set them aside or "bracket them off" to understand experience with minimal researcher bias. IPA involves an in-depth analysis to achieve a core understanding of an individual's experience of a particular phenomenon, and places the same importance Husserlian phenomenology does on uncovering the researcher's interpretations (Smith et al., 2021). However, IPA recognizes that experiences are not had in isolation, but in relation to other individuals, contexts, and past experiences. Therefore, IPA follows more closely the phenomenological branches of Heidegger, Merleau-Ponty, and Sartre who understood that experiences cannot be had apart from one's perception of the world (Smith et al., 2021).

Reflexivity can also be utilized to facilitate a process known as the 'hermeneutic turn' during IPA analysis (Smith et al., 2021). The hermeneutic turn refers to a cycle that begins with researchers engaging closely with, and immersing themselves within, the data. Researchers then return to their own understandings and pre-determined theories to aid in interpretation, and subsequently re-immersing themselves in the data. Additionally, the IPA researcher strives to avoid linearity in their analyses, but rather allows the smaller units of data to inform larger themes, and vice versa (Smith et al., 2021).

Finally, IPA research studies are deeply concerned with the in-depth analyses of a particular phenomenon by specific individuals in certain contexts (Smith et al., 2021). This

'commitment to the particular' [p.24] involves an immensely detailed analyses of small samples and at times, even single cases. Although there is flexibility in required sample sizes, the main concern for IPA researchers is to have adequate time to provide an in-depth analysis of each case involved. The range of sample sizes depends on the experience and level of the researcher, with the recommended sample size for a masters student expected to range from three to five participants (Smith et al., 2021). Despite small sample sizes, IPA can still contribute to research as findings can provide new insights or affirm what is already seen in large-scaled research.

## 1.7 Conclusion

In the following chapters, we aim to understand the scope of what is being researched with regards to boxing programs for PwP, and the direction in which future research can go to fill current gaps. Chapter 2 presents a scoping review that examines the extent to which the literature has covered boxing as an intervention for PD. This scoping review led to the conclusion that there is a lack of qualitative literature examining experiences of PwP in virtual boxing programs, and so Chapter 3 presents a qualitative study aimed at understanding the lived experiences of individuals who had participated in both virtual and in-person boxing programs (specifically Rock Steady Boxing). In this study, we viewed motivation to attend virtual boxing classes through the theoretical lens of the SDT, and aimed to identify the extent to which an individual's psychological needs of autonomy, competence and relatedness were supported in virtual boxing. This qualitative study was conducted as an interpretive phenomenological analysis. Finally, Chapter 4 presents an overall summary of these two studies.

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## Chapter 2

# Research Surrounding the Impacts of Boxing Programs for Person's with Parkinson's Disease – A Scoping Review

## 2.1 Introduction

### *2.1.1 Parkinson's Disease*

Parkinson's disease (PD) is a progressive neurological condition that is typically diagnosed in older adults (Hoehn & Yahr, 1967). The hallmark of PD is the loss of dopaminergic neurons within the substantia nigra in the midbrain, causing rigidity, bradykinesia, impaired balance, and shuffling gait (Guttman et al., 2003; Schapira et al., 2017). In addition to motor impairments, non-motor symptoms such as sleep disorders, mood disorders (e.g. depression, anxiety, apathy, amotivation), memory loss and speech impairment can also develop throughout the progression of the disease (Guttman et al., 2003; Schapira et al., 2017). The progression of PD has not been shown to be reversible by any current treatments (Guttman et al., 2003). Although symptoms can be temporarily managed with dopaminergic medications and deep brain stimulation, these therapies lose their potency as the disease advances. Further, higher dosages of medication may result in unwanted side effects such as dyskinesia, sleep disturbances, and hallucinations (Guttman et al., 2003).

### *2.1.2 Exercise for PD*

Exercise has been extensively explored as a method of managing PD symptoms and has been shown to improve motor abilities such as balance, gait, and postural instability (Amara & Memon, 2018; de Carvalho et al., 2018; Feng et al., 2020). Improving mobility in persons with Parkinson's (PwP) decreases risk of falling and may reduce the risk of adopting a sedentary lifestyle. This is important, as falls and sedentary behaviours are linked to an increase in hospitalizations and can exacerbate motor and non-motor symptoms (Creaby & Cole, 2018). Exercise has also been shown to provide relief from disturbed sleep, improve mood and cognition, and enhance overall quality of life (Amara & Memon, 2018; de Carvalho et al., 2018; Feng et al., 2020).

### *2.1.3 Traditional and Alternative Exercises for PD*

Traditionally, exercise programs for PwP target strength, aerobics, balance, and flexibility with conventional training techniques (van der Kolk & King, 2013). Traditional

exercise programs have been shown to incorporate treadmill training, stationary cycling, weighted exercises (dumbbell and bodyweight), balancing activities that use different bases of support and visual cues, and multi-axial stretching (Combs, Diehl, Chrzastowski, et al., 2013; van der Kolk & King, 2013). Alternative or non-traditional exercises have gained popularity as they involve uniquely enjoyable activities that also target a wide range of motor and non-motor symptoms (Alves Da Rocha et al., 2015; Amara & Memon, 2018; Combs et al., 2011). Non-contact boxing is an alternative exercise program that has been gaining recognition in recent years. Morris et al. (2019) outlined the impacts of boxing on PD symptoms in a systematic review, and found only two studies that investigated the impact of boxing on PD symptoms. The authors concluded that there was little research to support the wide implementation of boxing programs. Since this review, however, there has been a rapid increase in published and ongoing research investigating the impacts of boxing on PD. This scoping review aims to outline current research surrounding boxing as an intervention for PD. To this end, we will examine both quantitative and qualitative peer-reviewed articles, as well as grey literature that represents non-peer reviewed current or past research. This includes conference abstracts, poster presentations, journal supplements, and post-secondary student projects. We will also provide a general outline of the outcomes and trends that have been identified within current research.

## 2.2 Methods

### 2.2.1 *Review*

This scoping review was carried out using the PRISMA checklist for Scoping Reviews (Tricco et al., 2018) as well as the guidelines and criteria presented by the Joanna Briggs Institute Manual for Evidence Synthesis (2020).

### 2.2.2 *Search Strategy*

Through an iterative process of examining keywords used by Morris et al. (2019), preliminary searching through Medline, EMBASE, CINAHL, Pubmed & Scopus, and consulting with several librarians, we refined a search strategy, which is presented in **Table 2-1**. This search strategy was then applied to eight databases by two independent reviewers (LNM, LGM). Citation lists of all peer-reviewed literature identified in this fashion were also used to add to the pool of potential articles evaluated within this review. Supplemental and grey literature searching was also performed independently by the two reviewers by employing a modified

search strategy within Google Scholar and collecting relevant documents from the first 10 pages. The results from the database and supplemental searching are also found in **Table 2-1**.

Source selection, screening and data extraction was performed through Covidence systematic review software by the two reviewers. Any conflicts were resolved through discussion, and the disposition of equivocal studies were resolved through discussion with a third reviewer (AMJ). Studies were included if the study population was comprised of individuals diagnosed with PD by a physician, and if the main intervention involved boxing. Studies were excluded if their outcomes were not specific to PwP, or to the boxing intervention, and if the intervention involved other alternative exercises such as dance or tai chi. Additionally, articles were excluded if they studied PD that developed over years from contact boxing, or if the study or study abstract was inaccessible to the researchers. Further, although this review strategy allowed for the inclusion of studies that evaluated online boxing classes, it did not include studies that evaluated the effects of boxing game interventions as mediated by a game console such as the Nintendo Wii™. These criteria were applied both to database and supplemental searching. Grey literature was limited to conference abstracts, supplements, poster presentations, and student research projects. We did not include websites, newspaper articles, or blogs. Duplications were identified by Covidence and by the reviewers, and subsequently eliminated.

## 2.3 Results

### 2.3.1 Search Results

Our database search strategy collected 17 peer-reviewed articles, 22 conference abstracts, supplements and poster presentations collectively, and 2 student research projects. Our supplemental Google Scholar search gathered 2 peer-reviewed articles, 2 poster presentations and 4 student projects. Our citation search did not yield any new results. One peer-reviewed article and one student project were discovered outside of formal searching. A total of 51 studies were included for full data extraction within the Covidence systematic review software. The screening and extraction process is illustrated in the PRISMA diagram (**Figure 2-1**; Page et al., 2021). Each article was numbered for reference and displayed in **Table 2-2**.

**Table 2-1: Search Strategy**

<b>Database Searching</b>	<b>Search Strategy</b>	<b>Results</b>
CINAHL	<b>Parkinson's Disease Keywords:</b>	45
Cochrane Reviews	Parkins*	68
EMBASE (Ovid)	Parkinson* disease	179
Medline (Ovid)	Parkinsonian disorder*	61
Nurse & Allied Health	Parkinsonism	44
Scopus	Shaking Palsy	100
SPORTSDiscus	<b>Boxing keywords:</b>	47
Web of Science	Boxing,	868
	Boxer (NOT) dog	
	Boxing (adj3) Training	
	Kickboxing	
	Kick Boxing	
	Rock Steady Boxing	
	Combat Sport*	
<b>Supplemental Searching</b>	<b>Parkinson's Disease Keywords:</b>	8
Google Scholar (pg. 1-10)	Parkinson's disease	
Reference searching of included articles	Parkinson disease	
	Parkinsonian disorders	
	Parkinsonian disorder	
	Parkinsonism	
	Shaking palsy	
	<b>Boxing Keywords:</b>	
	Boxing	
	Boxing AROUND(3) training	
	Kickboxing	
	Kick Boxing	
	Rock Steady Boxing	
<b>Found Outside Formal Searching</b>	N/A	2

Figure 2-1: PRISMA diagram

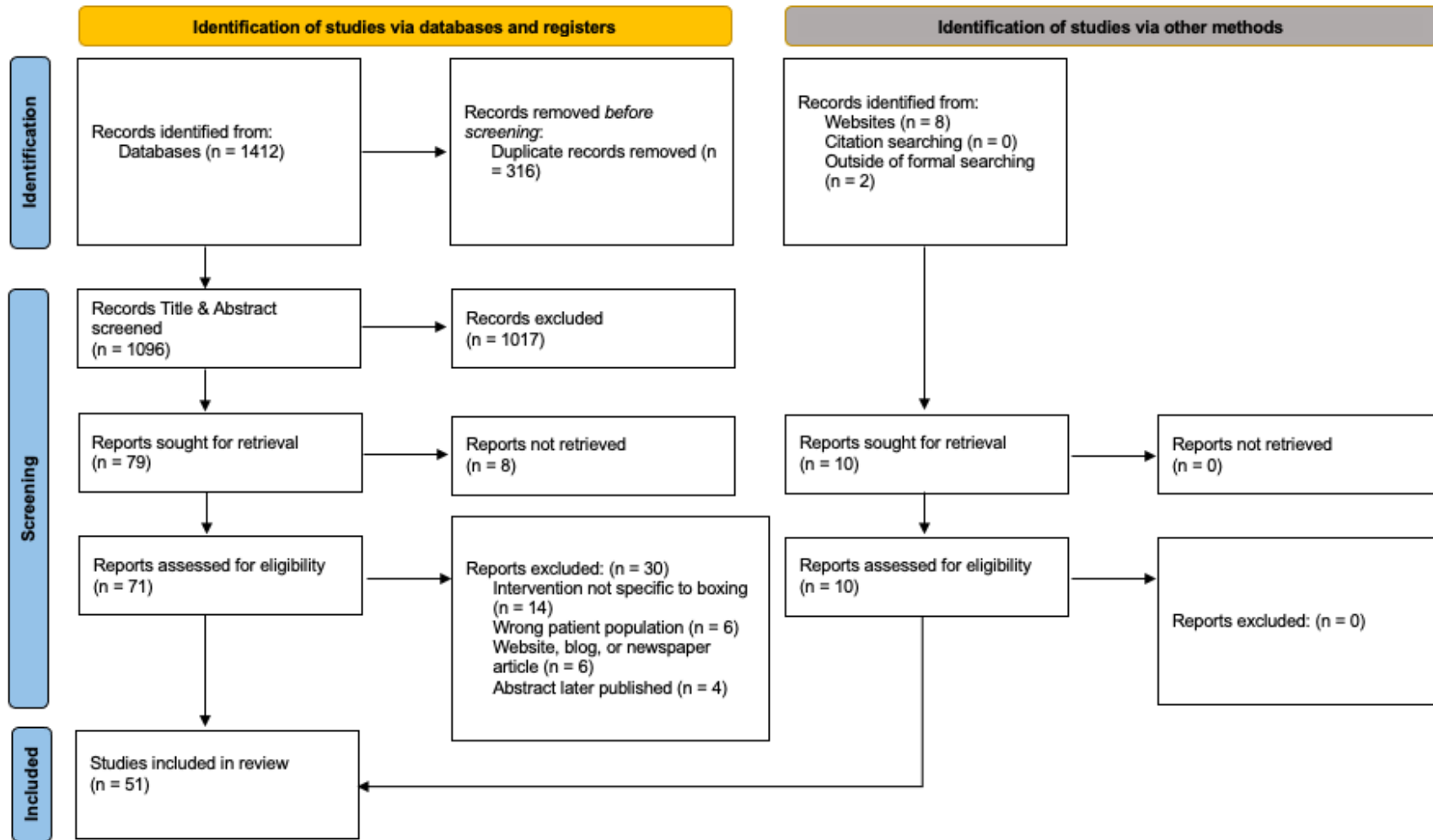


Table 2-2: Article Referencing Table

1	(Ketigian et al., 2022) <i>Transition and Sustainability of an Online Care Model for People With Parkinson's Disease in Response to the COVID-19 Pandemic</i>	11	(Borrero et al., 2022) <i>The meaning of regular participation in vigorous-intensity exercise among men with Parkinson's disease</i>	21	(Blacker et al., 2021) <i>Feasibility of Instituting Graduated High intensity Training (FIGHT-PD); Protocol for a non-contact boxing exercise study</i>	31	(Combs, Diehl, Bentz, et al., 2013) <i>Enhanced walking function with boxing training for persons with Parkinson disease.</i>	41	(Pascal et al., 2018) <i>The impact of high intensity training (HIIT) on balance and gait in Parkinson's disease</i>	51	(Bunyan et al., 2017) <i>Effects of strength circuit training and boxing circuit training in individuals with Parkinson's disease Effects of strength circuit training and boxing circuit training in individuals with Parkinson's disease</i>
2	(Meyer et al., 2022) <i>Effects of an acute boxing session on muscle activity in persons with Parkinson's disease</i>	12	(Dawson et al., 2020) <i>Boxing exercises as therapy for Parkinson disease</i>	22	(Benoit et al., 2020) <i>Effects of a community-based adapted boxing program on physical capacity and quality of life in individuals with Parkinson disease over a 12 month period</i>	32	(Patel et al., 2022) <i>A pilot study on the effect of a community-based boxing program on Parkinson's disease</i>	42	(Shearon et al., 2018) <i>Effects of boxing training on cognitive and physical function in patients with Parkinson's disease</i>		
3	(Sonne et al., 2021) <i>A Retrospective Analysis of Group-Based Boxing Exercise on Measures of Physical Mobility in Patients With Parkinson Disease.</i>	13	(Humphrey et al., 2020) <i>Perceptions of the impact of non-contact boxing on social and community engagement for individuals with Parkinson's disease: A qualitative study</i>	23	(Shearin et al., 2020) <i>Impact of community boxing program on motor impairments of Parkinson's Disease (PD) including: gait, functional mobility, dual task and coordination</i>	33	(McLeod et al., 2019) <i>Kickboxing and cognition in Parkinson's disease</i>	43	(Foster et al., 2013) <i>Assessment of individuals with Parkinson's disease participating in Rock Steady Boxing</i>		
4	(Brunet et al., 2022) <i>Boxing with Parkinson's Disease: findings from a qualitative study using self-determination theory</i>	14	(Urrutia et al., 2020) <i>Boxing to improve sleep quality and daytime sleepiness in individuals with Parkinson disease: Pilot study</i>	24	(Ghaffar, Gallagher, Rubin, et al., 2019) <i>Effect of non-contact boxing on non-motor symptoms in Parkinson's disease</i>	34	(Meinert & Hatkevich, 2019) <i>The effect of community-based therapeutic boxing on the speech, social interaction skills, and mental health of individuals with Parkinson's disease</i>	44	(Diehl et al., 2011) <i>Comparison of boxing training and traditional exercise on balance and quality of life outcomes in persons with Parkinson's disease: A pilot study</i>		
5	(Hermanns et al., 2021) <i>Counterpunching to improve the health of people with Parkinson's disease</i>	15	(Domingos et al., 2019) <i>Implementation of a community-based exercise program for Parkinson patients: Using boxing as an example</i>	25	(Ghaffar, Gallagher, McLeod, et al., 2019) <i>Procedural memory changes of Parkinson's disease patients post participation in boxing</i>	35	(Clack, Riemann, et al., 2017) <i>Changes in functioning associated with exercise in individuals with Parkinson's disease</i>	45	(Hall et al., 2022) <i>Effects of Rock Steady boxing on Parkinson's patients</i>		
6	(Horbinski et al., 2021) <i>Longitudinal observational study of boxing therapy in Parkinson's disease, including adverse impacts of the COVID-19 lockdown</i>	16	(MacCosham et al., 2019) <i>A qualitative phenomenological exploration of the experiences of individuals with Parkinson's Disease engaged in a boxing program</i>	26	(Pino et al., 2019) <i>Impact of boxing-based training in Parkinson's disease: A new lifestyle for PD patients in Chile!</i>	36	(Seibert et al., 2017) <i>Non-contact boxing as a mechanism for treating Parkinson's disease symptomology</i>	46	(Henige et al., 2022) <i>Physical activity behaviour in persons with Parkinson's disease</i>		
7	(Larson et al., 2021) <i>High satisfaction and improved quality of life with Rock Steady boxing in Parkinson's disease: results of a large-scale survey</i>	17	(Clack, Ashman, et al., 2017) <i>Assessing changes in cognitive function and quality of life associated with exercise in individuals with Parkinson's disease and their caregivers</i>	27	(Larson et al., 2018) <i>Effects of Rock Steady boxing on activities of daily living and motor symptoms of Parkinson's disease</i>	37	(Gobert et al., 2021) <i>Predictive relationships between Parkinson's disease outcome measures and participation in long-term HIIT exercise</i>	47	(Sloane, 2022) <i>Against the ropes: Fighting for the self against Parkinson's disease in a San Diego boxing gym</i>		
8	(Moore et al., 2021) <i>A community-based boxing program is associated with improved balance in individuals with Parkinson's disease</i>	18	(Sheehy et al., 2017) <i>Social comparisons, social support, and self-perceptions in group exercise for people with Parkinson's disease</i>	28	(Riemann et al., 2017) <i>Assessing changes in physical function, cognitive function and quality of life in individuals with Parkinson's disease</i>	38	(Gobert & McDowell, 2020) <i>Characterizing motor responses of persons with Parkinson disease to HIIT boxing training</i>	48	(Ricossa et al., 2021) <i>Knockout Parkinson's disease: A fine motor program</i>		
9	(Sangarapillai et al., 2021) <i>Boxing vs sensory exercise for Parkinson's disease: A double-blinded randomized controlled trial</i>	19	(Combs, Diehl, Chrzastowski, et al., 2013) <i>Community-based group exercise for persons with Parkinson disease: A randomized controlled trial</i>	29	(Denney et al., 2016) <i>Community boxing for adults with Parkinson's Disease – a feasibility study</i>	39	(Denney et al., 2019) <i>Boxing as an alternative treatment for sleep disorders in individuals with Parkinson's disease: A feasibility study</i>	49	(Bignal, 2020) <i>Perceived impact of non-contact boxing on daily life and occupational participation at home among individuals with Parkinson's disease</i>		
10	(Shearin et al., 2021) <i>The effect of a multi-modal boxing exercise program on cognitive locomotor tasks and gait in persons with Parkinson disease</i>	20	(Combs et al., 2011) <i>Boxing Training for Patients With Parkinson Disease: A Case Series Background and Purpose. A nontraditional form of exercise recently applied</i>	30	(Domingos, 2016) <i>The applicability of a multitask boxing program using the BoxMaster® for individuals Parkinson's disease</i>	40	(Pascal, 2018) <i>The effects of high intensity interval training and boxing on reaction time in Parkinson's disease</i>	50	(Hoime et al., 2018) <i>Impact of a community-based Rock Steady boxing program for people with Parkinson's disease: A pilot study</i>		

### 2.3.2 *Data Analysis*

Each article was extracted by two reviewers (LNM, LGM) using an agreed upon extraction template, found in Form A-1 in the appendix. Extracted data was organized in a Microsoft Word document (Version 16.66.1) and transferred to a table. Inductive thematic analysis was conducted manually through the table. Findings were charted, organized, and tallied to determine the frequency of certain study characteristics and to create a picture of what the current literature has studied so far. Demographic and program details from both peer-reviewed and grey literature are summarized in Table A-1 in the appendix. Study assessments, outcomes, and findings from both peer-reviewed and grey literature are summarized in Table A-2 in the appendix.

### 2.3.3 *Study Designs*

Studies included with this review utilized qualitative and mixed methods ( $n = 12$ ; [4, 5, 11, 13, 15, 16, 18, 34, 36, 47-49]), interventional methods ( $n = 24$ ; [2, 9, 10, 14, 17, 19, 21, 24-26, 28-30, 33, 35, 38-42, 44, 46, 50, 51]) and observational methods ( $n = 15$ ; [1, 3, 6, 7, 8, 12, 20, 22, 23, 27, 31, 32, 37, 43, 45]). Among peer-reviewed manuscripts, the ratio of study designs was almost even, with seven studies using qualitative and mixed methods [4, 5, 11, 13, 15, 16, 18], six studies using interventional methods [2, 9, 10, 14, 17, 19], and seven studies using observational methods [1, 3, 6, 7, 8, 12, 20]. From the grey literature, the most common study design was interventional as it was employed in 18 articles [21, 24-26, 28-30, 33, 35, 38-42, 44, 46, 50, 51]. Studies using qualitative and mixed methods or observational methods were less common as they were used in five [34, 36, 47-49] and eight [22, 23, 27, 31, 32, 37, 43, 45] articles, respectively. Four observational studies were also counted as retrospective [3, 8, 12, 22], with three coming from the peer-reviewed literature [3, 8, 12].

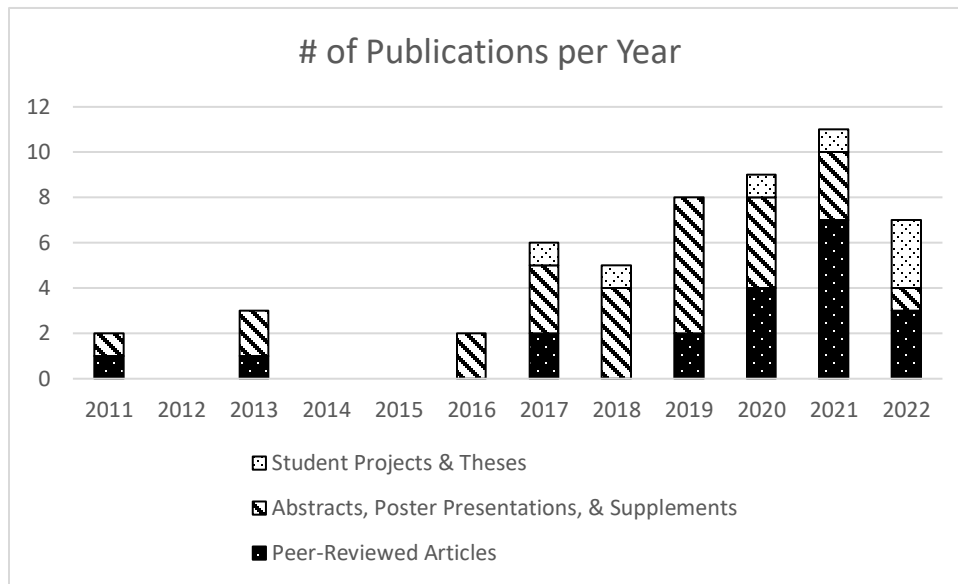
### 2.3.4 *Study Context*

The country in which research was conducted was determined by the authors' main university, the address of correspondence, or was specifically referenced in the article. Most authors were in the US ( $n = 41$ ; [1-3, 5-8, 10, 12-14, 17, 19, 20, 23-25, 27-29, 31-51]) and Canada ( $n = 5$ ; [4, 9, 16, 18, 22]). The remaining articles were located within the UK [11], Sweden [15], Australia [21], Chile [26] and Portugal [30]. Research in this area has been growing since 2011, with most studies, abstracts, presentations, and projects being published



between 2019 and 2022. A bar graph outlining the growth in research over the years can be found in **Figure 2-2**.

**Figure 2-2: Publications per Year**



### 2.3.5 Population Demographics

All the studies within this review focused on individuals diagnosed with PD by a physician. A total of 26 articles reported gender statistics and 24 of those articles indicated that either half, or majority of the participant population were males [2-14, 16, 18-20, 24, 27, 31, 38, 39, 45, 47, 49, 50]. Only two articles reported a percentage of male participants lower than 40% [18, 47]. However, in one of these studies, female participants were selectively sought out [47].

Approximately half of the articles described the disease severity of their participants. The PD stages of participants typically ranged from mild to moderate ( $n = 23$ ; [4, 8-11, 13-15, 17, 19, 20, 24, 26, 28-31, 37-40, 45, 49]), with very few studies including individuals who were in the later stages of the disease ( $n = 4$ ; [4, 20, 40, 49]). Most of these articles ( $n = 20$ ; [8-11, 14, 15, 17, 19, 20, 24, 26, 28-31, 35, 37-40]) determined disease severity through the use of the Hoehn & Yahr staging scale. Brunet et al. [4] alternatively employed the Unified Parkinson's Disease Rating Scale III, while Bignal [49] and Humphrey et al. [13] based disease severity on the class difficulty in which the participants qualified for. Only one article did not specify how they measured disease severity despite including it as a demographic characteristic [45].

### 2.3.6 Attendance Frequency and Program Length

The length of boxing programs varied widely among articles. For example, some authors performed assessments after PwP participated in a single boxing session [2, 42], while other studies included assessments done on individuals who had been participating for two [3, 6] to eight years [45]. Overall, these articles appear to be outliers as many articles presented programs lasting between 6 and 16 weeks (n = 20; [4, 5, 9, 10, 12, 14, 17, 19, 21, 23, 26, 28-30, 32, 35, 39, 44, 50, 51]). Other studies were more long-term, assessing their participants between 6 and 18 months (n = 13; [8, 15, 16, 20, 22, 27, 31, 36-38, 40, 41, 43]) with one conference abstract ranging from 3 to 9 months [24]. One team of undergraduate research students analyzed data after just one month of participation [46]. The remaining articles did not specify program length. In most studies, attendance ranged from two to three times per week (n = 26; [1, 3-6, 8-11, 13, 14, 16, 19-23, 26, 29, 37-39, 42, 44-46]). Alternatively, some articles evaluated individuals who attended as little as once per week (n = 4; [12, 24, 30, 50]), while others described participants attending as often as four times per week (n = 2; [15, 47]). Most articles reported the length of their workouts to range between 60-90 minutes or more (n = 24; [1, 3, 5, 8-13, 15, 16, 18-20, 22, 23, 27, 40-42, 44, 46, 47, 50]), with only eight articles permitting less time [2, 4, 14, 21, 29, 37-39].

### 2.3.7 Program Activities

Most studies described similar workout procedures for their programs. Of the 33 articles [1-6, 8-12, 14-20, 22, 23, 28, 29, 30, 35, 37-39, 42, 44, 47, 48, 50, 51] that described their workout activities, all but two reported boxing movements (e.g. drills, combinations, shadow boxing, heavy, light or speed bags and focus mitts). Ricossa et al. [48] and Borrero et al. [11] report their studies taking place in a Rock Steady Boxing program, where the boxing activities are implied. Many (n = 22; [1-4, 10-12, 16-20, 22, 23, 28, 35, 37, 38, 42, 44, 47, 50]) reported cardio (e.g. foot work, agility, jumping jacks, jump rope), strength and resistance exercises (n = 19; [3-5, 8, 10-12, 16-20, 23, 28, 35, 42, 44, 50, 51]), and several reported stretching (n = 8; [1-3, 5, 18, 42, 44, 50]), balance and core (n = 7; [1, 4, 5, 12, 16, 42, 47]). Other activities included in some programs involved voice exercises (n = 5; [5, 12, 16, 42, 47]), hand-eye coordination (n = 3; [3, 11, 12]), fine motor (n = 4; [5, 8, 12, 22]) and cognitive tasks (n = 4; [5, 15, 47, 50]).

### 2.3.8 Outcomes

Many outcome measures focused on motor aspects such as mobility, gait, balance, as well as quality of life and participation experience. Less studied outcomes regarded more non-motor symptoms such as psychological problems, cognition, sleep, and vocal control. A summary of these outcomes can be found in **Table 2-3**.

#### *2.3.8.1 Mobility and Gait*

Mobility (n = 13; [3, 12, 14, 19, 20, 26, 27, 29, 36-39, 46]) and gait (n = 16; [3, 6, 9, 10, 19, 20, 23, 27, 31, 36-38, 41, 45, 50, 51]) were prominent outcomes as they were assessed in a total of 22 articles. In terms of mobility, each article reported improvement apart from two articles that did not specify their findings [14, 38]. Statistically significant (n= 5; [3, 12, 19, 26, 39]), and non-statistically significant (n = 4; [20, 27, 29, 36]) improvements were both reported. To measure mobility, the Timed Up & Go (TUG) test was used in many of these studies (n = 10; [3, 12, 14, 19, 20, 26, 27, 37-39]), along with dual task and cognitive TUG (dTUG; n = 2; [19, 39], TUG-C; [14]), the Six Minute Walk test (6MWT; n = 2; [14, 26]), the Five Times and 30 second Sit To Stand test (5xSTS; [37], 30s STS; [12]), the Dynamic Gait Index (DGI; [26]), and the Four-Square Step test (4SST; n = 2; [37, 38]). Gobert et al. [37] reported a weak correlation between their mobility and balance test scores, and an inverse relationship between daily step count and both their 5xSTS and 4SST results. Authors of one preliminary study examined physical activity levels in boxers using an International Physical Activity Questionnaire (IPAQ; [46]). They report that their results are promising and that boxing interventions may increase moderate-intensity physical activity participation, walking time, and decrease sitting time.

Similar to mobility, several articles reported both statistically and non-statistically significant improvement in walking velocity, distance, and endurance at 8 [51], 12 (n = 5; [10, 19, 20, 23, 27]) and 24 weeks [20] of participation. Additionally, Shearin et al. [10, 23] measured the effects of boxing on backwards walking, stride length, cadence, self-selected gait speed, and dual task walking in which they found statistically significant improvement after 12 weeks. Three studies [3, 36, 41] found that after 6-12 months there were non-statistically significant improvements and positive trends in self-selected and fast-walking velocity, gait symmetry and endurance.

**Table 2-3: Outcome Count Table**

Article	Mobility	Gait	Balance	Quality of Life	Participant Experience	Depression	Apathy	Cognition	Sleep	Falls	Strength	Fine Motor Skills	Coordination
[1] Ketigian et al., 2022				•	•	•							
[2] Meyer et al., 2022											•		
[3] Sonne et al., 2022	•	•	•										
[4] Brunet et al., 2021					•								
[5] Hermanns et al., 2021			•	•	•	•							
[6] Horbinski et al., 2021		•	•							•			
[7] Larson et al., 2021				•		•	•	•	•	•			
[8] Moore et al., 2021			•							•			
[9] Sangarapillai et al., 2021		•		•									
[10] Shearin et al., 2021		•											
[11] Borrero et al., 2020					•								
[12] Dawson et al., 2020	•			•	•				•				
[13] Humphrey et al., 2020					•								
[14] Urrutia et al., 2020	•					•			•				
[15] Domingos et al., 2019					•								
[16] MacCosham et al., 2019					•								
[17] Clack et al., 2017				•									
[18] Sheehy et al., 2017					•								
[19] Combs et al., 2013	•	•	•	•									
[20] Combs et al., 2011	•	•	•	•									
[21] Blacker et al., 2021				•					•				
[22] Benoit et al., 2020			•	•							•		
[23] Shearin et al., 2020		•	•								•	•	
[24] Ghaffar et al., 2019				•		•		•					
[25] Ghaffar et al., 2019								•					
[26] Pino et al., 2019	•		•	•									
[27] Larson et al., 2018	•	•	•	•						•			
[28] Riemann et al., 2017				•				•			•		•
[29] Denney et al., 2016	•		•										
[30] Domingos, 2016					•								
[31] Combs et al. 2013		•											
[32] Patel et al., 2022				•		•	•						
[33] McLeod et al., 2019								•					
[34] Meinert & Hatkevich, 2019					•								
[35] Clack et al., 2017			•	•				•			•		•
[36] Seibert et al., 2017	•	•	•	•								•	
[37] Gobert et al., 2021	•	•	•	•					•		•		
[38] Gobert & McDowell, 2020	•	•	•								•		
[39] Denney et al., 2019	•		•			•			•				
[40] Pascal, 2018													•
[41] Pascal et al., 2018		•	•										
[42] Shearon et al., 2018								•		•	•		
[43] Foster et al., 2019			•		•						•		•
[44] Diehl et al., 2011			•	•							•		
[45] Hall et al. 2022		•	•										•
[46] Henige et al., 2022	•												
[47] Sloane, 2022					•								
[48] Ricossa et al., 2021				•	•								
[49] Bignal, 2020					•								
[50] Hoime et al., 2018		•	•	•				•		•	•		
[51] Bunyan et al., 2017		•	•	•					•		•		

One article reported self-perceived gait improvement in individuals who have been participating for up to eight years [45]. Gobert and McDowell [38] indicated a significant relationship between exercise dosage and outcome variables. In contrast, Sangarapillai et al. [9] did not detect a significant change after 10 weeks. Additionally, Combs et al. [31] did not report a greater fast walking speed or walking function in boxers in comparison to non-boxers despite seeing greater comfortable walking speed in boxers. Hoime et al. [50] reported varied results with many participants declining in comfortable and fast walking speed, while some showed improvement in backwards walking speed. Furthermore, Horbinski et al. [6] found no variance in normal walking speed, ability to walk in a straight line or backwards walking throughout their longitudinal study. Only one article failed to report their gait outcomes [37]. Several articles assessed gait parameters by using the 6MWT (n = 4; [19, 20, 31, 50]), the 10 Metre Walk test (n = 5; [3, 27, 31, 38, 51]) as well as GaitRite (n = 3; [19, 20, 50]), Zeno Walkway mats (n = 4; [9, 10, 23, 41]) and a self-reported questionnaire [45].

#### *2.3.8.2 Balance and Falls*

Balance was measured in 23 articles [3, 5, 6, 8, 19, 20, 22, 23, 26-29, 35-39, 41, 43-45, 50, 51]. Overall, the results were largely positive as most articles demonstrated either statistically or non-statistically significant improvements in balance from 11 weeks to 18 months (n = 13; [3, 5, 6, 8, 19, 20, 23, 26, 27, 29, 36, 43, 44, 50]). Others indicated no change after 8 weeks [51] and 9 months [41]. Hall et al. [45] reported that only 50% of participants experienced improved balance. Similarly, both Combs et al. [19] and Diehl et al. [44] indicated that the Berg Balance Scale (BBS) scores improved after 12 weeks, while the Activities Confidence Scale (ABC) and Functional Reach Test (FRT) scores did not. Gobert and McDowell [38] did not specify their findings apart from indicating a dosage relationship with their outcome variables as previously mentioned. Clack et al. [35] and Riemann et al. [28] only noted an improvement in physical functioning. Foster et al. [43] indicated a general improvement in balance for some participants after six months of Rock Steady Boxing training. The rest of the articles did not specify their balance findings [22, 39]. Measures of balance such as the Fullerton Advanced Balance scale (FAB; n = 5; [3, 5, 8, 22, 43]), BBS (n = 4; [19, 20, 27, 44]), ABC (n = 3; [44, 19, 20]), FRT (n = 3; [6, 26, 44]), Single Leg Stand (SLS; n = 3; [6, 37, 38]) and MiniBESTest (n = 2; [26, 50]) were commonly used. Less common balance scales consisted of the 4SST (n = 2; [37, 50]), the Romberg and Unipedal stance tests (RT & UT, respectively; [26]), the Modified Clinical Test

of Sensory Interaction and Balance (mCTSIB; [28]), the Sit and Reach test [43], TUG [43], and a self-reported questionnaire [45].

With regards to falling frequency and risk, several articles assessed fall risk using TUG ( $n = 3$ ; [8, 42, 50]) and found a decrease in fall risk for some of their participants after almost 3 months [50] and 6 months of boxing [8]. One study reported no change in fall risk, but the length of boxing intervention was not specified [42]. Similarly, Larson et al., [27] reported a slight decrease in fall frequency using the Fall Efficacy Scale I (FES-I). These results were reflected in a survey study that reported falls decreasing by 87% during the boxing program, doubling after COVID-19 lockdowns, and decreasing again after the program re-started [6].

#### *2.3.8.3 Quality of Life*

Quality of life (QoL) was commonly studied in the boxing literature, as it was included in 21 articles [1, 5, 7, 9, 12, 17, 19, 20-22, 24, 26-28, 32, 35, 37, 44, 48, 50, 51]. Most results were overwhelmingly positive between 6 and 12 weeks ( $n = 12$ ; [5, 7, 9, 12, 17, 19, 20, 26, 27, 37, 44, 51]). In their cross-sectional study, Ketigian et al. [1] presented good overall QoL for participants in virtual and in-person forms of boxing. One study found improvements after 24 weeks of boxing participation, however classes occurred only once a week [24]. Hoime et al. [50] reported that only 50% of participants improved their scores after 11 weeks of training, however they also held only one class per week. Furthermore, Clack et al. [35] and Riemann et al. [28] only described a correlation between QoL and cognitive and physical improvement. A minority of studies reported opposing results. One published article demonstrated a slight but significant increase in pain after 16 weeks, but this was shown only in participants new to exercise [12]. Additionally, Patel et al. [32] demonstrated no improvement in QoL even after 12 weeks of training. Three articles did not report their findings [21, 22, 48]. The most common QoL assessments used were the Parkinson's Disease Questionnaire-39 (PDQ-39;  $n = 14$ ; [1, 5, 7, 9, 17, 22, 24, 26-28, 32, 35, 48, 50]), and the Parkinson's Disease Quality of Life questionnaire (PDQL;  $n = 3$ ; [19, 20, 44]). Other assessments included the 36-item Short Form survey (SF-36; [51]), Parkinson's Disease Questionnaire-8 (PDQ-8; [37]), Schwab & England Activities of Daily Living scale (SE-ADL; [32]), and the Euroqual-5D (EQ-5D; [12]).

#### *2.3.8.4 Participation Experience*

Nine articles involved qualitative methods in the form of one-on-one interviews, focus groups, and observations [4, 5, 11, 13, 16, 18, 34, 47, 49]. Several articles also identified their

studies as being led by various qualitative methodologies such as phenomenology (n = 3; [11, 13, 16]), ethnography [47] and interpretative phenomenological analysis [18]. One article reported that participants feel empowered when the programs give them choice, offer opportunity for input, adapt to their needs, and support an encouraging social environment [4]. Another article outlines that the socialization aspects, such as collaborative teamwork, encouragement from other participants, and instruction from coaches were valuable features of the program [5]. Borrero et al. [11] found that a sense of determination, social engagement with other PwP, and purpose in life gave meaning to their participation in a community-based boxing program. Humphrey et al. [13] found two similar themes; “*The people I’ve met here and spent time with will be friends forever.*”, and “*I don’t have to be Muhammed Ali. It’s not about that.*” (p. 4). These themes highlighted that social connectedness and the physical, emotional, and cognitive benefits experienced in boxing programs factors greatly into their decision to continue participation. In MacCosham et al. [16], participants perceived their physical capabilities to be improving, related to and felt supported by other boxers, and experienced increased concentration. Meinert and Hatkevich [34] found that participants felt an improvement in speech production, comfortableness in social engagements, mood, role function in relationships, overall health, well-being, social connectedness, and relationships. Likewise, Sloane [47] described the culture within the boxing gym to be one of community, support, and resilience and Bignal [49] found that boxing impacted psychological well-being, the participant’s sense of community, and the participant’s daily routine in positive ways. Finally, Sheehy et al. [18] found three main themes: “*Reticence Evolving to Inspiration*”, “*Anxiety Relief and Breaking Taboos*”, and “*Maintaining Athletic Identity through Participating and Helping Others*” when interviewing boxing participants (p.290, 294, & 297 respectively). These themes describe how individuals felt reserved about their diagnosis and anxiety towards joining a PD-specific exercise program. However, they later found relief and comfort from the comradery in the community, as well as the ability to break taboos and maintain an athletic identity through their physical accomplishments and involvement in the class.

Four articles assessed participation experience through surveys, where the majority of responses indicated enjoyment, improved symptoms, and satisfaction within the boxing programs [1, 12, 15, 30]. One article used anecdotes from caregivers and trainers to describe how the participants were more positive, outgoing, and enjoyed social events [43]. Finally, one study

protocol presented with the objective to understand the experience of the fine-motor aspects of boxing program and how it relates to daily life, however the investigative methods or qualitative methodologies were not specified [48].

#### *2.3.8.5 Strength*

Strength was included in a total of 11 articles [2, 22, 23, 28, 35, 37, 38, 42, 43, 50, 51]. Each study that included results reported improved strength post-intervention. Some articles used observational tests such as TUG [22] and Sit to Stand (STS;  $n = 3$ ; [23, 42, 50]) to assess lower extremity functional strength, while others used machine testing like isokinetic testing equipment [28] or dynamometers [51]. One study used the Davies Test [43]. In relation to specific muscle groups, one study examined the impact of a single boxing session on upper extremity muscle activity, specifically the biceps brachii and triceps brachii, finding immediate improvement on tri-cep efficiency [2]. One article did not specify their means in testing strength and reported a slight general improvement in physical functioning [35]. Grip strength was also assessed and found to improve after boxing interventions, however the assessment was not specified [37, 38].

#### *2.3.8.6 Fine Motor Skills and Coordination*

Fine-motor skills and coordination were included in a total of seven articles [23, 28, 35, 36, 40, 43, 45]. Of the two studies that looked at fine-motor skills, only one study indicated improvement [36]. However, this study did not specify its assessment measures, while the other study used the 9- Hole Peg test [23]. Foster et al. [43] tested both fine and gross motor coordination with the use of the Purdue Peg Board test and Jump Rope test, respectively. They reported improvement for some participants at the end of six months. Riemann et al. [28] discussed their use of the Point Click test to measure hand-eye coordination and presented a result of generic improvement. This same result was reflected in Clack et al. [35], although the measurement used was not specified. Hall et al. [45] used self-reports in which 94% of participants indicated their coordination improved through boxing program participation. Additionally, one study used Dance-Dance Revolution™ to assess the impact of boxing training on stepping reaction time [40]. They found that individuals with a Hoehn-Yahr score of 1-2 improved in overall game score, step count and accuracy, while individuals in the later stages only improved in accuracy.



### 2.3.8.7 *Mental Health, Cognition, and Sleep*

Other less commonly examined outcomes involved depression, apathy, cognition, and sleep. Seven articles considered depression in their measurements and five of these studies found that depressive symptoms decreased after 6 (n = 2; [14, 39]) and 12 weeks of training (n = 3; [5, 24, 32]). PwP have also indicated a decrease in depressive symptoms and low depressive scores in two survey studies [1, 7]. Depression assessments included the Hamilton Depression Rating Scale (HDRS; n = 3; [14, 32, 39]), the Patient Health Questionnaire (PHQ-9; n = 2; [2, 24]), and the Centre for Epidemiological Studies Depression scale (CES-D) [5]. Additionally, Larson et al. [7] and Patel et al. [32] looked at apathy using tests such as the Starkstein Apathy Scale (SAS) and the Lilli Apathy Rating Scale (LARS) respectively but found little difference between boxing and non-boxing participants, or no change at all.

Cognition was considered as an outcome in only eight articles [17, 24, 25, 28, 33, 35, 42, 50]. The results from two studies indicate improvement in cognition in 30% [50] to 50% of participants [17]. Two studies reported improvements but did not specify the amount of participants that showed these improvements [33, 42]. Another two studies found that cognition positively correlated with improvements in physical functioning and quality of life [28, 35]. One study examined procedural learning through assessing reaction time in boxers and non-boxers [25]. They found that the boxers reaction time in response to random stimuli was faster than the non-boxers. One study did not specify its findings [24]. Cognitive assessments included Montreal Cognitive Assessment (MoCA; n = 2; [24, 42]), Scales for Outcomes in Parkinson's Disease-Cognition (SCOPA-COG; n = 3; [17, 28, 35]), Serial Reaction Time Task (SRTT) [25], and TUG-C [50].

Sleep and fatigue were examined in seven articles [7, 12, 14, 21, 37, 39, 51]. Several intervention studies indicated positive impacts of boxing programs on day-time sleepiness, sleep quality [14, 39] and fatigue [51]. Two studies investigated fatigue through surveys and found that 63.3% of current boxers self-reported better sleep and less fatigue than past boxing attendees [7] and that 57% of participants reported less fatigue after a 16-week boxing intervention [12]. Two studies used quality of life scales [21] and activity trackers [37] to investigate the impact on sleep patterns but did not specify their findings. The Parkinson's Disease Sleep Scale (PDSS) and Epworth Sleep Scale (ESS) were both used in two articles [14, 39] to assess sleep quality, and one article utilized the multidimensional fatigue inventory to assess fatigue [51].

#### 2.3.8.8 *Vocal Abilities*

Finally, one qualitative article set out to determine the impact of non-contact boxing programs on speech mechanisms [34], despite lacking a description of vocal exercises in their boxing program. Participants described experiencing a positive impact on speech, but the researchers did not provide detail as to which specific areas of speech were improved.

## 2.4 Discussion

This scoping review investigated recent literature pertaining to the impact of boxing interventions for individuals with PD. The United States has dominated research in this area since 2011, just five years after Rock Steady Boxing began in Indianapolis (Combs et al., 2011; Rock Steady Boxing, n.d.). However, studies are still emerging from Canada, Australia, UK, Portugal, Sweden, and Chile. There is currently a wide range of study designs within the published literature investigating boxing as an intervention for PD, but a notable subset within this literature is comprised of qualitative studies. As qualitative methods continue to be applied to the study of boxing in PD, a qualitative meta-synthesis may also be appropriate. For now, quantitative results indicate positive impacts on both motor and non-motor symptoms of PD, suggesting the feasibility of offering boxing programs as an alternative exercise for PwP. As virtual boxing programs are now more accessible, there is a need for future qualitative literature to examine the experiences of PwP within remote boxing programs.

As aerobic exercises and strength training have been extensively studied in the literature, official recommendations have been made for PD exercise programs outlining the intensity, frequency, and duration of those programs (Gallo & Mendola, 2018). However, for alternative exercises, such as boxing, specific guidelines are yet to be solidified. The majority of included journal articles ran programs two to three times per week, which is the recommended frequency for traditional exercises (Gallo & Mendola, 2018). However, Ellis & Rochester (2018) postulate that the optimal dose of exercise may depend on the severity of disease. Even though many participants included in this review had mild-moderate disease symptoms, optimal exercise dosing and workout frequency for individuals with advanced PD in boxing programs is yet to be explored. Apart from two studies that assessed participants after a single boxing session [2, 42] the minimum program length included was six weeks, which may be too soon to record gait and

mobility improvements. Most programs, however, ran for 12 weeks and showed improvement at post-program assessments. This is in line with previously studied alternative exercises such as Tai Chi, dance and yoga that described positive effects after 12 weeks (Ni et al., 2018). Traditional cardio and strength training takes four to 12 weeks in order to see physical benefits, but it is recommended that activities from both kinds are integrated into one's weekly physical activity (Ni et al., 2018). As boxing training generally includes a variety of activities, these programs may be well-equipped to incorporate several exercise modalities such as cardio, strength, and balance training into one program (Combs et al., 2011). This is demonstrated in the literature as many boxing programs incorporated cardio and agility (n = 22; [1-4, 10-12, 16-20, 22, 23, 28, 35, 37, 38, 42, 44, 47, 50]), strength and resistance training (n = 20; [3-5, 8, 10-12, 16-20, 23, 28, 35, 42, 44, 50, 51]), and balance and core exercises (n = 7; [1, 4, 5, 12, 16, 42, 47]). Currently, it is not advised for alternative exercises to replace traditional exercise (Gallo & Mendola, 2018). However, if boxing programs can incorporate several exercise modalities and provide similar advantages to traditional exercise, it is conceivable that it could be a viable substitute for traditional exercise.

Mobility, gait, and balance are the most studied physical outcomes in the literature to date, as they comprise the majority of peer-reviewed and grey literature. This emphasis reflects the severity of these impairments in PD populations (Halliday & McCann, 2010). The deterioration of mobility and balance is a major precursor to falling (Creaby & Cole, 2018; Grabli et al., 2012; Park et al., 2015). As Grabli et al. (2012) describes, "falls are a major milestone in the evolution of PD" (p. 3). Falling may accelerate the severity of the disease by increasing sedentary behaviours, the frequency of hospitalizations, and may ultimately reduce quality of life (Aarsland et al., 2009; Creaby & Cole, 2018; Grabli et al., 2012). Furthermore, falling once increases the likelihood of falling again (Grabli et al., 2012). Therefore, improving and assessing mobility are especially important. This review indicates that boxing interventions produce promising effects on mobility, as all but two articles that assessed this physical parameter indicated improvement.

Walking speed also appears to be a major predictor of falls in PwP as it relates to the necessity of gait shuffling to maintain a stable posture while moving (Creaby & Cole, 2018; Grabli et al., 2012). Improvements to walking speed may decrease fall frequency (Shen et al., 2016). In three reviewed articles, walking speed generally improved by 12 to 24 weeks [10, 19,

20] and one study presented a positive trend throughout their 6-24 month trial [3]. The grey literature also reported improvement in comfortable [31], self-selected [23], and fast walking speed [41]. Each of these studies (except for Combs et al. [31] who did not specify their activities) included cardio and strength exercises in addition to boxing drills. These findings relate to a study implementing Nordic walking, another alternative exercise (Reuter et al., 2011). This study compared three exercise programs over six months; two involved cardio (walking uphill) along with strength exercises for PwP, and one involved stretching exercises and focused exclusively on flexibility training. They reported a significant decrease in fall predictors such as gait variability and gait speed in the walking groups, but not in the stretching groups. This may speak to the importance of including cardio and strength training within specialized programs to improve these parameters.

Outlining the possible effects that boxing interventions may have on balance is also an important consideration in decreasing the risk of falls. All the published articles that included balance assessments reported improvement by the end of the program. However, results from the grey literature were less cohesive – although many articles indicated improvements, several articles indicated no change. Due to the lack of program details in many of the grey literature articles it is difficult to pinpoint a reason for why these discrepancies exist, but there are several possibilities such as differences in workout structure, time, frequency, and assessment frequency. Improving and maintaining balance is integral to sports in general, but boxing itself involves fast, dynamic movements, such as punching, which requires stability during trunk rotation (King & Horak, 2009). Five peer-reviewed studies [1, 4, 5, 12, 16,] had additional balance and core activities incorporated into their boxing classes but only one of these five specifically assessed for balance, finding that the majority of participants improved [5]. Sporting activities that focus on improving balance and posture may be a particularly beneficial option for PwP, especially as postural instability symptoms worsen during the disease and are not targeted by pharmaceuticals (Bloem et al., 2001).

Falling frequency itself was not a common outcome measurement. Only five articles in total looked at fall frequency [27] and fall risk [6, 8, 42, 50] with each showing an overall decrease in falls after the programs, except for Shearon et al. [42] who showed no change. None of the other studies reported falls during their programs. This may further demonstrate the mobility benefits attributed to boxing programs, but it may also be due to a lack of attention to

falls outside of class. Future boxing program studies should focus on fall frequency within and outside of the programs. Furthermore, fall frequency increases with disease severity, as gait and balance impairments intensify (Allen et al., 2013). In all included studies, the majority of participants were in the mild to moderate stages of disease (e.g. 1-3 on Hoehn & Yahr scale; (Bhidayasiri & Tarsy, 2012). Many active boxing programs are inclusive to all stages of PD and therefore, although these results look promising, more research should be done to assess the implications of boxing therapy on fall frequency with participants with more severe disease levels.

Quality of life (QoL) was also commonly studied through self-report questionnaires in peer-reviewed and grey literature. QoL is an important factor to consider as it is negatively impacted by both motor and non-motor impairments in PD (Fan et al., 2020). In particular, apathy, depression, and fatigue, significantly influence QoL (Fan et al., 2020; Zhao et al., 2021). Depressive symptoms are prevalent in almost half of PwP, and commonly goes untreated (Frisina et al., 2008; Marsh, 2013). Fan et al. (2020) has shown that the leading cause of reduced QoL was depression for individuals with mild cognitive impairments or dementia. Although most of the included studies that measured QoL reported improvement, non-motor symptoms such as depression and cognitive impairment were not as commonly examined in relation to QoL. Only four studies measured depressive symptoms alongside QoL, each reporting improvement or relatively good results [1, 5, 24, 32], and only one of those studies additionally considered cognition, although they did not report their cognitive results [24]. To further illuminate this relationship between participation in non-contact boxing and QoL, future research should investigate this impact in PwP in relation to depressive symptoms and cognitive impairments.

The improvement in depressive symptoms reported in this current review is notable, as a past review demonstrated that depression in PD did not improve with exercise in 60% of their examined articles (Lauzé et al., 2016). This discrepancy may be attributed to the lack of concurrent examination of depression, and cognition in articles included in the present review. These factors, along with anxiety and fatigue, are linked to one another, making effective treatment more difficult to achieve (Aarsland et al., 2009; Akhmadeeva et al., 2018). Therefore, as these studies did not consider the influence of these different factors, this could affect the interpretation of their results. Secondly, medication could present as a confounding variable, as

Levodopa treatments can enhance the severity of depression and anxiety symptoms (Akhmadeeva et al., 2018).

The qualitative literature also shone light on what boxing participation meant to PwP. These studies spoke of what is considered valuable in a training program, such as choice, perceived physical improvement, socialization with others experiencing PD and encouragement from instructors. Socialization seems to be particularly a highlighted and beneficial aspect to group-based exercise as it may promote longer adherence; however, it has been demonstrated in the literature that the differences in physical and mental benefit between exercising alone versus in a community are not particularly robust (Sajatovic et al., 2017; Yang et al., 2017). This indicates that community-based programs may be beneficial, but not necessary to see the same positive physical benefits. So far, the qualitative literature has examined experience within in-person settings of boxing programs. However, as a result of the self-isolation mandates during the COVID-19 pandemic in 2020, virtual boxing programs have become more prevalent. Future qualitative literature should examine the experience of virtual boxing programs for PD and examine how the experiences in in-person and virtual settings compare.

Fine motor skills and hand-eye coordination have not been commonly studied in the literature thus far, despite being included as components of several boxing programs (n = 6; [3, 5, 8, 11, 12]). In fact, there have been no peer-reviewed articles investigating either of these outcomes. The only publications that investigated these outcomes were from grey literature documents, and presented with limited data (n = 7; [23, 28, 35, 36, 40, 43, 45]). This suggests a need for more dedicated research.

Sleep disorders, including disrupted nighttime sleep, excessive daytime sleepiness, and even night hallucinations, are common consequences of both the disease and of dopaminergic drug usage (Comella, 2007). Exercise may play a significant role in improving sleep for PwP as reported in several recent studies (Amara & Memon, 2018). However, only three peer-reviewed articles [7, 12, 14] and four grey literature abstracts [21, 37, 39, 51] in this review examined the impact that boxing programs may have on fatigue, night-time sleep quality and daytime sleepiness. Two of the abstracts did not report any findings [21, 37], while the rest indicated either improvement in sleep quality, or a reduction of fatigue or daytime sleepiness. Due to the scarcity of studies focusing on sleep outcomes in relation to boxing programs for PwP, more research is needed in this area.

Interestingly, although vocal exercises were included in several boxing programs (n = 5; [5, 12, 16, 42, 47]), the impact of boxing workouts on voice control has been examined in only one qualitative journal supplement [34]. Speech complications are common and can arise as PD advances (Dashtipour et al., 2018; Guttman et al., 2003). As boxing programs can give individuals more opportunity to activate their voices while working out, this may influence speech impairments. Future research should consider the impact that boxing interventions may have on voice control and speech production in PwP.

## 2.5 Limitations

There are several limitations within this scoping review. More than half of the included literature was comprised of conference abstracts, poster presentations, journal supplements and student research projects. Due to the nature of these pieces of literature, many study details were excluded and this limited the conclusions that could be made as to the future implications of these studies. Despite this, however, these studies provided a broad insight into what has been studied in recent years and gave an idea as to which areas warrant more intensive study in future research.

## 2.6 Future Implications and Conclusion

This scoping review examined 51 studies focused on researching the impacts of boxing in Person's with Parkinson's disease. Overall, the current literature surrounding boxing interventions for PwP suggests promising benefits. Many published interventional and observational studies present with positive outcomes in terms of gait, balance, and quality of life. Future research on outcomes such as fall frequency, depression, apathy, cognition, sleep, fine motor skills, and hand-eye coordination need to be further addressed to explore and verify the benefits seen in the literature thus far. Investigations on how boxing programs impact quality of life in PwP with depressive and cognitive symptoms needs to also be further explored. Investigations on the impacts of boxing interventions on speech impairments in PwP is also warranted as the effects have not yet been quantitatively studied. The impact of boxing interventions on falling frequency is another avenue in which future boxing studies can direct their focus. More attention to 'on' periods should also be taken into consideration in future research to comprehensively understand the impact of exercise. Additionally, recommendations

for program frequency and class duration should be further solidified in relation to alternative exercises, so that guidelines may be implemented to aid program managers. Finally, individuals in the advanced stages of PD should also be considered in future boxing research as a limited number of studies included this subset of the population.



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## Chapter 3

# The Lived Experience of Virtual Boxing Programs for Persons with Parkinson's Disease – A Qualitative Study

### 3.1 Introduction

#### 3.1.1 *The Impact of Parkinson's Disease*

Parkinson's disease (PD) is a progressive neurodegenerative disorder in which mobility is severely impacted (Guttman et al., 2003). This results from the depletion of dopamine in the basal ganglia as dopaminergic neurons in the nigrostriatal pathway deteriorate (Guttman et al., 2003). The four cardinal motor symptoms of PD involve slow movements, impaired balance, non-essential tremor, and muscle rigidity (Halliday & McCann, 2010). A number of non-motor impairments are often seen in individuals with PD such as impaired sense of smell, sleep, depression, apathy, anxiety and cognitive deficits overall impacting one's quality of life (Schapira et al., 2017). As there is currently no cure for PD, pharmacological and surgical treatments target symptomatic relief to improve quality of life (Guttman et al., 2003). These treatments however, come with their own complications and side effects including dyskinesia, cognitive deficits, and complex psychological symptoms (e.g., hallucinations; Guttman et al., 2003).

#### 3.1.2 *Community-based and remote exercise programs for PD*

Exercise has been widely covered in the literature as an adjunctive therapy to help slow the progression of PD and provide symptomatic relief to motor and non-motor symptoms (Alberts & Rosenfeldt, 2020; Emig et al., 2021; Feng et al., 2020). The majority of clinical exercise interventions included in the literature reviews conducted by Feng et al. (2020) and Emig et al. (2021) are based in an exercise centre or clinical setting in which participants are led through exercises within a group. However, home-based exercise programs are of growing interest since the stay-at-home measures implemented during the height of the COVID-19 pandemic (Langer et al., 2021). The benefit of home-based exercise extends beyond the pandemic as it overcomes common barriers to participation such as travel and weather concerns (Ellis et al., 2013; Johnson et al., 2018; Schootemeijer et al., 2020). Evidence suggests that structured programs are more effective to maintain adequate levels of physical activity at home as opposed to just being physically active (Domingos, Família, et al., 2022). Despite these



positive effects of remote exercise, adherence to structured at-home programs is still a concern. In a feasibility study investigating attendance, safety and experience of a PD-specific tele-monitored exercise program, Torriani-Pasin and colleagues (2022) found that overall, the participants enjoyed having a routine for home exercise, but they missed exercising alongside other people. Additionally, attendance was much higher for individuals who had the presence of a caregiver or family member, for their safety and encouragement (Torriani-Pasin et al., 2022). In a qualitative study, Rowsell et al. (2022) found that during a 6-month home-based program, motivation to continue independent exercise decreased as the frequency of physiotherapy visits declined and they received less encouragement and feedback. As home-based exercise is increasingly available and an important option for PwP, it is worth investigating the motivation behind exercise adherence at home. Theories of motivation, such as Self-Determination Theory can help in our understanding of how to encourage compliance in at-home exercise programs.

### *3.1.3 Self-Determination Theory*

The Self-Determination theory (SDT) postulates that activities driven by autonomous motivation are most likely to be continued in the long-term. Ryan and Deci (2008) explains motivation as a spectrum, with intrinsic motivation leading to feelings of satisfaction and long-term adherence on one end, and controlled motivation often resulting in disinterest, low engagement, and low adherence on the other. Intrinsic motivation can be discerned by the amount of volition to do an activity in the absence of rewards or punishments, or the degree of enjoyment and interest an individual has in an activity (Ryan & Deci, 2000). Thus, intrinsic motivation is described as the most autonomous type of motivation in which the activity is the reward itself. On the spectrum between controlled and intrinsic motivation are different motivational regulators that influence the degree of autonomy a behaviour has. Moving from controlled to intrinsically motivated behaviours, there are external, introjected, identified, and integrated regulators. External regulators generally motivate behaviour through rewards and punishments, much like the theory of operant conditioning (Ryan & Deci, 2000). Introjected regulators function to motivate individuals to act based on the maintenance of their self-esteem. This type of motivation generally strives for feelings of pride and accomplishment, and avoids feelings of shame and guilt (Deci & Ryan, 2008). Identified regulators align with an individual's personal beliefs or values. For example, an individual can be motivated to exercise because they believe it is good for them. Integrated regulation is the internalization of identified regulators

into one's identity or sense of self. Finally, intrinsic motivation is the most autonomous form of motivation in which activities are done out of personal satisfaction or enjoyment. Ryan and Deci (2000) theorized that there are three psychological needs that must be supported in order to maintain intrinsic motivation: autonomy, competence, and relatedness. An individual's autonomy can be supported through engaging with the ideas, preferences, choices, and initiatives of other individuals (Gagne et al., 2003). Autonomy is necessary for the development of competence, in which individuals feel confident, able, and accomplished when overcoming tasks (Deci & Ryan, 2008; Ryan & Deci, 2000). Finally, relatedness can be synonymously exchanged with a sense of belonging, or connection to others with a common goal (Ryan & Deci, 2000). This important component facilitates internalization, the process of an individual adopting values that they were not inherently motivated to adopt previously.

SDT is particularly useful in research on physical activity, and is commonly applied within this research domain (Deci & Ryan, 2008; Manninen et al., 2022; Quinn et al., 2020; Ryan et al., 2007, 2009; Teixeira et al., 2012). Through a systematic review and meta-analysis on the impacts of SDT-based exercise interventions, Manninen et al. (2022) found small heterogeneous effects on the improvement in identified regulation and intrinsic motivation and slight decreases in external regulation and amotivation in individuals who participated in SDT-based exercise programs. The mix of results found in this study could be accredited to the variety of different ways in which the studies discerned which practices in their programs were SDT-based, and the small sample sized articles. Similarly, Teixeira et al. (2012) found a positive correlation between autonomous motivation and exercise behaviour. These researchers also found that certain motivations might be inherently tied to specific motivational regulators. For example, health is more likely an identified regulator whereas beauty is more likely an introjected regulator. The type of motivation can also be influenced depending on the individual. Athletes may find physical activity more enjoyable or satisfying, and thus intrinsically motivating compared to other individuals. In this case, it is possible that PwP have identified regulation influencing their decision to join exercise programs as they personally value its impact on their symptoms and the health benefits. Teixeira and colleagues (2012) also noted that exercise for health is treated as more of a clinical prescription, focusing on organized programs as opposed to sporting activities. Engaging in sport activities as opposed to exercise programs for physical activity can be more influenced by autonomous motivation (Ryan et al., 2009). Perhaps

embracing sport activities as viable options for PD-specific physical activity may promote intrinsic motivation as there are enjoyable elements to sports.

The sport of non-contact boxing was introduced in 2003 as an alternative exercise for PwP by Scott Newman in a program titled Rock Steady Boxing (Rock Steady Boxing, n.d.). Since 2011, research surrounding non-contact boxing exercise on motor and non-motor symptoms of PD has been growing (Combs et al., 2011). Most published studies have been looking at quantitative measures of motor outcomes such as mobility, gait, balance, strength, and fall frequency, as well as non-motor outcomes such as quality of life, sleep, apathy and depression (Clack et al., 2017; Combs et al., 2011, 2013; Dawson et al., 2020; Hermanns et al., 2021; Horbinski et al., 2021; Ketigian et al., 2022; Larson et al., 2021; Meyer et al., 2022; Moore et al., 2021; Sangarapillai et al., 2021; Shearin et al., 2021; Sonne et al., 2021; Urrutia et al., 2020). A number of qualitative studies have also been conducted to understand the experience of engaging in boxing programs for PwP (Borrero et al., 2022; Brunet et al., 2022; Hermanns et al., 2021; Humphrey et al., 2020; MacCosham et al., 2019; Sheehy et al., 2017). One qualitative study in particular focused on identifying different aspects of the boxing program that influenced their participant's motivation, using the Self Determination Theory as the lens in which they analyzed their results (Brunet et al., 2022). As they discerned their participant's motivation to attend boxing class to be self-determined, they found that four factors influenced this type of motivation. These four factors involved feeling the physical benefits from the program, having access to variety and their input surrounding class activities validated, having individualized and tailored exercises, and receiving social support. Feeling the benefits of physical activity and having access to a variety of different exercises weren't associated by the authors to the three psychological needs but were nevertheless important contributors to their participant's motivation. The authors did identify, however, that by validating input, tailoring exercises, and providing a strong social network within the boxing program, the needs of autonomy, competence and relatedness, were fostered respectively. Although other qualitative studies didn't specifically analyze their data with a SDT lens, these themes have also been identified (Borrero et al., 2022; Hermanns et al., 2021; Humphrey et al., 2020; MacCosham et al., 2019; Sheehy et al., 2017). Each of these studies, however, examined the experiences of boxing programs within community-based in-person settings. Thus, the experience of virtual boxing programs and how it compares to in-person experiences remains to be explored.

### 3.2 Research Aim

Current literature includes qualitative studies aimed at understanding aspects of experience in non-contact boxing programs for PwP, but there is a lack of research exploring the experience of group home-based exercise programs and virtual boxing programs for PwP. Therefore, our main research aim was to understand the participant experiences of PwP participating in virtual Rock Steady Boxing. Furthermore, we also wanted to understand the ways in which the psychological needs of autonomy, competence, and relatedness were experienced or supported in the virtual setting.

### 3.3 Methods

As our research team comes from an epistemology of post-positivism, we understand that every contributor in a research project (i.e., the researchers, research assistants, and participants) brings with them a different assumption, worldview, and interpretation influenced by theory and past experiences. As such, the definitive truth of an experience may be closely resembled, but never fully illuminated (Guba & Lincoln, 1994). Within the current investigation, we wanted to not only understand the lived experience of PwP in virtual Rock Steady Boxing (vRSB), but to understand how the virtual setting impacts influences of motivation previously researched in the in-person settings of RSB. As our understanding, and thus our interpretation of motivational influences was informed by the SDT, the methodology of Interpretive Phenomenological Analysis (IPA) was well aligned with the purpose of this study.

IPA is a branch of phenomenology that seeks to understand an individual's experience of a phenomenon, and how that individual makes sense of their experience. This is done through an integration of the participant's experience with the researcher's interpretation of that experience (Smith et al., 2021). In comparison to Husserl's original conception of phenomenology that separates experience from the essence of a phenomenon, IPA describes the experience *as* the phenomenon (Smith, 2018). Furthermore, IPA is heavily influenced by the theory of interpretation and symbolic interactionism, acknowledging that an individual's experience of a phenomenon is inseparable from their interpretation, and that personal meaning attributed to an experience is both influenced and malleable (Biggerstaff & Thompson, 2008; Smith et al., 2021). The theory of interpretation is particularly representative in Heidegger's branch of

phenomenology in which being and time are united to the conceptualization of an experience (Smith et al., 2021).

With the addition of appreciating individual and flexible meanings, IPA requires careful and intentional involvement of the researcher's presuppositions and theoretical understandings to tease out the participant's reflective experience, patterns of cognitive appraisals, and meaning-making strategies. This greater focus on reflective experience, as opposed to pre-reflective experience, may be argued by some to not be truly phenomenological (van Manen, 2017). However, investigating an individual's reflective and interpreted experience still greatly contributes to the understanding of phenomena in the context of social cognitions and external influences (Smith et al., 2021). The product of an IPA may be considered to be doubly hermeneutic, as the researcher is making sense of the individual making sense of their experience. As mentioned previously this interpretation is intrinsically linked and informed by the researcher's presuppositions and theoretical lenses. In the case of the present study, our understanding of motivational influences was informed by the SDT.

To uncover these aspects of an individual's experience, the researcher must rigorously analyze the participant's experience. This motivates IPA studies to be idiographic, focusing on the experiences of a limited number of individuals. These in-depth and detailed analyses need a considerable amount of devoted time. Therefore, for this study we aimed to recruit three to eight participants. Prior to recruitment, our study was submitted to the Western Research Ethics Manager (WREM) for ethics approval. A copy of our ethics approval certificate can be found in Form B-1 of the appendix. Following ethics approval, our recruitment ad was distributed through the Parkinson's Society of Southwestern Ontario electronic newsletter. Within this ad, individuals were given a description of the study with a link to our letter of information and consent, and an eligibility quiz operated by a university-hosted Qualtrics survey platform. Individuals were included if they had participated in a minimum of two classes of in-person Rock Steady Boxing and two classes of virtual Rock Steady Boxing, if they received a PD diagnosis from a physician, if they were older than 18 years of age, and if they were fluent in English. Our aim with these criteria was to gain unique perspectives of individuals who had experienced both virtual and in-person settings, and thus made comparisons (both conscious and subconscious) between the two. It was expected that these criteria aided in gathering a

homogenous group of participants, an important consideration for IPA recruitment (Smith et al., 2021).

Individuals who met the eligibility criteria were then contacted by the research team (LNM, AMJ) either via email or phone to schedule an interview. The virtual setting of RSB in areas of Southern Ontario was typically hosted online using video conferencing technology such as Zoom™, with sessions typically ranging from one hour to an hour and 15 minutes, while the in-person sessions were typically held in community and boxing gyms with sessions ranging from one to one and a half hours (*About Rock Steady Boxing, 2023; Health Management - Rock Steady Boxing, 2023*). To maintain coherence with the context in which the virtual setting was experienced, interviews were conducted using a university-hosted Zoom™ platform. Each interview was semi-structured and aimed to last 60-90 minutes. Questions ranged from the general to the specific and touched on aspects of experience such as the impact of vRSB on home-life, social life, and motivation to exercise. The full annotated interview guide is presented in Form B-2 of the appendix.

The interviewers (LNM, AMJ) practiced memoing throughout the interviews to document tacit moments, to make note of concepts that may need further probing, and to record discussion points to bring up with each other post interview. The interviewers engaged in reflexive writing to discern and note any pre-conceptions after each interview. Data analysis was carried out by one research team member (LNM) through a seven-stage process guided by the principles of IPA, as outlined by Smith et al. (2021). The first stage of analysis involved a read through of each interview in its entirety. The second stage involved a second read-through as the researcher attributed codes to small units of data. Coding is not typically done in IPA (Smith et al., 2021) and the codes produced were not specifically used during analysis. However, taking an extra step to code the transcripts encouraged an additional critical read through of each interview and enabled the research team member to categorize aspects of the interviews to better navigate the transcripts. The third stage involved a third read-through as the researcher created line-by-line exploratory notes made up of ideas, thoughts, reflections, and comments about the data. Read-throughs of each interview were important to repeat throughout the first three stages of analysis to facilitate and reinforce immersion within the material and allow the researcher to better focus on the participant's point of view. During the fourth stage of analysis, the researcher collected, read through, and summarized the exploratory notes and their meanings within their

local context of the transcript to create broader experiential statements. These experiential statements were then collected in the fifth stage and were compared, connected, and summarized into larger themes termed personal experiential themes (PETs). In the sixth stage, the PETs from each participant were then collected, and compared with one another to tease out larger themes seen across the interviews, termed group experiential themes (GETs). These GETs are then laid out with their relevant sub-themes and quotations to clearly demonstrate the converging and diverging experiences and perceptions seen in the data. Throughout the analysis phase, reflexive journaling was practiced to better understand the interpretations and influences the researcher was bringing to the study. The PET's and GET's were then presented to the other research team members for review.

### 3.4 Credibility

The credibility of this study was upheld in several ways. First, IPA highly encourages a close analysis of every participant perspective and how they make meaning of their experiences. Therefore, a thick description of each participant's individual experiences was included. Furthermore, as IPA studies aim to be steeped in context, coherent purposive sampling is of high importance (Smith et al., 2021). The individuals recruited for this study experienced both in-person and virtual formats in order to share their experiences of both settings (to facilitate comparisons between modalities). To follow this coherently in our methods, we interviewed individuals using the same online platform in which they engaged in vRSB.

### 3.5 Results

A total of six participants agreed to participate in semi-structured interviews for this study. To maintain confidentiality during transcription and analysis, each participant was given a participant number ranging from one to six (e.g. P#). All but one participant were female, and the ages ranged from 58 to 72 years of age. A summary of the participant characteristics can be found in **Table 3-1**. Three general exploratory themes (GETs) were uncovered that focused on the individual, physical and social dimensions of the participant's experience of virtual Rock Steady Boxing. The title of these themes and their sub-themes are identified in **Table 3-2**.

**Table 3-1: Participant Characteristics**

Participant	Gender	Age	Time Since Diagnosis	Time in RSB and vRSB	Current Enrolment
P1	Male	66	~8 years	~5 years	RSB
P2	Female	58	2 years	~1 year	RSB + vRSB
P3	Female	72	5 years	~4 years	RSB + vRSB
P4	Female	61	8 years	~6 years	None
P5	Female	66	7 years	~6 years	RSB + vRSB
P6	Female	61	3.5 years	~3 years	RSB + vRSB

### 3.5.1 GET #1 – Individual Experience - IN THE RING WITH PD

Living with PD is a difficult experience that adds significant challenges to one's life – both at the time of diagnosis and afterwards. PD adds physical and emotional burden, and simultaneously takes away one's sense of control over their body and social activities. In the experience of our participants, pharmaceutical and surgical advances have helped with some aspects of their symptoms, but the unpredictability, short-term action, and side effects make them difficult to rely on. This pushes the participants towards a desire to commit to physical activity as an adjunctive therapy. They feel a need to participate in exercise in order to equip themselves to fight against PD for their quality of life. Both the in-person and virtual formats of Rock Steady Boxing (RSB) are valued as important contributors to their battle as it provides for them high intensity exercise. This is demonstrated by the frequent participation (in both settings) by participants, as well as the fact that participants sought out boxing activities outside of class. The virtual setting of RSB allows participants to engage in this valued exercise at home - independent of travel concerns and weather constraints. Even as in-person classes were made available, many of our participants continued in both formats to increase their participation frequency. This drive to engage in Rock Steady boxing means that RSB becomes an apt metaphor for participant ideation about the illness; to wit, 'In the Ring with PD'



**Table 3-2: Themes and Sub-themes**

GET	Type of Theme	Title of Theme	Subthemes
#1	The Individual Experience	<i>In the Ring with PD</i>	<ul style="list-style-type: none"> <li>• What PD gives and takes</li> <li>• The importance of physical activity as an adjunctive therapy to medication</li> <li>• The perception of RSB and vRSB as valuable physical activity</li> <li>• Freedom experienced in vRSB</li> <li>• Freedom in vRSB contingent on technology</li> </ul>
#2	The Physical Experience	<i>vRSB Impacts Intensity</i>	<ul style="list-style-type: none"> <li>• Overcoming difficulties in the beginning with dedicated participation</li> <li>• The physical benefits from RSB effects more than PD symptoms</li> <li>• Classes were individual in intensity</li> <li>• The home setting with limited space and equipment impacts physical improvement</li> <li>• Despite its downfalls, there are physical benefits in vRSB</li> </ul>
#3	The Social Experience	<i>vRSB Limits Social Interactions in Positive &amp; Negative Ways</i>	<ul style="list-style-type: none"> <li>• Community and Support Felt in RSB</li> <li>• Seeing others work hard inspires hard work</li> <li>• Friendship in RSB</li> <li>• The virtual setting maintained connections during times of social isolation</li> <li>• One-on-one personal contact is needed for deeper connections</li> <li>• The impact of limited social engagement</li> <li>• Distant coaching limits personal instruction, accountability and challenges socializing within the class.</li> <li>• The virtual setting limited the negative aspect of socializing with other PwP</li> </ul>

### 3.5.1.1 What PD gives and takes

The experience of being diagnosed with PD brought difficulty and emotional burden into the lives of the participants. Anxiety became particularly debilitating, impacting the lives of several of our participants and being deemed one of the worst symptoms they endured. For example, P1 noted:

*“I get severe anxiety attacks, you know, till it was dealt with medication. That was my worst. The anxiety was like debilitating. Like mentally, physically. You know, that’s what the most, the one I hate the most.”* (P1 – 02:22)

For P3, this diagnosis wasn’t expected. PD originally manifested in her life through frightening episodes of choking in her sleep, which ultimately led to a diagnosis of a PD. While her social life remained unaffected by the diagnosis, P3 continues to live with the disappointment of receiving the PD diagnosis.

*“I woke up choking a few times...it was frightening and [the doctor] thought I had sleep apnea...They found that my muscles didn’t relax...I was told that can be a sign of neurological disease”* (P3 – 01:05)

*“Psychologically I mean, it’s always a disappointment \*chuckles\* to me ‘ah I gotta live with this’.* (P3 – 02:31)

For others, PD was experienced as a separate entity that slowly took away physical and social control. P4 describes her experience with PD as her body having a ‘mind of its own’, making social situations difficult as P4 couldn’t predict how her PD symptoms would manifest and be perceived by others.

*“I just felt like it is sort of like your body has a mind of its own. Because I couldn’t control it socially, you know, we’d go out, but not as much as I would have liked to, like, we go out with our friends and it was always like, OK, how is this going to go?”* (P4 – 02:14)

Similar to P4, P1 described how PD determines his social windows. He is limited to socializing within the time that his medication is working, as his symptoms make it increasingly difficult to do otherwise.

*“I kind of try to make a point of not having, socializing the least amount because I find communicating difficult when...I’m off the medication or I’m on an off-period.”* (P1 – 03:18)

This is echoed in P5’s description of her experience with tremor and rigidity as infiltrating her day-to-day. Commonly daily tasks such as computer work are referred to as situations that her tremor ‘doesn’t like’ and so it limits her proficiency in these areas.

*“So it tries to interfere with my life, and I try to not let it...and for me, it’s tremor... left dominant rigidity and of all things, actually working on a computer is typically very challenging for me because for whatever reason, my tremor does not like the computer and ramps up when I’m trying to write a letter or do something on the computer.”* (P5 – 00:41)

Up until her diagnosis P5 had been leading a life devoted to healthy living. From this perspective it seems that she has done everything in her personal power to prevent long-term illness, only to receive a PD diagnosis by an uncompassionate practitioner. She describes this experience as not starting off on ‘good footing’ as it was unexpected and upsetting. With the burden of receiving this diagnosis, there were additional challenges in trying to control how others come to know her diagnosis. P5’s experience in this makes it evident that she wasn’t entirely able to control this aspect of her life either.

*“Initially, I really had a difficult time accepting the diagnosis because I always exercised. I eat well, I’m you know, we dance, I don’t drink too much, I don’t do drugs, I am pretty granola overall. And then this, this diagnosis was dumped on me...it took me a while to share with people what was going on... It started becoming visible...so then ...it’s better to say something than not say something when that happens.” (P5 – 03:11).*

P3 understands this difficulty with regards to her productivity, as PD confines her ability to work effectively only within the boundaries of her on-periods. The slowness and fatigue that she experiences hinders her activities and converts daily tasks into challenges.

*“Well, I guess everything seems a bit more of a challenge, except when my drugs are working. I can rip around the house and get things done quickly and when the drugs start wearing off, it’s a different story.” (P3 – 00:46)*

### *3.5.1.2 The importance of physical activity as an adjunctive therapy to medication*

Physical activity is generally valued as a way to stay healthy, but its impact on one’s life may be more significant for those with PD. All the participants in this study have an understanding of the role physical activity plays in their fight against PD, especially as an adjunct to pharmaceutical and surgical procedures. P1 values physical activity as way to equip yourself with good health, which subsequently facilitates your ability to fight off disease. This is evident throughout his interview with his use of fighting descriptors to explain his perception of exercise.

*“I guess I look at it, you know, the healthier you are, the better you’re able to fight something, you know? You know, I think if you’re not in shape in that no matter what disease I think you’re, you’re able to battle something better when you’re healthy” (P1 – 04:40)*

*“And like I said, the health aspect. Why am I doing it. And the secondly, battling away this disease.” (P1 – 05:30)*

For P4 & P5 physical activity is valued as a way to enjoy life in the present, as well as working towards a more hopeful future with minimal impact from PD.

*“I want a good quality of life for whatever amount of time, because who knows how long I am going to live?” (P4 – 41:34)*

*“Oh its it’s the hope, yeah, it’s the hope of slowing the progression. Ideally, getting rid of it altogether would be the ideal, but slowing progression and staying as active as possible. I’ve got grandkids. I want to be able to play with them and have fun and yeah.” (P5 – 06:05)*

P3 demonstrates her value of, and drive towards, physical activity by her daily participation and her motivation to make the most of each exercise. This drive to participate in physical activity is similarly demonstrated by all the other participants, regardless of the setting.

*“I always try and do it as well as I can. I don't try and take the easy way out.” (P3 – 45:13)*

In P3’s experience, medication either fails to work or leaves her feeling helpless when it wears off. This experience further pushed her commitment to exercise as a way to supplement the shortcomings in current medication.

*“I mean, I have to help myself, like, if I don't help myself, who’s going to help me? ... like my posture gets very bad when I get weak and the drugs are wearing off. I stoop a lot. And I’m trying to fight back with getting myself stronger.” (P3 – 04:33)*

As described by P5, medical advancements in PD research appear frustratingly stunted. Similar to P3, P5 wanted to minimize her reliance on drugs. This may be due in part to her personal drive to seek out natural ways of healing, but it is also influenced by her fear of side-effects.

*“Well, I’m the type that I will do any anything natural to help myself as possible, so increasing my medication is not my first choice. If I can do something to slow down progression without that. I am really scared of Levocarb. I’m scared of getting dyskinesia ... So I’m trying to keep my dosage as low as possible, but still function as normally as possible. So exercise seemed like an option.” (P5 – 10:45)*

On the contrary, P4 underwent deep brain stimulation surgery to improve her response to medication as her PD symptoms continued to progress. This procedure is generally performed as a last resort medical treatment (Guttman et al., 2003). In this light, P4 can’t rely on further advancing her medical treatments and is thus highly motivated to use physical activity to act against PD progression.

*"I always had this thought that I wouldn't have DBS until I was desperate. And for sure, I wouldn't be desperate until I don't know I was 70 or something, 70 or 80. But what do you know? Like, I was desperate a couple of years ago. So then I had my DBS and then it's like, what's next? There is not a next." (P4 – 41:34)*

### 3.5.1.3 *The perception of RSB and vRSB as valuable physical activity*

Boxing is widely recognized by the participants as a beneficial high intensity exercise in which individuals with PD engage, to actively fight PD. The action of boxing itself is described as intense, giving the participants sense of 'building up a sweat' and working hard towards their physical goals. Participation in RSB also made participants feel stronger cognitively, more coordinated, and more in control.

*"It made me feel just like a little bit more in control of my body ... It just felt good, I felt strong, I felt capable. I don't know. And...the thing is too you're remembering everybody's names as well, so you kind of go round the class, you go "wow I just remembered 10 people's names", which sounds stupid, but really, I always forget people's names. But for some reason in boxing, I remembered everybody's name." (P4 - 11:02)*

*"I want to be stronger. And I don't know [if it's] because I feel so weak sometimes that that's my goal. That's why I do weights at the Y and I always want to box because I get satisfaction from it." (P3 – 44:01)*

P3 and P6 demonstrate high motivation to seek out boxing in particular, as they continue to box beyond RSB class, with P3 using boxing bags on her own during days with no classes, and P6 attending non-PD boxing programs.

*"One of the instructors gets out the battle ropes for me at this Y when I go in for weights, so I always do the battle ropes and he...hangs the speed bag up for me." (P3 – 09:43)*

*"The club I go to for Rock Steady Boxing, there's two days a week you can go in-person, but... she runs a gym so you can also go when it's not for Rock Steady Boxing. Like it's just ... people that are not afflicted with Parkinson's. So, usually I used to, before my injury, I would go on Saturdays to [that] class." (P5 – 13:23)*

The feelings elicited from boxing also brought a cathartic experience to some, as they would visualize themselves boxing with PD in a literal sense, or they would release their negative emotions while pounding on the heavy bag.

*"I mean, it's like I said, to be doing Rock Steady Boxing, you've been given a diagnosis. ... And it, you know, if you're feeling frustrated one day, or down about it one day- ...-That physical activity of actually punching something, \*laugh\* is good! And I've heard and other people have expressed that to me too." (P2 - 45:46)*

*"...I visualize PD on the heavy bag and really pound it. \*chuckle\*" (P5 – 07:04)*

#### 3.5.1.4 Freedom experienced in vRSB

During the COVID-19 pandemic RSB had to temporarily pause, and the virtual format of the class became available. Before this, all of our participants were attending, or starting to attend in-person regularly. As social isolation mandates were being implemented, the participants appreciated their gyms offering a virtual alternative with which they could access RSB. Some participants valued vRSB as a way to help maintain a workout routine in general as they pursued physical activity at home.

*“[If it wasn’t for virtual] would I have been doing lunges and squats? Maybe not. I’m not one that’s good at exercising on my own. \*laugh\* ...I need somebody telling me what to do and the virtual does that.” (P3 – 42:32)*

For P1 and P4, the physical and social differences they felt between the virtual and in-person greatly impacted their experience with RSB. Both participants utilized vRSB temporarily, until RSB was made available again. For the other participants, however, continuing to attend class in both settings was a valuable option to increase participation frequency.

*“I know that I’m better off doing the boxing than not doing it. So whether it’s in-person or virtual, I know it’s better for me.” (P5 – 32:46)*

A common reason why the participants continued in the virtual setting was that the classes were held within their own homes. The proximity of exercise programs matters for persons with Parkinson’s disease. Travelling and weather concerns were drawbacks to participating in in-person RSB for many of our participants.

*“And then the in-person classes, she moved the studio from [PLACE 1] to [PLACE 2]. So, and it’s not like it’s that much of a drive, but it is for us. It is that much of a drive.” (P4 – 07:49)*

*“So during the pandemic I participated in virtual. Before that, it was in person at the Y here [at the local gym].. Since they haven’t got the program back and I really wanted to participate in it. I, you know, I went to [the farther gym] even though I have to make that drive or my husband has to.” (P3 – 08:28)*

vRSB offered freedom to participate in boxing workouts more often, without having to make a long drive or face weather concerns. This convenience was appreciated by both independent drivers and those who arranged rides. However, this convenience may have been particularly freeing for the participants who arranged rides with friends and spouses, as the virtual setting gave them the freedom to access the class without needing assistance to travel.

*“...Unfortunately, the Y that has Rock Steady is a bit further than I that I would normally go to...so...you know, having the virtual as an option so I can alternate is great for me. (P5 – 33:23-33:35)*

*“It’s convenient. I mean, if the weather’s bad or anything like that, you just sign on and you can still exercise. The weather’s not an issue.” (P5 - 29:08)*

*“It’s handy and it’s a day I don’t have to drive to [the farther gym]” (P3 - 09:04)*

It also allows for individuals to join a RSB class from all different geographical areas. Opening access to RSB programs in this way is recognized as being beneficial as RSB classes aren’t commonly offered.

*“Most Y’s don’t offer it actually, it’s an exception when they do. So this, if you are a Y member, you can access the class from wherever you are right?” (P5 – 54:21)*

Some participants also experienced freedom in vRSB as it offered a shorter time commitment than in-person classes. With home-based exercises, the participants had less to prepare before class, and didn’t spend time commuting. This allowed the participants to continue with their workouts while having more time in their day for other activities.

*“Well, more freedom in the sense that I could have five minutes to get ready and get there versus having to get up early and make it to the Y.” (P5 – 39:31)*

Having a shorter time commitment proved to be very valuable for P6 in particular, giving her the freedom to participate more frequently while not compromising her full-time work schedule.

I: *“How important is [a shorter time commitment] to you?” (36:58)*

P6: *“To me, it’s important because I work right? If I was not working I probably wouldn’t be as important because I’d say, “OK, well... takes me 20 minutes to get there. That’s OK”. And I think it’s just convenient. That convenience is nice, so it allows you to do it more often, right? So, you know, now you can do it almost every day where if you were just going to... an in-person class you might go only three times a week and now you can go five times a week or something like that, right? It allows you to increase your participation.” (37:01-37:05)*

### *3.5.1.5 Freedom in vRSB contingent on technology*

The unique freedom that vRSB presents comes with unique conditions for access. Technological and interface problems were described by almost every participant as a potential barrier to participation. This could involve poor internet connection for both the participants and coaches, or difficulty accessing the boxing class through online portals. Some participants

expressed their frustrations with these technological difficulties and how it made vRSB more challenging in the beginning.

*“Well, the beginning, there's always, you know, the technical difficulties sometimes can be a bit, you know...everybody else seems to be working and you're not working, and most of us aren't techy geniuses, so the technology can sometimes be a little, you know, challenging. I think that's the biggest problem, really. And most days, that's not a problem at all...” (P6 – 38:06)*

In one case, program leaders recognized the difficulties of navigating the virtual setting, and thus provided technologically capable individuals to offer real-time help for those struggling to join the class. However, for most participants, the virtual setting was something the participants had to learn to navigate independently or receive support from family.

### 3.5.2 GET #2 – Physical Experience – vRSB IMPACTS INTENSITY

Many of our participants were surprised at how difficult the in-person workouts were and felt a sense of accomplishment as they overcame the challenge. Most participants noted that the virtual setting lowered the intensity of the workouts. This was in part a consequence of the limitations in exercise variety and equipment, smaller workout spaces, and a less engaging environment at home. Despite these limitations, participants still felt that some areas of physical fitness were improved or maintained by their continued attendance in both the virtual and in-person setting.

#### 3.5.2.1 Overcoming difficulties in the beginning with dedicated participation

Upon initially joining RSB, the participants were faced with physically exhausting and challenging workouts, while simultaneously learning a plethora of new terms and exercises. P1 describes his initial impression of the strenuous workouts.

*“I never realized boxers, I realize how in shape they are, you know, everything, but being in the ring \*chuckle\*... You know, the exercise regimen is like when I first started, and I wasn't in great shape, I went up to my coaches. I mean like, this is brutal work, you know?” (P1– 27:51)*

However difficult the workouts were, each of our participants experienced that with dedicated time and consistent practice, they became more competent and able to understand the moves and complete the workouts.

*“...I've never done this type of exercise before... The first few times like anything, it's like, “I don't know what they're talking about” when they're talking about jab-jab-cross, uppercut, whatever, one, two, three, four, five, six, you know, left hook, right hook. I'm like, “Oh my gosh!”. But eventually ... you know, like*



*anything, you do it a few times and like “Yeah, I caught onto this”. So just, you know, it's just perseverance, doing it a few times.” (P6- 25:37)*

*“My competency has improved definitely over the year. At the beginning it was more challenging, of course. But as time has gone on, I'm finding my competency obviously has gotten better.” (P2 – 32:37)*

For P4, she wasn't sure if she could keep up with the intensity of the workouts. When she joined, she found that a lot of the other boxers were strong individuals and were mostly male. This gave her the impression that the workouts were very difficult, and she hesitated in putting in a lot of effort. Over time, however, she realized she was able to work just as hard as the other boxers and was able to do things she previously doubted she could do. Working hard to overcome the challenging workouts made her feel stronger and more capable.

*“I was surprised at how much I could do, because at first, you know, the first couple of classes ...you sort of think ‘how hard am I going to try?’, \*chuckle\* you know, because it looked really hard and a lot of people are quite strong. And there was only two women in the class. And then finally, by like class number three, I thought, ‘OK, I've got to try really hard’. And yeah, I don't know. It just felt good, I felt strong, I felt capable.” (P4 – 11:02)*

### *3.5.2.2 The physical benefits from RSB effects more than PD symptoms*

In addition to fighting their PD symptoms, each of our participants experienced impactful physical and cognitive improvements through participation in RSB. Originally, P2 joined RSB in order to take action against her diagnosis of PD in the broad sense. However, through her participation, she found that her back, core and balance were getting stronger and improving. Subsequently, these physical improvements became additional specific results to strive after.

*“Like I said, my goal is... really is not-, like those are...I guess, side effects of Rock Steady boxing. And if I didn't have Parkinson's, I wouldn't be doing Rock Steady Boxing. And somebody said to me “Oh, you're boxing! Oh, I should look into that! Who are you doing it through?” I said “Rock Steady Boxing”, “Oh, I'll have to look at it”, I said, “Well, you'll have to get Parkinson's first and then then you can think about it”. So that is, \*pause\* I guess when you talk of my physical goals, my number one physical goal is to slow down Parkinson's. And it just so happens that all those other things are happening.” (P2 – 34:35)*

In a similar way, P6 found that by participating in RSB she not only felt her PD symptoms alleviate, but she felt improvement in other physical domains.

*“I could feel the benefits of it. That's why I think it's good because it ... helps to get rid of some of the slowness, ... I did have some other issues, whether they're Parkinson related or not, ... but it helped with those issues with my muscles that they're no longer an issue now...So that...worked away. And, you know, because... it's a good workout for you.” (P6 – 45:06-45:32)*

### 3.5.2.3 *Classes were multifaceted and individual in intensity*

As there are differences between RSB boxers in terms of age, gender, and disease progression, each of our participants noted that their RSB coaches provided a variety of exercises with freedom to modify according to each person's unique needs, offering many different ways to modify intensity while maintaining the challenge of the workouts.

*“The instructors tell you modifications because everybody is at a different ability. And so they give you modifications for each, particularly...balance exercises that we're doing and core type exercises. That varies so much... and they always say work to your ability ...and even on a day-to-day basis, everybody's abilities are different, so it is very easy to modify.” (P2 – 14:01)*

Another important component to help ensure that the boxers were individually challenging themselves was to time exercises as opposed to counting repetitions. This gave participants the ability to benchmark against themselves as opposed to comparing to an external standard.

*“So usually, I mean, all the time, actually, it wasn't like do 10 sit ups. It was keep doing sit ups for 45 seconds. Everything was timed rather than each exercise, which was very good for everybody because no matter what, like some sometimes you'd only get in two of whatever.” (P4 – 40:32)*

Other opportunities for individual expression and choice were found in the in-person setting as some boxers were able to choose and lead class activities such as group stretches, or curate the workout music soundtrack. However, none of the boxers described the same opportunity in the virtual setting.

*“Everybody would take a turn doing a ‘Hey [P1], you do a stretch for everybody to do’ and everybody would get that opportunity” (P1 – 22:55)*

*“If you didn't like the music, you could say so...I think at one point somebody used to create some of the playlists.” (P6 – 48:10-48:14)*

### 3.5.2.4 *The home setting with limited space and equipment impacts physical improvement*

Bringing RSB into the home allowed for increased participation. However, it came at the expense of having less equipment, less space, and a smaller variety of exercises. This impacted the intensity of the exercises, and many participants found the workouts generally less challenging and unsatisfying. Large contributors to this were the lack of heavy bag equipment and the limited space at home. 'Shadow boxing', or punching the air was almost unanimously

experienced as not feeling as rewarding as heavy bag boxing. Every participant would choose in-person classes over virtual if they could only select one delivery mode.

*“We'll skip, for instance, and we'll run around the gym. So we do aerobic exercise, a bunch of different ones... it's just really fun. Or sometimes we will like, walk backwards, we'll do lunges across the room, forward and back, sideways, across, or I don't know know what that's called, but you know, we'll \*laugh\* just shuffle sideways, both ways. And yeah, so we'll do all those. A lot of strength ones, so like seriously, I felt really strong when I was in boxing all the time. So even just punching the bag is really like you wouldn't believe how much energy it takes to punch a bag.” (P4 – 16:32)*

When participating in RSB at home, P4 missed the challenging impact that the equipment brought.

*“We would do like when we were in-person and we had bags, you're punching the bag. But without the bag like virtually, except for a couple of people, nobody had bags, right? So you just punching the air. And that is not fun. Not satisfying at all.” (P4 – 27:22)*

P3 had similar experiences in the virtual setting. In addition to boxing bags, P3 had access to heavier weights, cardio machines, and battle ropes in the in-person setting. Even for equipment that she wouldn't normally use, she appreciates having her options open. Having really enjoyed using the equipment during the in-person workouts, it became one of the first things she noticed that lacked in the virtual setting.

*“My initial impressions were I miss the bags. I miss the bags \*chuckle\*. But it was still moving, it was still stretching...I've got some dumbbells that that they encourage you to use or the stretchy bands... but there's the equipment again, the equipment issue, if you're going to do it virtually, it's better to have some equipment on hand.” (P3 – 21:43)*

In the virtual setting, equipment options were limited to items that were commonly owned. Some coaches even used household items, like brooms or cans of food, to facilitate the weighted and warm-up portions of the workout. However, this restricted the types of exercise they could do in a workout. P2 describes having more equipment as having the freedom to do a larger variety of exercises.

*“In the gym you've got all the equipment and you have the freedom to do a larger variety of exercises than you do in your basement. The basement is pretty standard. You just have your hand weights and your gloves.” (P2 – 29:09)*

Furthermore, P4 describes becoming disengaged during virtual workouts and distracted with her home surroundings. As distractions frequently lead the boxer away from the workouts, the exercises became less effective, and satisfaction wasn't felt afterwards.

*"Because the virtual program, \*sigh\* I couldn't focus \*chuckle\* like I would be-, I'd be doing it, then I think, "Oh, I have to text my daughter" so I would walk away and text my daughter, or like right before a class I'd put bread in the oven or something like that. But I just couldn't focus" (P4 - 07:49).*

#### 3.5.2.5 Despite its downfalls, there are physical benefits in vRSB

Regardless of the lack of intensity, reduced range of equipment options, and restricted (and suboptimal) space, most participants did experience some physical benefits while enrolled in the virtual class. The exercises, although more limited in variety, were still challenging and even comparable to in-person exercises for some.

*"Well, I mean, the only thing would be because of the lack of the heavy bag. You don't get that intensity that you got in-person. But otherwise, you know, the exercises were comparable...other than the intensity, you don't do really miss out on anything with the virtual." (P5 – 40:26 – 41:04)*

Some participants appreciated that the virtual setting maintained or improved their physical fitness, and that it kept them familiar with the moves.

*"I think they help make me stronger and...worked on my balance and kept me familiar with the boxing punches \*laugh\*." (P3 - 45:44)*

As a result of this, many of the participants remained in a hybrid schedule, participating in both in-person and virtual boxing.

*"I think I like the mixture of the two...because I do still get a good workout in the basement. And honestly, I don't think I would want to drive out to [PLACE 1], five mornings a week." (P2 – 20:02-20:31)*

### 3.5.3 GET #3 – Social Experience - vRSB LIMITS SOCIAL INTERACTIONS IN BOTH POSITIVE AND NEGATIVE WAYS

The social environments within RSB classes were experienced as encouraging, supportive, accountable, and a place in which strong bonds were formed between boxers. As these programs are tailored towards individuals who are impacted by PD, the relationships formed are unique in their understanding and support. However, this also leads to unique challenges. Given the nature of the virtual setting, PwP experienced limitations in their ability to form deep connections with other boxers and feel accountable to one another when compared to in-person settings. However, seeing other individuals impacted by a progressive disease can be a difficult experience. Thus, the virtual setting also limited the negative impact that these social interactions would bring.

### 3.5.3.1 Community and support felt in RSB

Rock Steady Boxing is a program that is tailored towards those who have received a diagnosis of Parkinson's disease. As each of the boxers come into the program with similar circumstances, there is a sense of understanding between the boxers. However, this can also be a point of anxiety for those who join the first time. This is demonstrated as P2 first describes her experience joining as an anxious occasion.

*"I mean, anybody starting something like this, you've obviously been given a diagnosis, right? So, you're doing it for a different reason than a lot of other people are just going to join a gym...So, I was nervous."* (P2 - 16:00)

Nonetheless, it was that point of commonality between the boxers that became very important to P2. As she worked alongside others impacted by PD, she felt a strong sense of familiarity, freedom, and relatability on a very personal level. This experience influenced her opinion on having individuals with no connection to PD refrain from joining the class.

*"Well, we do have people in the class that don't have Parkinson's because each person is allowed a support person...So my husband now comes with me...And some other people have their partners come as well...And I think the people should have some connection to Parkinson's...Because there's such varying levels of abilities, and we talk about things that, you know, are personal in our journey with Parkinson's...That somebody else really may not understand or you may not be so free to talk about if there were other people there."* (P2 - 35:52-36:46)

For P3, the social aspect was experienced as a personal encouragement. Several times she describes the feeling of being part of the RSB community. This sense of belonging comes from mutually sharing experiences, issues, and goals with the other participants.

*"It is motivating to be with people who are doing the same thing. It's encouraging...It's more of a confidence builder, I think, when you're in person...You all [have the] same goal, you all have the same issues, well, sort of. So there's a common goal there. And you feel more a part of a group when you're in-person."* (P3 - 30:58-31:15)

One of P4's first impressions of RSB was a recognition that she, as a woman, was in the minority. However, this made no impact on how she felt received into the class as the boxers greeted her with genuine kindness. It was the social support within RSB classes that P4 particularly valued.

*"Yeah, well, there was a lot of men, right? It was mostly \*laugh\* men. And everybody was just so nice. Like, so just like genuine, really nice people. And it was good. Yeah, they're really good."* (P4 - 51:47)

*"But then also for boxing in particular, it was a whole social aspect of it. Like you get so that you're friends with everybody in the room and you all like support each other. The level of support is fantastic." (P4 - 05:02)*

P5 also describes the RSB community as a support network for those who are in need of one. P5 considered her primary support network to exist outside of class. However, she valued the social aspect as a way to share notes, ideas and stories with other individuals in relatable situations.

*"But for some people, it is, like there are some people that don't have a support network. And those people are their support network. I'm very fortunate. I have family and friends and I have a support network." (P5 - 57:56)*

For P6, the supportive community was entirely inclusive which was especially important for individuals with more advanced or severe symptoms.

*"It's not just for people that at one level...you know, it's good for every level and also...you know, I think the love and the encouragement they receive from the participants...I think helps them. So it keeps them motivated to come, so, which is important." (P6 - 01:07:05)*

When compared to her time in non PD-specialized boxing programs, this experience of community, encouragement and support for one another was not seen to the same degree, even when it was led by the same coach. Although she still felt able to develop relationships (and experience support) within non-PD programs, the focus was more on the physical aspect.

*"Maybe a little different, like you're there -...you're more a little to get your exercise and go home kind of thing, right?" (P6 - 01:08:22)*

### *3.5.3.2 Seeing others work hard inspires hard work*

The participants also found encouragement in seeing others more advanced in age or disease working hard during the workouts, and it inspired them to push themselves more. This kind of comparison has been experienced as a motivating factor for most of our participants.

*"There was a woman in the class, she was like 88, and they are amazing. So, I think well, if [she] is doing that, I better get moving. But that's only in-person, you know, that I feel that. \*chuckle\*" (P4 - 55:39)*

Similar to this, P2 was initially upset to see individuals who were at more advanced stages of PD than she was. However, she found encouragement seeing them work hard, and they became an inspiration to her.

*"When I started out in [PLACE 1], to meet people for the first time, there was one gentleman who was \*pause\*, the first time I met him, it actually upset me because he was so advanced in his Parkinson's, but boy, could he workout. Holy mackerel...I said, 'No, I can't keep up with you, man'. Like, 'slow down!'." (P2 – 41:19)*

### 3.5.3.3 Friendship in RSB

The community and encouragement experienced in RSB grew into strong friendships that would extend beyond the class in some situations. For example, P1 noted that he developed deep connections to some of the other boxers, rooted in the time they spent together fighting PD. These friendships were pursued outside of class.

*"We get together. Just a couple of Sundays ago, we all decided to go out for dinner, you know? You know...there's a core of us have been together for at least five years, you know...we work out together and we're battling the same disease, you know, we're in the same boat. So, its priceless" (P1 - 37:38)*

Similarly, P4 described how she particularly enjoyed her friendships with the other boxers not only during the workouts but during organized events after class.

*"When I was doing in-person boxing, we would go to different events together. Like, for instance, there used to be a big luncheon to support the [ORGANIZATION]. And so that was in downtown [PLACE 1]. So we, you know, we had our class that day then we all got changed and went to lunch and one time somebody organized getting tickets to a [BASKETBALL TEAM] games and...you know what I mean? It is that kind of thing?" (P4 - 53:43)*

Similar to P1, P5 felt a closer bond with certain boxers who had been boxing alongside her for years and found their friendship to extend beyond the class. Although this wasn't true of all her boxing relationships, she still experienced a mutual connection within class between all the participants.

*"Yeah, like I said, we are friends that will get together outside of class and then others are just, you know them in class, but there's a rapport there. You know something about them, you know whether they have grandkids, you know how their spouse is doing, and stuff like that." (P5 - 53:00)*

Similar to P5, P3 valued the relationships formed within the classes. In particular, she felt more connected to individuals she saw frequently in both types of class (i.e., virtual and in-person). For P3, however, this connection was limited to the class, due to location constraints.

*"I feel a little closer to them when I've seen them virtually and then see them in-person...But it's not like we, you know, go for coffee or anything like that...But they live in other places, a lot of them live in other places." (P3 - 46:52-47:37)*

#### 3.5.3.4 *The virtual setting maintained connections during times of social isolation*

As the safety measures taken during the COVID-19 pandemic-initiated periods of social isolation, the introduction of vRSB gave the participants opportunity to not only workout, but to provide a social avenue in which participants could check in with one another and maintain their relationships. For this reason, the virtual platform was especially welcomed in the beginning by all the participants, even by those who discontinued it after in-person classes were again available.

*"I thought it was fine, actually, because, once again, because it was during the pandemic, I was just happy we were doing something at that point...And also it felt good to check in on everybody because I had been concerned right? And, anyway, that was a part of it as well."* (P4 - 22:35-22:46)

*"The virtual setting? Gave an opportunity to say hello and interact still with people I have met, but I've met them through the live environment...but at least during a time of shutdown, you were with other people. It allowed you to see other people and say hello and interact. So I think there's still-, you know, still has a social aspect to it."* (P6 - 58:47-59:01)

P6 even describes after-class activities in the virtual setting as a chance for the boxers to become better acquainted with each other outside of vRSB.

P6: *"We had had a few social occasions to get to know each other, so that's good."* (01:02:40)

I: *"Oh, yeah. Were these organized within the virtual setting?"* (01:02:45)

P6: *"They were live...virtual but you were live."* (01:02:49-01:02:52)

#### 3.5.3.5 *One-on-one personal contact is needed for deeper connections*

The deep connections and friendships that were created in person had an element of one-on-one personal connection. In the virtual setting, social interactions are mostly confined to a group setting outside of class. As the space for individual connections was lacking in the virtual setting, developing deeper friendships was found to be more challenging by the participants.

*"I think it's easier to develop that in-person because, you know, you can chat when you get ready to-, getting your shoes on and that kind of thing where ... in the online kind of thing, it's a little harder because...everybody's there, so it's hard to have a one-on-one. But you know, you can still do it a little bit."* (P6 – 01:03:45)

*"Oh I mean, there's less interaction, obviously, because if you're in a class, you've got the whole class there all the time, whereas when it's face to face, you can at the beginning or at the end you can actually, you know, chat with the person on a more personal level."* (P5 – 48:23)



Consequently, P1 described this social environment as not being as warm as the in-person environment.

*“With the virtual, you know you had everybody like, say, where I’m at, you had how many people in your class all, you know, and like I mentioned, you know, if you wanted to speak, you had to speak, two people couldn’t speak at the same time... You know...it’s just not as warm as in-person, you know.” (P1 – 41:11 – 41:30)*

For P4, it was specifically the social interactions during the exercises that she missed in the virtual setting. She enjoys conversing with fellow boxers during in-person workouts but had to remain muted in the virtual setting so as to not distract from the coach. For all six of our participants, virtual RSB classes were held over Zoom™ which only allows one person to speak at a time. This resulted in the coaches and boxers not being able to privately approach an individual without speaking to the entire class. This loss of social contact was considerable for P4.

*“You know what, I think the difference is too is in-person, when I was exercising with somebody beside me, I mean, often we would talk, right? So there was like, actually, I talk the whole-, constantly. So, you know, that’s a whole different thing, too because when it was Zoom, you know, you really have to pay attention and also you’re muted right? Only the instructor was on. Otherwise we could hear people’s dogs barking and whatever. So that made a big difference too, because I, you know, my big thing with meeting people is just the one on one and being able to say, you know, “what are you doing here?” Sort of thing.” (P4 – 57:57)*

When asked if her relationships would be the same if she had met all her fellow boxers online, she responded without hesitation that she’d be surprised if they were. This is similar to P1’s response about forming friendships in the virtual. For him, the online setting doesn’t replace in-person human contact. He values engaging in light conversation and humour with his fellow boxers throughout the workout.

*“I find when you’re on virtual, it’s kind of to the point, do you know what I mean? Whereas you’re, you know, you can say there’s people on either side of me working out and you can sit there and crack a joke or something.” (P1 – 39:45)*

This sense of ‘to the point’ interactions during virtual workouts is mirrored in P6’s experience. She describes missing the back-and-forth conversations she would have in the in-person setting as she would instead have more one-way interactions in the virtual setting.

*“I just missed see, like actually, you know, you can talk to people kind of...in between exercises...Like on Zoom, it’s very focused. You’re not going to sit and chat to each other while you’re exercising. But it’s more interactive, I think in live.” (P6 – 41:50)*

P3 experienced losing the sense being a part of a group in the virtual. She compares her experience in vRSB to her experience in virtual choir. Similar to boxing, she had participated in a virtual choir program in which the only unmuted person on the Zoom™ call was the instructor. This meant that P3 could only hear the instructor sing, but not the whole group together. For P3, having individuals working alongside her makes her feel like she's part of a group. Therefore, by having everyone muted during the vRSB workouts, P3 felt like she wasn't part of that group.

*“Choir is hearing other people sing...It's the same thing with virtual boxing...it's not the same as being with the group. Well, I'd like to hear other people sing, I'd like to sing with other people, harmonize with other people. And I find it's the same with virtual boxing. It's not the same as being, you know, right with them.” (P3 – 28:36)*

As previously mentioned, internet connectivity problems further complicated virtual social connections. Described as occurring at least once per class, P4 would lose the ability to hear and see the other individuals in the class from her loss of internet connection. This experience became increasingly frustrating for her.

*“Oh, frustrated. And kind of confused, because at first, you go “oh, are you mov-? Oh” \*laugh\* you start doing this whole goofy thing that yeah, I just felt super frustrated whenever that happened.” (P4 – 29:00)*

### 3.5.3.6 The impact of limited social engagement

The absence or limitations of these social interactions can leave participants feeling less inspired to work hard, making the workouts feel less challenging.

*“I think the in-person is more challenging because, virtually you're just there by yourself, and you're not, you know, even though the instructors encourage you, it's not the same as being out in the gym and them, you know, yelling “get going!” or you know...and you've got your fellow boxers and you know, you got your bags and the bag does, it's nice, it's nice to be able to hit something like that and just, you know, it's good.” (P2 – 30:49)*

Participants are less inspired to challenge themselves when they perceive that they are alone. This may be because they believe they are less visible to others and that others are less visible to them. With this lacking, it's more difficult to feel accountable and motivated to try harder.

*“Yeah, yeah. I felt kind of lazy, actually. I wouldn't push myself as hard...I didn't feel as accountable. God knows why. Because, I, you know, really, it's ridiculous. It's just because I'm doing this for me. But when there weren't other people, like physically around me, I wasn't as motivated.” (P4 – 21:54-22:01)*

P6 described looking across the room and seeing individuals who are challenging themselves and subsequently feeling encouraged to do the same. In the virtual setting, however, she finds that she is more limited in how much she can see other people. Therefore, this external motivating factor lacks in the virtual and it becomes her responsibility to motivate herself.

*“It's more one-on-one. Like you ... can't really look around and...I guess you could you put everybody up on your screen and stare at how all they're doing, but it's not as noticeable, like when you're more on your own, when you're doing Zoom because you're focused on the instructor, what they're doing and then, you know, doing it yourself kind of thing, there's nobody around you except yourself...So that can be a positive or a negative, because sometimes...you get motivated by looking at other people....So you push yourself more saying, “Oh gosh, look at this person, they're doing this... I should be able to do that” So you push yourself more. Where you're in a Zoom setting...it's more left to you to probably motivate yourself a little bit more because you can't look at other people and say, “Oh, jeez, look at [FELLOW BOXER]. He's done 50 and I've done 10. I think I better pick it up a notch.” Like you don't know.” (P6 – 20:04-20:35)*

Home exercises can limit engagement in the exercises not only with less equipment and space, but because they are isolated in the home setting. P6 describes a lack of engagement in voice exercises when she was participating in vRSB. Voice exercises generally involved shouting during the workouts, which seem to be practiced more comfortably in a gym setting surrounded by other participants than alone at home.

*“In-person, sometimes you work on counting and like you'll yell things out, which is good for your voice right? To work on your voice control. They encourage you to do that when you're obviously virtual, but you're by yourself like “one-two” like, you're not going to scream it out where you're more likely to work on screaming it out, and doing those kind of voice kind of exercises when you're with a group. So ...I'm not going to sit in my basement yell “One two three four five” and scream, I'm probably more likely to do that in a in a, you know, in-person situation.” (P6 – 54:32)*

*3.5.3.7 Distant coaching limits personal instruction, accountability and challenges socializing within the class.*

The coaches were praised by every participant for being compassionate, energetic, and positively influencing the in-person class experience. Participants appreciated the knowledge and understanding the coaches had of PD so that they could effectively challenge them.

*“The coaching is excellent. They're very positive, encouraging you to work to your maximum physical ability, which is where you start to get the benefits.” (P2 - 11:03)*

*“Oh, they're so good. They're very upbeat. They \*chuckle\* well, I always say “I need people to yell at me to make me work hard”. But that's it. But they do it, I mean, they're so nice, right? Like, they're very nice, very supportive. They get it... Yeah, they're super positive, really supportive, really energetic.” (P4 - 15:05)*

In-person classes have also been described as having several trainers and helpers circulating within the room. This increases participant visibility for the coaches so that they can approach and assist each person. Not only is this valued for helping new boxers learn more effectively, but it also enhances accountability, and assists anyone who seems unsteady so that everyone can get the most out of their workout.

*"When I started, there was 20 some people there and five or six coaches, so they would pay a little more attention to you, obviously, if you're new because they knew that you're just learning. ... You know, not knowing anything. So the same when we get new people, you know, they'll work with them. And then eventually you know, we know what they're talking about. The lingo." (P6 - 26:57-27:12)*

*"[COACH] is very good, she actually was a boxer. And I forget the guy's name at [PLACE 1] who helps her. And then they have volunteers. So it doesn't matter what group you're in, there's somebody coming around to see how you're doing or to monitor you or to keep an eye that your form is right or, you know, things like that...With the bags they encourage you to hit harder, hit faster, and that's all motivating too, to have somebody cheering you on." (P3 - 13:15)*

*"And they seem to have eyes everywhere because, you know, not everybody has good days, right? And so, for instance, we had one fellow that would often get dizzy. So...somebody had an eye on him. So as soon as he go, "I'm dizzy" he has somebody by his side and he would sit down or kneel down or whatever." (P4 - 15:05)*

In virtual RSB, however, the coaches were limited in their interactions with the participants in two critical ways. First, the coaches had difficulty physically observing the boxer's form. They had transitioned from seeing each boxer face-to-face, to seeing each boxer within a small portion of their screen, physically limiting visibility. Not being able to watch form properly may have impacted the extent to which an individual will physically exert themselves, as well as the safety of the exercises. Despite this, however, every participant described feeling safe during virtual RSB classes.

*"It's harder to do, right? Because the coach is, you know...showing the exercises but, you know, she only sees-, like we are now those small screens" (P5 - 37:22)*

Secondly, virtual Rock Steady Boxing presents coaches with the difficulty of limiting private interaction between themselves and the participants. The virtual setting is also limited to one coach to teach the class, which contrasts with in-person RSB and their host of trainers, volunteers, and helpers. The participants see this as especially significant for new boxers and individuals who are impacted by greater physical or cognitive decline who would benefit from more personalized coaching.

*"And she... can't really stop the whole class to show somebody, "OK, you're not..." you know, "your bridge, bring your..." , you know, "bring-, come up higher" or whatever. So I think for people that are more limited, it might have, it wouldn't present everything that in-person would." (P5 - 37:22)*

*"When they're doing kicks they're not going to say like "Now [P6] can't do kicks, so you should do this". I just, you know, shouldn't be doing kicks today. So I just do my own thing." (P6 - 24:26)*

Personalized coaching made a meaningful difference to the participants engagement with the class, especially during the first few classes of RSB. As previously mentioned, our participants experienced a learning curve in understanding the coordinated boxing movements and their corresponding terminology. For P6, the in-person interactions she had with the coaches helped her to better understand and learn the moves effectively so that she could participate more fully in the in-person setting, and subsequently in the virtual setting.

*"I think it would be hard to start virtual if you'd never done it before, but I'd already done it in-person, so I knew what the punches and that were. Although they explain them to you and everything, but it's just helps when you have a little bit of knowledge and then you can, you know, then it's so much easier when you're virtual because you know all your punches and, you know, what they're doing, but they always show you...I think it would be a little bit harder to start, but I think...it just might take longer to catch on, right?...you know because when you're in the gym, they can look at you and they can come over and say, "Hey, you're not doing your punch quite right." Or "Try this" or "Try that" right?" (P6 - 23:17-23:54)*

Given the limitations that the coaches face in properly watching and correcting form, two participants felt less inspired to engage fully with the class. P1 describes becoming less focused in the virtual setting as he felt less accountability.

*"You're able to cheat a little bit, you know, like say you're skipping rope, you know, and you can go off camera... like if you have a good trainer, a good coach, like, say, in person, they'll sit there and say, you know, he or she will say, "Okay come on, [P1]. Lets..." you know, kinda urge you on, you know, and you don't get that in virtual, it's basically up to you." (P1 - 28:38)*

This lack of engagement and focus on the exercise resulted in both participants feeling unsatisfied with the intensity of the workout and with their physical progression when they participated solely online. Neither P1 nor P4 continued in the virtual setting after in-person was made available again.

*"Oh, it was good. But I, you know, I would sit there after class and go, you know, it wasn't as good of a workout than I would have in person, but that would be my fault, you know?...I would sit there and say, oh yeah, it was good. It was successful, but not as good, not as successful as in person." (P1 - 32:44-33:21)*

I: *"And do you think the virtual rock steady boxing made a positive impact on your physical abilities?"*

P4: *“Not as much...No. well, but its because it wasn't, you know, I was doing the dishes \*chuckle\* or answering the door for the Amazon driver” (37:47-38:02)*

When individuals join a typical in-person RSB class for the first time, they are met with a welcoming atmosphere and social activities that the coaches facilitate, accelerating the new boxer's incorporation into the class.

*“It was kind of a little bit of an intimidation because you're going to this-, a boxing club, you know, and I walked in there when there is a Rock Steady class in there, and I was welcomed, you know” (P1 – 15:47)*

*“So we start with the warm up, which was also sort of a get-to-know-you session. So if people hadn't been there before, we would do voice exercises as well. So you would shout out your name or they would ask a question like um, you know, “what did you do when you worked?” or if you are working, “what's your job?”” (P4 – 13:25)*

In the virtual setting however, there was a need for social engagement to be more intentional as it became easier for a new boxer to join and leave the class without anyone noticing their attendance. This issue was recognized by some of the coaches as P6 described how they welcome each attendee as they join in efforts to make everyone feel more included and seen.

*“And sometimes I think for some people, it might be when they join this group, like they're quiet and they don't want to, it's maybe intimidating. So they just kind of join, and you know, nobody even knows they're there. So the group I belong to, they do a good job of acknowledging everybody, but you could get into this where you join and nobody ever known to there.” (P6 – 38:37)*

As previously described, the workout itself loses a general sense of social connection as the interaction becomes a one-sided instructional session. Some coaches want to minimize distractions by muting all the participants, further distancing social connection. To account for this, each participant described coach efforts at increasing social engagement at the beginning of the class by adding a 10- to 15-minute period in which the boxers could greet each other.

*“And part of that hour and 15 minutes at the beginning, they like to do a get to know you thing.” (P5 – 23:28)*

*“I think the in-person is better at the social aspect of it than virtual. Mind you, we do have our 15 minutes of chatting before we start boxing...and we get some pretty good conversations going.” (P2 – 37:37)*

Some participants benefitted from these intentional social windows. P5 experienced a growing friendship with another boxer after interacting during the social segments. This friendship grew more after they were able to connect on an individual level.

*“Actually even connected with a new friend on a class because you know that get-to-know-you thing, she had said a few things one day. I don’t know if she initiated it or I did because she was brand new to boxing, she joined during Zoom during COVID, and she chatted and said you know, “If you get time, do you mind if I call you?” and yeah, and you meet people that way.” (P5 – 29:08)*

However, by being confined to a group setting there is a loss of personal connection with the coaches themselves. Some participants describe this loss in virtual Rock Steady Boxing, and P4 felt her motivation to attend vRSB was impacted by it.

*I: “OK and did [weaker connections with the coaches] impact on your motivation to continue in Rock Steady Boxing?” (49:35)*

*P4: “That...probably was part of it because I didn’t feel the strong connection virtually.” (49:42)*

Although the virtual setting has changed the way in which the coaches motivated, socially integrated, and personally connected with the boxers, it did not change how the participants experienced coach demeanour. For the participants, the coaches were still encouraging, inclusive, knowledgeable, experienced, and compassionate. Switching from one-on-one in-person coaching to virtual coaching didn't change these impressions. Rather, as P5 puts it, the coaches "were still the coaches" (50:51).

*P5: "Like I said, they were well-coached. They had gone and done the program in the States, the Rock Steady program. So they were knowledgeable. One coach, as I said, was a professional boxer. So she had the boxing down pat and they were-, there was good interaction. They encouraged that, so the social component was there. So yeah, they were very pleased with my coach." (50:12)*

*I: "And did those impressions change at all when you kind of switched to the virtual setting or is it just kind of...?" (51:09)*

*P5: "Well, like I said you got less one-on-one interaction. But there's still, you know, it was still good. There wasn't a negative, you know, they didn't change. They were still the coaches. \*chuckle\*" (50:51)*

In fact, P3 appreciated the familiarity of the coaches in the virtual setting.

*P3: "Well, I liked it because, um, I knew them before the virtual. I knew them from being at the Y in [PLACE 2]. So it was like having an old friend help you virtually instead of in-person. So that I like that they were the same people that I already felt like I kind of knew or knew what to expect anyways." (48:42)*

*I: "Yeah, yeah...so your first impressions of the coaches when you knew them in-person did that impression change at all?" (49:14)*

*P3: "No, no they were very effective, I found. And they were effective in the virtual as well." (49:25)*

### 3.5.3.8 The virtual setting limited the negative aspect of socializing with other PwP

In-person social interactions with other PwP during workouts can be a difficult experience. As previously described, knowing that RSB was a PD-specific program made it more difficult for some of the participants to join for the potential of seeing how the disease impacts others.

*"It was hard to join Rock Steady because of that, because there were definitely people far more advanced in their symptoms that it was scary and upsetting to see, you know?" (P5 - 10:45)*

In comparison to seeing other PwP in support group settings, seeing other PwP in a physically active setting was particularly difficult as it more clearly demonstrated the extent of an individual's physical decline.

*"I think it was harder seeing it with the Rock Steady because we're there to be physically active and you watch people with, you know, freezing of gait or you know like I said...some people, and I feel sorry for them, have the tremor on both sides... because tremor on one side, and for me I'm again lucky it's not my dominant side, but it really impacts you on those times when the tremor is really bad. So seeing it in...an environment where are you supposed to be physically active? It really jumps out at you more than in a support group environment." (P5 - 01:04:13)*

Similarly, P3 described how easy it was to notice and compare the degree to which PD was impacting other boxers physically and cognitively.

*"Well...I don't know if they've had the disease longer than me, but you notice who maybe isn't doing as well as you \*laugh\* and then you, see others who seem to be doing better than you. I don't know-, I couldn't help but kind of notice that." (P3 - 51:46)*

Comparing disease severity factors into the difficulty of socially interacting with other individuals impacted by PD. P5 finds that social interactions with other PwP who are at a similar level of disease severity as her were beneficial in that the boxers could exchange experiences and notes. However, the more advanced an individual was in their disease progression, the harder it was to want to interact with them.

*"Because there were a number of people that were kind of at the same level as me, it was, from a social aspect, it was nice say, "OK, does this happen to you?" You know, and you can kinda compare notes with instead of just reading about it it's actually somebody that's saying, "OK, I've got dyskinesia" and "I'm struggling with this"...some of them I would have preferred not to see, actually, because there was a couple that were quite advanced in their symptoms at the time." (P5 - 24:10)*

Not only is it upsetting to see individuals more advanced in their disease, it is upsetting to see the individuals who started RSB at a similar level progressing more in their symptoms.



*"I think it's still hard to see the ones that started with me, for example, that weren't that bad and that have progressed. A couple of them...had to have DBS done, because their symptoms that advanced so much, so it's nice to have the others there, but it can be upsetting as well." (P5 - 56:16)*

As previously mentioned, the virtual setting limits one's ability to see other boxers apart from the coach during the workout. Although this limits the social connectedness one may feel towards the other boxers, it can also limit the negative impact of these social connections as well. P5 expressed the heavy impact that seeing the progression of other PwP had on her. She recognized that the benefit from seeing others maintain their physical ability is reduced, but the negative impact was also restricted.

*P5: "Well, you don't see it as much, right? Because when you are exercising virtually, all I see is my coach, right? I'm focused on the coach. So you don't see that as much." (59:44)*

*I: "Mm hmm. Does that in general make it like easier in virtual? Or a little more difficult or mixed bag?" (01:00:00)*

*P5: "Either way, I mean, I'm not the type that puts, you know, my head in the sand kind of person, so I know when there's progression and all that, it's harder to see them than not see them, I think? But on the flip side, there are some that have maintained." (01:00:06)*

## 3.6 Discussion

This study engaged with IPA methodology to examine the experience of person's with Parkinson's disease in virtual and in-person forms of Rock Steady Boxing. Three aspects of the meaning of their experience were further analyzed in depth: the individual experience; the physical experience; and the social experience. We also explored the psychological needs that influenced motivation, in the context of the virtual setting, through the lens of SDT: autonomy, competence and relatedness.

### 3.6.1 *The Individual Experience*

From the time of their first diagnosis with PD, many of the boxers in this study experienced a loss in some aspect of their lives. One qualitative review has suggested that adjusting to having PD is a complex and dynamic process, and that coping with the illness and its associated losses requires strategy changes as the disease progresses (Wieringa et al., 2022). This sense of loss included losing the energy to do daily activities, losing one's sense of control, and losing the freedom to socialize without concern for timing or symptom manifestation. In addition to these losses, many of our participants experienced anxiety as one of the most debilitating

symptoms. O'Brien et al. (2016) found similar experiences of loss in their grounded theory qualitative study. Their participants felt significant losses in their identity as an active person due to their debilitating mobility. O'Brien et al. (2016) also showed that their participants were driven to engage in activity so as to not lose any more than they had already. In our study, this was reflected in participant comments about not wanting to lose the opportunity for future engagement with family, or their ability to perform normal daily tasks. Engaging in physical activity was seen as a method of holding on to these future activities. Participants also noted that this was particularly important given the limitations and side effects that accompany pharmaceutical and surgical options. Eriksson et al. (2013) found that the meaning of exercise for PwP is to 'keep going to retain the healthy self' (p. 2239) and that they were taking action towards their future, and felt competent that they could do so. Each of our participants were highly motivated to start boxing. Not only did boxing provide them with a stronger sense of agency and physical strength that would help combat PD, it also provided them with a cathartic and emotional release when hitting the heavy bags, a phenomenon only outlined by one other qualitative study specific to boxing for PD. MacCosham et al. (2019) suggested that the emotional release and physical exertion experienced when boxing heavy bags could be used as a way for PwP to cope with their diagnosis. Similarly, a scoping review investigating the impact of non-contact boxing programs on mental health suggests that boxing activities can be used as a way to release emotional stress, anxiety and anger (Bozdarov et al., 2023). One of the studies included in the review examined the benefit of non-contact boxing with individuals who are struggling with depression, anxiety and psychosis (Hefferon et al., 2013). Reflecting the experiences of our participants, these individuals felt a sense of loss in their physical activity as a consequence of their mental health difficulties. However, the boxing activities made them feel empowered, as well as physically and emotionally stronger. Bozdarov et al. (2023) also suggest that non-contact boxing is a promising intervention to relieve mental illness, which may be significant as anxiety is a common non-motor symptom for PwP (Schapira et al., 2017) and was a debilitating experience for some of our participants. However, more standardized trials are warranted to confirm these suspicions.

As common barriers to participation in exercise for PwP can involve external circumstances such as weather and travel (Ellis et al., 2013; Johnson et al., 2018; Schootemeijer et al., 2020), the virtual platform helped to overcome this. The boxers experienced a sense of

freedom in being able to participate regardless of weather and travel concerns. The opportunity to join vRSB from home allowed one boxer in particular to have the freedom to work full-time while still continuing to participate in RSB almost every day. Others gained the freedom to access boxing class without depending on their friends or spouse for transportation. Common among the boxers was the freedom to have more time for other activities during the day, while still maintaining a consistent workout schedule. As we will see later, however, this increase in freedom came at the cost of the cathartic experience due to the lack of equipment at home. This freedom was additionally contingent upon proper navigation skills of the online setting and an absence of technological issues. Difficulties such as poor internet connection and trouble operating online portals were experienced. Without adequate support, technological complications can act as a barrier to a platform that is meant to make physical activity more accessible. This is echoed in previous studies focusing on home-based exercises aimed at understanding adherence, barriers, and the experience of participation in home-based exercise programs for older adults and PwP (Gray et al., 2022; Rowsell et al., 2022; Torriani-Pasin et al., 2022).

### 3.6.2 *The Physical Experience*

As individuals entered RSB for the first time, they were met with a plethora of new terms and movements that they had to learn. Each participant described how unexpectedly challenging the workouts were, not only in terms of physical exertion, but also in terms of understanding the boxing language and commands. Some participants described how the coaches would give boxing commands using terms and numbers as the individuals boxed. Examples of some of these commands included 'uppercut' (P5 – 11:43), 'jab across' (P5 – 11:43), and 'one-three-five' (P3 – 05:11). Translating commands into action may be representative of a dual-task activity, which is seen to increase postural instability and the risk of falling (Holmes et al., 2010). After interviewing PwP who participated in a high-intensity balance program with dual-task components, Leavy et al (2017) found that the dual-task activities were most memorable for the individuals. The participants felt that in their day-to-day life they had to take 'one thing at a time' (p. 85), and thus described the dual-task components as exposing their weaknesses, and challenging them to overcome them. This may explain why the participants found the boxing programs difficult when they started, having to learn new terms, movements, and commands, all while challenging their postural balance to punch the bag.

Similar to Leavy et al (2017), overcoming these challenges was a positive and favoured experience for the participants. Leavy et al (2017) noted that as PwP overcome difficult challenges, they 'rethink their individual motor and cognitive resources' (p. 88) as they realize they can be pushed farther than they previously thought. Our participants grew in confidence and self-assurance as they witnessed themselves achieve various physical and cognitive results through their participation in the boxing program. After transferring to the virtual setting during the pandemic, many of our participants craved the challenge as the virtual setting presented them with less intense programming. O'Brien et al (2016) found that while some of their participants preferred easier exercises to grow their self-confidence, most others would opt for more difficult challenges in order to obtain what they perceived as better results.

Goal setting is an important part of documenting physical progress. As O'Brien et al. (2016) showed, the process of goal setting for PwP is dynamic and its development can be influenced by factors such as age and disease severity. Many of our participants had broad goals such as fighting PD progression and maintaining health, and they used physical activity to achieve these goals. However, some goals of our participants changed and became more specific as they continued to improve in physical fitness. One participant explained how at first, she joined boxing class because it was purported to help slow down PD progression, and as she continued to exercise she noticed she wanted to improve specifically her back, core, and balance. Another participant also specified her goal as increasing her participation to five sessions a week. Both participants were highly motivated to attend RSB almost every day in both formats, which may suggest that specific goals are more motivating than broad ones.

In both the in-person and virtual settings, the participants appreciated the knowledgeable support they received from the coaches. Most of our participants described the idiosyncratic nature of PD symptoms and noted that tailored or modifiable exercises are valued. Whether the participants were being led through virtual or in-person workouts, coaches were understanding of symptom variability, and provided many different alternative exercises to challenge individuals at different levels. In this way, everyone was given appropriate and optimal challenges.

In general, the virtual exercises were experienced as being less intense, less rewarding, and less satisfying compared to in-person classes. One component that most participants identified missing was the intensity they got from hitting the heavy bags and using the other equipment options. Without this, they lost the sweat-building experience, and the satisfaction

that they received from it. The variety of exercises was also limited due to the limited amount of other equipment such as weights and cardio machines. This, along with the boxing bags, was a significant loss for some individuals and they struggled to engage fully with the virtual class and feel the same physical exertion. Not only did the equipment change this, but the home setting changed things as well, particularly for one participant. She found that the home environment was distracting as they were relatively available to engage in household activities (such as cooking and cleaning) while doing the exercises. This distraction from the workout resulted in the participant feeling less satisfied with their physical progress afterwards. However, despite the lack of intensity, vRSB was still considered good exercise by most of the participants. To them, the meaning of exercise isn't always about working up a sweat, but about moving your body and keeping active. This is in line with Alberts and Rosenfelt (2020) who suggest that the type of exercise may not necessarily matter if the intensity and frequency of the exercise is optimal to stimulate physical benefits.

### 3.6.3 *The Social Experience*

The social aspect of boxing programs for PwP has been extensively highlighted in qualitative literature (Borrero et al., 2022; Brunet et al., 2022; Hermanns et al., 2021; Humphrey et al., 2020; MacCosham et al., 2019; Sheehy et al., 2017). Participants feel supported, encouraged, and connected to one another through their similar circumstances and fight with PD. The boxers in this study were no different. As one participant described, their boxing community felt like a family. Several others referred to the group as friends, and some of these friendships were pursued even beyond the class. There is a certain sense of personal freedom and familiarity when other individuals can resonate with one's circumstances first-hand. With the common ground, mutual support and longevity found in these boxers' relationships, deep connections of friendship are no surprise.

Working alongside others was an important for motivation in several ways. First, the boxers were encouraged to push harder and do more repetitions when they could see another individual pushing themselves harder. This is demonstrated in other qualitative studies interviewing PwP who had participated in exercise programs (Claesson et al., 2020; Leavy et al., 2017). Secondly, working alongside other individuals inspires adherence to exercise programs. Although many of our participants were motivated to continue in both in-person and virtual settings, two participants decided to discontinue in the virtual for the lack of social

connectedness. This lack had impacted their engagement with the class by limiting their sense of accountability and making them feel alone. Yang et al. (2017) compared two groups in which one would engage in three group-based exercise workouts with a physiotherapist a week, while the other group would complete three one-on-one sessions with a physiotherapist each week. Each group was given at-home exercises to do in addition to their classes. Of the two groups, the group-based participants showed greater compliance in completing at-home exercises than the home-based group. The authors suggest this difference may be due to the camaraderie and accountability felt between the group-based participants, as their efforts at home would be seen, supported and praised when they return to the group-based class. Similarly, Franco et al (2015) has shown in a qualitative systematic review that group cohesion is an important motivator to continue exercise in older adults.

Although the virtual setting had created an avenue through which individuals can keep up their relationships with other boxers during times of self-isolation, the virtual setting did not provide the same atmosphere provided by in-person boxing, for developing those deep friendship connections. Meaningful connections for our boxers were made face to face, through impersonal conversations or humour. One reason for this is disconnect is due to the virtual platform on which these boxing sessions were held. Zoom™ software was used in each of our participant's boxing programs. The platform is set up in a way that only allows one person to speak at a time and can only address the whole group. This limited the conversations boxers could have with each other during the workouts and interactions between the coaches and individual boxers. To improve socialization in the virtual setting, some coaches opened the video calls early to allow boxers to chat beforehand. A few coaches would try to facilitate discussion while others kept the floor open for the participants to facilitate themselves. Some participants felt they could still take part in good discussion beforehand, however others still felt that personal connection was limited even then. Domingos et al. (2022) suggest from their 16-week Zoom™ exercise intervention for PwP that keeping microphones active during the exercises contributed to the high attendance and satisfaction rates seen in their results. As many of our participants described keeping themselves muted, this may have limited their social connection during the workouts.

Furthermore, the coaches were limited in their ability to individually instruct, and correct form without addressing the rest of the boxers. This limited perceived accountability, and favoured boxers having prior knowledge of the exercises to be able to modify themselves as

needed. Flynn et al. (2022) found similar results when they interviewed individuals who had undergone 10 weeks of predominantly home-based or predominantly centre-based exercise programs. Each group had attended an in-person group for the first five weeks. During the remaining five weeks the home-based group engaged in three home workouts and the centre-based group engaged in two in-person workouts and one home-based workout. The home-based group greatly appreciated the in-person sessions at the beginning of the trial as they felt more competent and equipped to do the exercises at home. Additionally similar to the findings of our study, individuals in the home-based program also appreciated the convenience of home exercise, but they missed the social contact that they had in person and lost motivation, interest, and prioritization due to a lack of accountability (Flynn et al., 2022). Claesson et al. (2020) found that PwP needed coach interaction to tell them what to do or else they likely wouldn't engage in exercise. Even having high demands from the trainers is suggested to be motivating (Leavy et al., 2017). Furthermore, being supervised intensively has been identified as a motivator in a recent review (Schootemeijer et al., 2020). The authors suggest that apps and physical activity trackers may provide more avenues to monitor and give feedback, which could increase motivation and accountability.

Sheehy et al. (2017) examined how PwP make social comparisons when interacting with other PwP, and these social comparisons can be negative or positive. Although it may be encouraging, as previously described, to see an individual with more severe symptoms exercising well, it is often discouraging to see individuals who are advanced in their symptoms. It was particularly difficult to see individuals with severely advanced symptoms for one of our participants, as they did their best to maintain a healthy lifestyle for years. For her, it was disturbing to see both individuals who are already advanced in their symptomology, and individuals who are progressing fast. However, the virtual setting limited these negative social aspects by limiting the visibility of other participants, despite also limiting the positive social aspects.

#### *3.6.4 Connections to Self-Determination Theory*

Overall, our participants demonstrated great motivation to participate, as adherence to RSB and vRSB classes ranged from one to five years. Two participants, however, only attended the virtual setting until the in-person classes were made available again. The rest of our participants remained in both settings after the COVID-19 stay-at-home mandates lifted. Our

findings maintain the postulations of the Self-Determination theory that by supporting or thwarting the basic psychological needs of autonomy, competence and relatedness, the degree to which an activity is autonomously motivated will shift, thus impacting enjoyment and adherence. We suggest that our boxers were more intrinsically motivated to attend in-person RSB classes than vRSB. Rather, vRSB attendance was motivated more by identified regulators. This observation was supported by the data as we came to understand that the basic psychological needs were better supported in the in-person setting and as the boxing equipment made the in-person classes more enjoyable and challenging.

As previously described, autonomy support can be seen by engaging with the ideas, choices and preferences of other individuals (Gagne et al., 2003). From this perspective, autonomy was demonstrated in both settings as our participants were equipped with adequate alternative exercises with which they could accommodate their individual and varying abilities. However, the in-person setting may have provided more opportunity for input and choice such as determining what music to play, or choosing the group stretches. These opportunities were alternatively not described in the virtual setting. Overall, the level of autonomy may not have been drastically impacted by the virtual setting, however, the in-person setting may provide more circumstances in which individual choices contributing to class experience can be made.

Furthermore, competence was fostered through feedback and overcoming optimal challenges (Ryan & Deci, 2000). These are aspects that were seen in each participant's descriptions of the in-person class. However, in the virtual setting, visibility and coach-boxer interactions were reduced, and individual feedback was more difficult to achieve. Furthermore, the virtual setting was perceived to be less challenging than the in-person setting. Although some qualitative researchers describe easier challenges as being preferred, as they stimulate feelings of accomplishment in PwP (O'Brien et al., 2016), many of the participants in this study did not feel as satisfied after a virtual workout.

Finally, relatedness is fostered through an increased sense of belonging, connection and reaching a common goal alongside others (Ryan & Deci, 2000). Relatedness helps to facilitate internalization of external motivations. Many of the boxers described feelings of belonging inside RSB classes, and developed friendships that extended beyond the class. They felt encouraged and motivated when working alongside other individuals, as they would often compare their physical exertion to the exertion of others and be inspired to work harder. This



was all demonstrated in our boxer's descriptions of their social experience in the in-person setting. In the virtual setting, however, it was difficult to see the other boxers during the workout, and even more difficult to speak one-on-one with them as the exercises were happening. This was due to the nature of the virtual platform as only one person could speak at a time and could only address the entire class. This minimized personal connection and accountability between the boxers during the workouts, which subsequently impacted the intensity and enjoyment of the class.

As noted previously, the in-person setting provided participants with the freedom to use a variety of punching bags during their workouts. Most of our participants considered the boxing activity to be enjoyable and cathartic and noted that it provided emotional release. Unless the individual made the choice to have boxing bags in their home, they had to participate in virtual RSB through an activity called 'shadowboxing' or punching the air. This further resulted in a loss of engagement, intensity, and enjoyment, although some appreciated keeping familiar with the movements. As intrinsic motivation describes the activity as the reward itself in terms of enjoyment and satisfaction (Ryan & Deci, 2000), it became clear that the boxers suffered a loss of enjoyment in the boxing activity when they no longer had a variety of boxing equipment to work with. Despite the shortcomings in the virtual setting, most of the participants continued attendance in both online and in-person classes as they believed the workouts to be physically beneficial. This suggests a shift from intrinsically motivated attendance in the in-person setting to being more influenced by identified regulators to attend the virtual setting (Ryan et al., 2009). For some of the participants this loss of intrinsic motivation in the virtual setting was significant, and adherence to the virtual setting ended once the in-person classes were made available again.

### 3.7 Limitations

Our study was not without limitations. First, although the analysis process was reviewed, critiqued and approved by several members of the research team (as were the research outcomes), the bulk of the transcription and analysis work was performed by one researcher. With the lack of at least a second researcher working transcripts and analysis, there is a chance some concepts and ideas may have been overlooked and lost. Second, although boxing programs typically have a male majority (see chapter two), our study included a female majority, with only one participant being male. This response bias may be due to the possibility of fewer males

participating in virtual settings of RSB, a condition that was an inclusion criterion for this study. However, gender differences surrounding the likelihood of participating in virtual home-based boxing exercises have not yet been explored. Nevertheless, this may impact our results as it largely excludes a male perspective. Finally, as we exclusively interviewed participants using the online platform Zoom™, we remained coherent with the context of experience in which we wanted to study. However, this may have excluded the voices of individuals who may have used Zoom™ in the past, but are currently unable (or unwilling) to use this online platform at this present time.

### 3.8 Future Implications

In this study, we examined the experiences of individuals who have participated in both virtual and in-person settings of RSB. Although this was valuable to our understanding of the experiences of vRSB in comparison to the experience of the in-person setting, future qualitative studies should pursue the experiences of individuals who have only participated in the virtual setting. This could further illuminate aspects of the virtual setting that are conducive or antagonistic to the influences on motivation. Additionally, program managers should explore ways to improve social interactions and visibility between boxers and coaches during remote exercises with apps, physical activity trackers and other technological options. This could help promote motivation by providing an avenue in which individuals can receive more feedback and feel accountable to others. Affordable options for at-home boxing equipment should also be explored by program managers in order to increase the intensity of the workouts. Furthermore, a strong theme within our study was the experience of emotional release during physical combat with the boxing bags. This was described by many of our participants, however few peer-reviewed studies thus far have examined the impact of the activity of boxing on mental health (Bozdarov et al., 2023). Future studies should qualitatively and quantitatively examine this potential benefit of boxing activity for PwP in particular, as the longevity and progression of PD is distressing, and mental health complications are common non-motor symptoms (Schapira et al., 2017). Finally, future research should investigate potential gender differences for engaging in online, remotely supervised workouts, and in particular virtual boxing workouts.

### 3.9 Conclusion

This was the first study to examine experiences in synchronous home-based boxing exercises for PwP. This study has collected and analyzed the meanings of three different aspects to this experience: the individual experience, the physical experience, and the social experience. The secondary aim of this study was to identify whether the psychological needs of autonomy, competence, and relatedness, three components necessary for the cultivation of intrinsic motivation (Ryan & Deci, 2000) were supported in the virtual environment. Overall, our participants enjoyed the RSB program for its engaging and cathartic boxing activities, challenging exercises and highly sociable environment. The virtual setting provided convenience and opportunity to participate apart from travel and weather concerns, but it ultimately lacked in intensity and social accountability. Furthermore, the psychological needs of autonomy, competence and relatedness were better supported in the in-person setting. Program coordinators should explore ways in which to make boxing equipment more portable and affordable for the home setting, and ways in which to increase socialization within their virtual boxing programs.

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## Chapter 4

### Conclusion

#### 4.1 Introduction

In this chapter we gave an overview of the research goals that guided both the scoping review and the qualitative study, which can be found in chapters 2 and 3, respectively. This chapter then discussed how the researchers addressed these goals and how their results would affirm aspects of the motivational theory known as Self-Determination Theory (SDT). Additionally, researchers discussed how their findings can guide virtual boxing programs in the future. Finally, the gaps in research, limitations and strengths found within these studies and the avenues future studies may have to build on this work were addressed.

#### 4.2 Scoping Review

Non-contact boxing for Parkinson's disease (PD), including Rock Steady Boxing (RSB), has risen in popularity, both in research and in practice. RSB was conceptualized in 2003 (Rock Steady Boxing, n.d.) and started to be referenced within the literature in 2011 (Combs et al., 2011). Since then, the impact of non-contact boxing on motor and non-motor symptoms of PD has been increasingly explored. This growth in research called for a scoping review to understand what has been and is being done in research and to determine the gaps thus far. To do this, we conducted a wide-scale search, using a highly detailed search strategy across eight databases. In addition, we conducted supplemental searching of article references and through the common search engine Google Scholar™. We found a total of 1,422 articles from our primary and supplemental searches and extracted 51 articles that aligned with our inclusion and exclusion criteria. Of these 51 articles, we identified 20 peer-reviewed articles, and 31 grey literature abstracts, presentations, and student projects. Of these studies we classified 24 interventional studies, 15 observational studies, and 12 qualitative and mixed method studies. We found that most outcomes focused on the quality of life and motor symptoms such as mobility, gait, and balance. The less-studied outcomes consisted of motor symptoms such as strength, fine motor skills and coordination, and non-motor symptoms such as sleep, depression, anxiety, apathy, and vocal control. Qualitative studies featuring the experiences of virtual boxing

programs also lacked. Overall, this study gathered and synthesized 51 research articles, presentations and student projects studying the impacts of boxing on symptoms in persons with Parkinson's disease (PwP).

### 4.3 Qualitative Study

Each of the qualitative articles found through our scoping review focused on PwP participating in in-person boxing classes. However, the stay-at-home mandates set forth in response to the COVID-19 pandemic in 2020, shifted many boxing programs online. As the change in setting from in-person to virtual overcomes barriers such as travel and weather concerns, there are other aspects of the setting that may be experienced in a negative light such as isolation and self-accountability. Therefore, our primary research goal was to understand the experience of PwP participating in virtual forms of RSB. Furthermore, we wanted to understand how the experiences of virtual and in-person RSB are compared to one another. To do this, we purposively recruited PwP who had participated in both in-person and virtual forms of RSB. Additionally, as understanding motivators behind joining and maintaining participation in a workout program is important for PwP, our secondary aim was to understand influences to motivation experienced in the virtual setting. The motivational theory we chose to investigate motivation with was inspired by the work of Brunet et al. (2022) who engaged with the Self-Determination Theory (SDT) to understand the ways in which the psychological needs for autonomy, competence and relatedness were supported within an in-person boxing program for PwP. SDT is a motivational theory commonly used for physical activity and exercise (Ryan & Deci, 2000). From this evidence, we wanted to investigate whether the virtual setting supported the psychological needs for autonomy, competence and relatedness and thus influencing motivation to maintain long-term exercise behaviour. To meet these research goals, we conducted an Interpretive Phenomenological Analysis (IPA), collected data in the form of semi-structured interview transcripts from six PwP that met our criteria, and analyzed the data using an intricate process of analysis outlined by Jonathon Smith to examine the themes (Smith et al., 2021).

## 4.4 Contributions

The findings from our scoping review sheds light on the current advances in literature, and especially on what avenues we should pursue in future research. Outcomes such as mobility, gait, balance, and quality of life were commonly studied, especially in the peer-reviewed literature. It is important then to consider the less commonly studied outcomes such as sleep, depression, apathy, strength, fine motor skills, coordination, and vocal control, as these aspects are also impacted by PD progression and can affect one's quality of life.

From the results of our qualitative study, we found that there are three important aspects outlining the experience in virtual boxing programs: the individual; the physical; and the social experience. In our first theme, deemed 'In the Ring with Parkinson's' we identified that individuals with PD feel a significant loss of control because of the disease. However, after joining RSB, they valued the boxing program as a way to take back their control. Even more, they found a cathartic emotional release from the boxing activity itself when using proper boxing equipment.

In the physical experience theme titled 'The Physical Impact of vRSB', the boxers expressed how they felt stronger, more capable, and more confident in in-person RSB after seeing their physical progress exceed what they originally thought they were capable of. With the transition to the virtual format, however, the boxers found that they no longer had that same challenge without the equipment and particularly without the boxing bags. As a result, the virtual experience felt less satisfying than the in-person classes.

Finally, the social aspect titled 'The Virtual Setting Limits Interactions in Positive and Negative Ways' outlines the ways in which the positive feelings of belonging, connection and camaraderie were felt in the in-person classes but were missing from the virtual setting. This greatly impacted the engagement, accountability, and enjoyment for some of our participants as our participants could no longer see or communicate with each other during the exercises. However, as seeing the disease progression and advanced symptoms in others can be a difficult experience and more potent in a physical activity context, the virtual setting also minimized this negative aspect.

Furthermore, the in-person setting may be better equipped to support the psychological needs of autonomy, competence, and relatedness. Autonomy was maintained in the virtual setting as the individuals were given a variety of ways they could modify and individualize their



workouts, still be able to modify the exercises and join the class no matter what they had to do that day. However, the in-person setting allowed for more choice within the class such as giving participants the opportunity to choose the music or the stretching activities. With competence, feedback was limited and thus the boxers had to rely on knowledge from previous in-person classes on how to do the exercise correctly. The workouts in the virtual setting were also less challenging, which impacted feelings of satisfaction and accomplishment. Finally, relatedness was the most impacted, as virtual interactions were often one-way apart from the social sessions at the beginning and end of the workout. During the workout, however, individuals did not feel encouraged to work harder by their fellow boxers and deep relationships were more difficult to foster. For some of the boxers, the limitations in the physical and social aspects were enough for them to stop attending the virtual setting completely, while many of the other boxers continued because they identified the exercise to be beneficial despite these limitations.

This shed light onto what program instructors should consider when they lead synchronous virtual programs. It may be beneficial for software developers to investigate ways in which communication and visibility can be more open and accessible for group home-based exercise programs. With boxing in particular, lack of equipment within the in-home environment was a significant factor. Program coordinators should examine different options in portable and cost-effective boxing equipment in which they could offer to their home-based boxers.

#### 4.5 Relation to Existing Theories

SDT proposes that activities done out of autonomous motivation are more likely to be sustained in the long-term. The most autonomous type of motivation, intrinsic motivation, is suggested to be the most optimal for sustaining long-term behaviours. In our study we found that individuals who attended in-person classes experienced enjoyment and satisfaction with the boxing activities themselves. This experienced enjoyment suggests that the boxing activity was the reward itself, representing an intrinsically motivated activity. The psychological needs of autonomy, competence and relatedness were also better supported in the in-person classes. Furthermore, most of our participants had been attending in-person RSB for several years. From this evidence, we suggest that they had experienced intrinsic motivation to participate in in-person RSB. When the class shifted to online, their autonomous motivation also shifted to be more influenced by identified regulation. For example, our participants continued in the virtual

because they knew the exercises would improve their health, rather than to achieve the same level of enjoyment and satisfaction as the in-person classes. Furthermore, some participants ceased virtual participation after in-person classes re-opened. Their participation in the virtual setting thus appears to be more influenced by extrinsic identified regulators than intrinsic motivation. These results maintain that when the basic psychological needs are thwarted by a change in environment, then motivation will shift from a more autonomous position to a less autonomous position. This also supports the idea that the degree of autonomous motivation can influence the persistence of behaviour, as demonstrated by the individuals who did not continue in the virtual setting.

#### 4.6 Limitations

These studies present with several limitations. In our scoping review, more than half of the included articles consisted of grey literature such as conference abstracts, poster presentations and post-secondary student projects. Although the inclusion of these articles presented a more comprehensive view of research activity in this area, many details were lost such as length of the boxing program, type of tests used, and even results due to the nature of these articles. Thus, what is currently being done in current non-peer reviewed literature was difficult to comprehensively outline. Our qualitative study also presented with limitations in the recruitment and analysis phases of our research. First, our population of participants who agreed to participate in the research consisted mainly of females, with only one individual being male. This gender disparity may be attributed to the conditions in which participation was granted in the study. Individuals were included if they had participated in both virtual and in-person forms of Rock Steady Boxing. It may be that fewer males participated in virtual boxing, in comparison to females. However, this gender bias regarding virtual boxing has not yet been explored in research. Nonetheless, this presents with limitations in our understanding of possible differences between male and female experiences in virtual RSB. Our method of interview was also selective towards those who could access and utilize Zoom. This was coherent with the context in which we wanted to examine experience, but it may have limited our patient population and the experiences of those who cannot currently access virtual platforms. Furthermore, the transcription and analysis phases of our research was completed by one research team member.

Although the analysis and transcripts were presented to the other research team members for review and critique, there is still a risk of oversight.

#### 4.7 Strengths

Despite the limitations listed above, the scoping review and the qualitative study included many strengths. First, the scoping review search was conducted with the guidance of several librarians at Western University. Together with their insight, the first reviewer (LNM) constructed a comprehensive search strategy for eight databases. Secondly, database searching, title and abstract screening, and extraction of the results was led independently by two reviewers (LNM, LGM), and conflicts were resolved by a third reviewer (AMJ). This allowed multiple insights and perspectives to inform decision making throughout data collection and extraction. With regards to the qualitative study, IPA focuses on an in-depth analysis of an individual's experience, therefore thick descriptions were included in the analysis. IPA also encourages the recruitment of homogenous groups of individuals to get a firm understanding of the context surrounding the phenomenon at hand. Therefore, purposive sampling was conducted, and participants with Parkinson's disease who had participated in both virtual and in-person RSB were recruited. Finally, to maintain coherence within data collection, the interviews were conducted using Zoom™, an online conferencing platform that virtual RSB classes are commonly held on. Each of these factors contributed to this study's credibility and strength.

#### 4.8 Gaps in Research and Recommendations for Future Studies

The neurological impact that impairs mobility and balance also impairs non-motor functions such as sleep, cognition and psychological well-being leading to depression, anxiety and apathy (Schapira et al., 2017). So far in the peer-reviewed literature, boxing interventions for PwP have focused on the impact on motor symptoms while exploration into the impacts on these non-motors symptoms is minimal. In particular, examination of the effects of boxing interventions in PwP with depressive and cognitive symptoms should be examined as this may greatly impact quality of life. Likewise, speech impairments progress with the disease, leading to communication difficulties. The impact of boxing interventions on speech impairments has not been explored, despite several articles describing vocal activities within their programs. Although motor symptoms are an important area of PD research, the impact of boxing

interventions on these non-motor symptoms needs to be explored further. However, research surrounding the impacts of boxing interventions on certain motor abilities such as strength, fine motor skills, and coordination is lacking and warrants further research. Furthermore, individuals with advanced PD were not commonly recruited to boxing studies, and thus the physical impact that boxing interventions may have on individuals with advanced PD should also be considered in future research. Furthermore, the impact of boxing interventions on fall frequency outside of class also remains to be studied more extensively.

Virtual home-based exercise interventions for PwP are generally introduced as individual workouts with some form of remote contact with a physiotherapist or coach. Although this allows for more freedom to schedule the exercises at any point of the day, exercising in the absence of a group may impact the drive to participate. However, few studies have looked into virtual group exercises and their effects on adherence. Furthermore, the long-term impacts of virtual group exercises on adherence needs to be investigated further. As we recruited individuals who had participated in both virtual and in-person settings, it is worth noting that these experiences may differ from individuals who have only attended the virtual setting of boxing programs. This may further illuminate aspects of the virtual experience that could enhance or minimize the motivation to attend and engage in class and merits further exploration. Our study also examined the experience of emotional release during the boxing activity itself. It is unknown if this feeling is experienced in other individuals with neurodegenerative or mobility-impairing conditions and thus warrants further exploration as potential therapeutic route. The potential of this benefit is important to further understand as the progressive nature of PD is inherently distressing, and psychological difficulties, such as depression and anxiety, frequently occur among this population (Schapira et al., 2017).

## 4.9 Conclusion

Research surrounding non-contact boxing programs for PwP has grown rapidly during the past few years. As it continues to grow, it is important to consider what needs to be investigated further. Our study has demonstrated a need for more peer-reviewed interventional papers examining the impacts of boxing programs on non-motor symptoms such as sleep, depression, apathy, and anxiety. Motor symptoms such as strength, coordination, fine motor control also need to be investigated further. Furthermore, as the virtual setting for boxing

programs overcomes barriers to participation such as travel and weather concerns, some aspects of this setting need to be addressed. Although the psychological need of autonomy was not largely impacted, this need is still better supported in the in-person setting. The reduction of intensity with the lack of boxing equipment at home may impact feelings of accomplishment. Additionally, as social contact was reduced, enjoyment, accountability and engagement was also reduced. Finally, the enjoyment and satisfaction experienced through the boxing activity was diminished in the absence of proper boxing equipment and socialization. These changes suggest that our participants were intrinsically motivated to attend in-person boxing classes, and subsequently became more influenced by identified regulators in their motivation to attend the virtual setting.

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## Appendices

### Appendix A

Form A-1: Extraction Template

Table A-1: Study Demographics and Exercise Program Design

Table A-2: Study Outcome Assessments and Results

### Appendix B

Form B-1: Ethics Approval

Form B-2: Interview Guide

**Appendix A Form A-1: Extraction Template****EXTRACTION:**

- a) Year:
- b) Journal:
- c) Author(s):
- d) Title:
- e) Country:
- f) Study Design:
- g) Inclusion Criteria:
- h) Exclusion Criteria:
- i) Number of participants:
- j) Disease Severity:
- k) % Male:
- l) Length of Exercise program:
- m) Length of Workout:
- n) Frequency of Workout:
- o) Warmup length:
- p) Exercise length:
- q) Exercise Activity:
- r) Cooldown Length:
- s) Outcomes assessed:
- t) Outcome assessments:
- u) Frequency of outcome assessment:
- v) Findings:
  - a. Gait
  - b. Balance
  - c. QoL
  - d. Other
- w) Difference in outcomes between disease severity:
- x) Limitations:



**Appendix A Table A-1: Study Demographics and Exercise Program Design**

Authors; Country	Study Design Objective	Population	% Males	Disease Severity*	Program Details (length, frequency, and time of workout) and boxing activities
[1] Ketigian et al., 2022; US	Cross-sectional Observational study, <i>To investigate the practicability, barriers to, and satisfaction of online programs for PwP including virtual Rock Steady Boxing</i>	n = 46	NS	NS	(NS, 2-3/w, 60m) Agility, balance, boxing (punching), footwork, posture, stress coordination, & stretching
[2] Meyer et al., 2022; US	Cohort Observational study, <i>To assess the acute effects of a single boxing session on upper extremity muscle activity</i>	PwP: n = 10; YA: n = 12; OA: n = 14	PwP: 60%; YA: 58%; OA: 57%	NS	(1 session, 45m) Agility, boxing (shadow boxing, focus mitts), footwork, & stretching
[3] Sonne et al., 2022; US	Retrospective Multi-Centre Analysis study, <i>To assess the effects of group-boxing programs for PwP</i>	n = 68	79%	NS	(6-24 mo, 2-3/w, 75-90m) Aerobics, agility exercises (footwork patterns, large amplitude stepping), boxing (punching bags), hand-eye coordination/manual dexterity exercises, resistance exercises (free weights & bands), stretching, & walking laps
[4] Brunet et al., 2021; Canada	Qualitative – NS, <i>To investigate the experience of PwP participating in a boxing program and its influences on motivation towards physical activity</i>	n = 9	55.6%	Mild-Severe [2-16], average: Moderate [7]	(6+w, 2/w, 45m) Boxing, balance, cardio, & strength exercises
[5] Hermanns et al., 2021; US	Mixed Methods, <i>To Investigate the effects of boxing on balance, quality of life, &amp; depressive symptoms in PwP and participation experience of PwP and their caregivers</i>	<u>Quan</u> : n = 6 <u>Qual</u> : n = 15 BOX: n = 6 CARE: n = 9	BOX: 67% CARE: 22%	NS	(12w, 2/w, 60m) Balance, boxing, fine-motor tasks, vocal exercises, memory exercises, mobility training, strength, & stretching
[6] Horbinski et al., 2021; US	Longitudinal Descriptive Observational, <i>To investigate the longitudinal effects of boxing on fall risk in PwP</i>	Pre-Lockdown: n = 98  Post-Lockdown: n = 81	78%	NS	(~23 mo, 2/w, NS) Boxing exercises
[7] Larson et al., 2021; US	Cross-sectional Observational study, <i>To compare population demographics between current, past and never participants of boxing</i>	n = 1709 Current P = 1333 Past P = 166 Never P = 210	Current & Past RSB P: 59%	NS	(NS, NS, NS) NS
[8] Moore et al., 2021; US	Retrospective Cross-sectional study, <i>To Investigate the effects of boxing on fall risk reduction and balance in PwP</i>	n = 12	75%	Mild-Moderate (1-3)	(~6 mo, 2-3/w, 90m) Boxing drills (jabs, hooks, uppercuts), fine motor activities (tying shoes, picking up small things, stringing beads), & strength/endurance exercises (speed bags, ball slams, bodyweight squats)

[9] Sangarapillai et al., 2021; Canada	Randomized Control trial, <i>To compare the effects of boxing and sensory training on PwP</i>	BOX: n = 20 PDSAFE: n = 20	BOX & EX: NS	BOX & EX: Mild-Moderate (2.5)	(10w, 3/w, 60m) BOX: Boxing exercises PDSAFE: Sensory specific exercises, stretching, cardio exercises
[10] Shearin et al., 2021 US	Pre-Post Intervention study, <i>To investigate the effects of boxing on gait parameters, dual-task and backwards walking in PwP</i>	n = 26	77%	Mild-Moderate (1-3)	(12w, 2/w, 60m) Boxing (fast punching activities), footwork, & strength activities (upper & lower exercises, eccentric control)
[11] Borrero et al., 2020; UK	Qualitative – Phenomenology, <i>To understand the meaning of participating in multiple vigorous intensity exercises</i>	n = 8	100%	Mild (2)	(NS, NS, NS, but 120-388m per week of RSB, 5-13.8h per week of total exercise) RSB program involves agility, endurance exercises, footwork, hand-eye coordination, speed, & strength exercises. Other vigorous exercises entail running, swimming, cycling, & weightlifting
[12] Dawson et al., 2020; US	Retrospective Observational study, <i>To investigate the effects of boxing in PwP</i>	New & Returning P = 47	72%	NS	(16w, 1/w, 90m) Agility, balance, boxing (punching bags, combinations), cardio, core, fine motor exercises, footwork, gait, hand-eye coordination, strength, & vocal exercises
[13] Humphrey et al., 2020; US	Qualitative – Phenomenology, <i>To understand the experience of PwP participating in a boxing program</i>	n = 10	70%	Less severe-More severe *Based on class placement	(NS, 2-3/w, 75m) NS
[14] Urrutia et al., 2020; US	Pilot Pre-Post Intervention study, <i>To investigate the effects of boxing on sleep quality and daytime sleepiness in PwP</i>	n = 15	67%	Mild-Moderate (1-3)	(6w, 2/w, 50m) Boxing exercises
[15] Domingos et al., 2019; Sweden	Qualitative – Descriptive Design, <i>To evaluate the acceptability and safety of a boxing program for PwP</i>	n = 17	NS	Mild-Moderate (1-3)	(1-18mo, 2-4/w, 70m) Boxing (combinations, increasing speeds, focus mitts), functional training (sitting-standing, walking & turning, lower limb with bobbing maneuvers), & cognitive loads
[16] MacCosham et al., 2019; Canada	Qualitative – Phenomenology, <i>To understand the experience of PwP participating in a boxing program</i>	n = 12	58.3%	NS	(1-12 mo, ~2/w, 50-70m) Balance, boxing, cardio, endurance, strength, & voice exercises
[17] Clack et al., 2017 US	Pre-post Intervention, <i>To assess the changes in cognitive function and quality of life associated with exercise in individuals with Parkinson's and their caregivers</i>	n = 23 PwP = 14 CARE = 9	NS	Mild-Moderate (~2.4)	(6w, NS, NS) Agility (ladder drills), boxing, strength training, whole body movements
[18] Sheehy et al., 2017; Canada	Qualitative – Interpretative Phenomenological Analysis,	n = 20	40%	NS	(NS, NS, 90m) Anaerobic, boxing (speed bag, jump rope), resistance, flexibility

[19] Combs et al., 2013; US	<i>To understand the experience of social comparisons, social support, &amp; self-perception in PwP participating in a boxing program</i> Single-blind Prospective Randomized Control trial, <i>To compare the effects of group boxing training to traditional exercise in PwP</i>	BOX: n = 17 EX: n = 14	BOX: 65% EX: 71%	Mild-Moderate (2-3)	(12w, 2-3/w, 90m) BOX: Boxing, cardio, endurance, & strength exercises EX: Balance, endurance & strength exercises
[20] Combs et al., 2011; US	Case series, <i>To investigate the effects of boxing training on mobility and quality of life in PwP, and compare effects across disease severity</i>	n = 6	100%	Mild-Severe (1-4)	(9mo, 2-3/w, 90m) Boxing, cardio, endurance, & strength exercises
[21] Blacker et al., 2021 Australia	Protocol for a Feasibility study, <i>To determine the feasibility &amp; logistics of a boxing program for PwP</i>	NS	NS	NS	(15w: 4w blocks separated by 1w recovery, 3/w, 30-60m) NS
[22] Benoit et al., 2020; Canada	Retrospective Observational study, <i>To investigate the long-term effects of boxing training on mobility and quality of life in PwP</i>	n = 23	NS	NS	(12-16mo, 2/w, 90m) Agility, boxing, footwork, & fine-motor exercises
[23] Shearin et al., 2020; US	Intervention study, <i>To investigate the effects of boxing training on mobility and gait in PwP</i>	n = 20	NS	NS	(12w, 2/w, 60m) Boxing (punch bag), core, footwork drills, & strengthening with a focus on lower extremities.
[24] Ghaffar et al., 2019; US	Pre-Post Intervention study, <i>To investigate the effects of boxing training on cognition, mental health, &amp; quality of life in PwP</i>	n = 44	75%	Mild-Moderate (1-3)	(12-36w, 1/w, NS) NS
[25] Ghaffar et al., 2019; US	Randomized Control trial, <i>To investigate the effects of boxing training on procedural memory in PwP</i>	n = 28 BOX: n = 14 CTRL: n = 14	NS	NS	(NS, NS, NS) NS
[26] Pino et al., 2019; Chile	Pilot Pre-Post Intervention study, <i>To investigate the effects of boxing training on mobility in PwP</i>	n = 15	NS	Mild-Moderate (1-3)	(12w, 3/w, NS) NS
[27] Larson et al., 2018; US	Pre-Post Intervention study, <i>To investigate the effects of boxing training on mobility in PwP</i>	For 12 w: n = 12 For 24w: n = 5	58%	NS	(6mo, NS, 90m) NS
[28] Riemann et al., 2017; US	Cohort Observational study, <i>To investigate the effects of exercise on mobility, cognitive function and quality of life in PwP &amp; caregivers</i>	n = 42, PwP: n = 24 CARE: n = 18	NS	NS	(6w, NS, NS) Agility, boxing, strength training, whole body movements

[29] Denney et al., 2016 US	Feasibility study, <i>To investigate the feasibility of a boxing training program for PwP</i>	n = 6	NS	Mild (1-2)	(6w, 2/w, 30m) Boxing (combinations, heavy bag, focus mitts)
[30] Domingos, 2016; Portugal	Intervention study, <i>To test the applicability of using BoxMaster equipment in a boxing program for PwP</i>	n = 8	NS	Mild-Moderate (1-3)	(12w, 1/w, NS) Boxing combinations using the BoxMaster
[31] Combs et al., 2013; US	Longitudinal Cohort study, <i>To longitudinally compare walking function between PwP who participate in boxing and those who do not</i>	n = 65 BOX: n = 39 NO-BOX: n = 26	71%	Mild (1.75)	(12mo, NS, NS) NS
[32] Patel et al., 2022; US	Pilot Pre-Post Intervention study, <i>To investigate the effects of boxing training on motor &amp; non-motor symptoms in PwP</i>	n = 14	NS	NS but PwP were ambulatory & functionally independent	(12w, NS, NS) NS
[33] McLeod et al., 2019; US	Quasi-Experimental Comparative study, <i>To investigate the effects of boxing training on cognition in comparison to regular exercise for PwP</i>	BOX: n = 10 EX: n = 9	NS	NS	(NS, NS, NS) NS
[34] Meinert & Hatkevich, 2019; US	Qualitative – NS, <i>To investigate the effects of boxing training on speech, social skills and mental health in PwP</i>	n = 7	NS	NS	(NS, NS, NS) NS
[35] Clack et al., 2017; US	Observational study <i>To assess the changes in functioning associated with exercise in individuals with Parkinson's disease</i>	n = 42	NS	NS	(6w, NS, NS) Agility, boxing, strength training, whole body movements
[36] Seibert et al., 2017; US	Intervention study, <i>To investigate the efficacy of boxing as a modality of exercise for PwP</i>	PwP: n = 12 CARE: n = 9 TRAIN: n = 3 RESEARCH: n = 4	NS	NS	(12mo, NS, NS) NS
[37] Gobert et al., 2021; US	Longitudinal Observational study, <i>To investigate the relationship between motoric PD assessments &amp; long-term HIIT programs with boxing activities</i>	n = 42	NS	Mild-Moderate (1-3)	(6-12mo, 2-3/w, 45-60m) Boxing, & total body HIIT exercises
[38] Gobert & McDowell, 2020 US	Intervention study, <i>To investigate the dosage response to HIIT exercises with boxing activities for PwP</i>	n = 37	73%	Mild (1-2)	(6mo, 2-3/w, 45-60m) Boxing, & high intensity whole body exercises
[39] Denney, et al., 2019; US	Feasibility study,	n = 6	50%	Mild (1-2)	(6w, 2/w, 50m) Boxing exercises

[40] Pascal, 2018; US	<i>To investigate the effects of boxing on sleep quality and daytime sleepiness in PwP, the impact sleep has on mobility in PwP</i> Longitudinal Observational study, <i>To investigate the effects of HIIT exercises with boxing activities on reaction time for PwP</i>	n = 20	NS	Mild-Severe (1-4)	(9 mo, 1-3/w, 90m) NS
[41] Pascal et al., 2018; US	Longitudinal Observational study, <i>To investigate the effects of HIIT exercises with boxing activities on balance &amp; gait for PwP</i>	n = 20	NS	NS	(9 mo, 1-3/w, 90m) NS
[42] Shearon et al., 2018 US	Pre-Post Intervention study, <i>To investigate the immediate effects of a single boxing session on physical and cognitive function</i>	n = 13	NS	NS	(NS, 2.5/w, 90m) Agility, balance, boxing (punching coordination), core strengthening, flexibility, vocal exercises, & weight lifting
[43] Foster et al., 2013 US	Preliminary Observational study, <i>To assess the physical progress of PwP participating in 6 months of RSB</i>	n = 30	NS	NS	(6mo, NS,, NS) NS
[44] Diehl et al., 2011; US	Pilot cohort study, <i>To compare the effects of boxing training on balance and quality of life to traditional exercise</i>	n = 20 Sizes of BOX & EX groups NS	NS	NS	(12w, 2-3/w, 90m) BOX: Boxing, cardio, strength, & stretching exercises EX: Balance, cardio, strength, & stretching exercises
[45] Hall et al., 2022; US	Cross-Sectional Survey, <i>To investigate the effects of boxing training on PwP's perception of improved proprioception</i>	n = 18	61%	Majority were Mild to Moderate *scale not identified	(1-8y, 3/w, NS) NS
[46] Henige et al., 2022; US	Pilot Study - Preliminary Analysis of Longitudinal Observational study, <i>To investigate the longitudinal effects of boxing training on physical activity in PwP</i>	n = 6	NS	NS	(1mo, NS, 60m) NS
[47] Sloane, 2022; US	Qualitative – Ethnography, <i>To understand the experience of PwP participating in a boxing program</i>	Interview: n = 13 Conversations: n = 60	Interview: 38% Conversations : 67%	NS	(NS, 4-5/w, 90m) Balance, boxing (combinations, heavy bag punching, sparring, speed bags), footwork, lunges, vocal exercises, & dual task activities
[48] Ricossa et al., 2021 US	Proposal for a Mixed Methods study, <i>To investigate if a fine motor program at RSB would improve movement, function and quality of life in PwP</i>	NS	NS	NS	(NS, NS, NS) Vigorous exercise
[49] Bignal, 2020 US	Qualitative – NS, <i>To investigate whether PwP perceive an impact on their daily life and secondary occupations as a consequence of participating in a boxing program</i>	n = 17	82%	11 Mild-Moderate 6 Moderate-Severe *Based on class placement	(NS, 2-3/w, NS) NS
[50] Hoime et al., 2018	Pilot Pre-Post Intervention study,	n = 10	50%	NS	(11w, 1/w, 90m)

<p>US [51] Bunyan et al., 2017; US</p>	<p><i>To investigate the effects of boxing training on mobility and quality of life in PwP</i>  Cohort Observational study, <i>To compare the effects of strength and boxing circuit training programs on strength, balance, &amp; quality of life in PwP</i></p>	<p>NS Sizes of BOX &amp; STR groups NS</p>	<p>NS      NS</p>	<p>Agility, boxing (shadow boxing, heavy bags, speed bags, speed mitts) cognitive exercises, dual task activities, endurance circuits, strength, &amp; stretching (8w, NS, NS) BOX: Balance, boxing circuit training, core &amp; upper/lower strength training STR: Balance, strength circuit training, core &amp; upper/lower strength training</p>
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Highlights: Peer-reviewed articles, conference abstracts, supplements, poster presentations, post-secondary student projects. \*The measure used to assess disease severity is indicated by the brackets surrounding the numerical score; two measures were used – (Hoehn & Yahr scale and modified Hoehn & Yahr scale) and [UPDRS III]. Abbreviations used: BOX: Boxing exercise group. CARE: Caregivers. CTRL: Control Group. DS: Disease Severity. EX: Exercise control group. HIIT: High Intensity Interval Training. NO-BOX: Non-boxers. NS: Not Specified. M: % of Males. “m”: Minutes. “mo”: Months. OA: Older adults. P: Participants. PDSAFE: Parkinson’s Disease Sensory Attention Focused Exercise. PwP: Person’s with Parkinson’s Disease. RESEARCH: Research team observers. RSB: Rock Steady Boxing. STR: Strength training. TRAIN: Trainers. YA: Young adults. W: Weeks. “yrs”: Years.

## Appendix A Table A-2 Study Outcome Assessments and Results

Authors	Assessment Frequency	Outcomes	Assessment Measures	Findings
[1] Ketigian et al., 2022	Once	<u>QoL</u>	PDQ-39	NS for vRSB P, but overall good QoL in 61 of P who did the assessment.
		<u>Virtual Participation Experience</u>	Online Survey	Overall self-perceived improvement in motor symptoms and mood. Majority would continue post pandemic. Attendance to two classes per week was high, indicating overall high satisfaction.
		<u>Depression</u>	PHQ-9	NS for vRSB P, but overall low scores of depression in 66 of P who did the assessment
[2] Meyer et al., 2022	Within 30m pre-intervention and immediately post intervention	<u>Upper Extremity Muscle Activity</u>	Electromyography of the biceps brachii & triceps brachii of both arms	Results suggest increased efficiency or better recovery time in the triceps after a single boxing session. No difference between most and least affected sides.
[3] Sonne et al., 2022	BL, 6mo, 12mo, 18mo, 24mo	<u>Mobility</u>	TUG	Significant Improvement at 6 & 12mo
		<u>Gait</u>	10MWT	No significant difference, but positive trend
		<u>Balance</u>	FAB, 30CST	Significant improvement at 6, 12 and 18mo
[4] Brunet et al., 2021	END	<u>Participation Experience</u>	Semi-Structured interviews	Five main values in a BP program: Benefits of choice, staying active, variety in programs and allowing input, adaptable classes, group and trainer socialization
[5] Hermanns et al., 2021	BL & END (12w)	<u>Balance</u>	FAB scale	Majority maintained or improved score
		<u>QoL</u>	PDQ-39	Majority maintained or improved score
		<u>Depression</u>	CES-D scale	Majority had reduced scores
		<u>Participation Experience</u>	Focus groups One-on-one interviews	Three main values in a BP program: Physical benefits, socialization, support & motivation. Caregivers reported emotional and physical benefits, commitment in boxers, and travel concerns.
[6] Horbinski, et al., 2021	Every month, excluding 3 months during the COVID-19 lockdown	<u>Gait</u>	NS	Minimal variance in normal walking speed, ability to walk in a straight line or backwards walking
		<u>Balance</u>	STS SLS	Significant improvements in majority during the pre-and post-lockdown months. A small minority were able to stand on their one leg for the full 30s. For the P who could not single leg stand for the full 30s, they improved by 5-7% each leg every month.
		<u>Falls</u>	Self-reports	Falls decreased by 87%

[7] Larson et al., 2021	Once	<b><u>QoL</u></b>	PDQ-39	Current P had better QoL than Past or Never P
		<b><u>Self-Efficacy</u></b>	SEE scale	Current P have better SEE scores than Past and Never P
		<b><u>Apathy</u></b>	SAS scale	No difference between groups
		<b><u>PD Symptoms</u></b>	Self-report	Majority of Current P had improved social life, less fatigue, less falls, less fear of falling, & fewer depressive & anxiety symptoms. Statistically significant difference between Current and Past P in terms of light headedness, and fatigue.
[8] Moore et al., 2021	BL, ~6 mo	<b><u>Balance</u></b>	FAB	Significant increase in FAB
		<b><u>Fall Risk</u></b>	TUG	Significant decrease in TUG time, but did not meet MDC for PwP
[9] Sangarapillai et al., 2021	BL, END (10w), 20w	<b><u>Gait</u></b>	Zeno Walkway Protokinetics UPDRS protocols	BOX PD symptoms worsened at 10 & 20w compared to baseline. PDSAFE showed greater improvement in symptoms at 10 & 20w than BOX. BOX showed no difference in stride length at 10w, and a decrease at 20w. PDSAFE showed an increase at 10w and maintained the increased stride length at 20w. BOX showed an overall decrease in stride velocity at 20w, while PDSAFE showed an increase.
		<b><u>QoL</u></b>	PDQ-39	Both groups improved at post-program assessment
[10] Shearin et al., 2021	BL, 12w	<b><u>Gait</u></b>	Zeno Walkway Enhanced Gait Variability Index in PKMAS Gait Analysis software	Significant improvement in self-selected gait velocity & cadence. No difference in fast walking. Significant improvement in backwards walking velocity, step length. Significant improvement in dual-task walking velocity, & step length Enhanced gait variability.
[11] Borrero et al., 2020	Once	<b><u>Participation Experience</u></b>	In-depth interviews	Three main values in BP: Socialization with PwP, a sense of purpose, confidence. One negative case of a former elite athlete feeling disappointment and loss instead of empowerment.
[12] Dawson et al., 2020	BL & END (16w)	<b><u>Mobility</u></b>	TUG STS	Significant improvement in New and Returning P Significant improvement in New and Returning P
		<b><u>QoL</u></b>	EQ-5D	New P showed slight but significant increase in pain
		<b><u>Satisfaction</u></b>	Satisfaction survey	Majority responded to survey. Majority reported improvement in stiffness, fatigue, gait and balance. Most had no change in tremors. All respondents enjoyed the program and most would recommend the program and take it again.
[13] Humphrey et al., 2020	Once	<b><u>Participation Experience</u></b>	Semi-structured Interviews	Two main values in BP: Creating a strong core group of people who understand you Not about being the best, but about fighting the disease progression
[14] Urrutia et al., 2020	BL, 7w, 13w	<b><u>Mobility</u></b>	6MWT TUG cTUG	NS NS NS
		<b><u>Sleep</u></b>	PDSS	Non-significant improvement in nocturnal sleep



			ESS	An MCID was reached between baseline and 12w, but no significant scores reported.
		<b><u>Depression</u></b>	HDRS	Score improved at 7 & 13w compared to baseline
[15] Domingos et al., 2019	Once, after 18 mo	<b><u>Program Satisfaction</u></b>	Questionnaire	Large majority were satisfied or very satisfied with the program
[16] MacCosham et al. 2019,	Once, post-program	<b><u>Participation Experience</u></b>	Semi-structured Interviews	Three main values in BP: Physical benefits, socialization, better concentration
[17] Clack et al., 2017	BL, 6w	<b><u>QoL</u></b>	PDQ-39 (for PwP) SF-36 (for CARE)	Statistically significant improvement in function and wellbeing in 79% of participants No statistically significant change
		<b><u>Cognition</u></b>	SCOPA-COG (for PwP)	Statistically significant improvement in cognitive functioning in 50% of participants
[18] Sheehy et al., 2017	One to two assessments, before or after a workout	<b><u>Participation Experience</u></b>	Semi-structured interviews Follow-up interviews	Three main themes in BP: Reticence evolving into inspiration, finding relief through camaraderie and breaking taboos, and maintaining athletic identity through participating and helping others
[19] Combs et al., 2013	1w pre-program, 1w post-program	<b><u>Mobility</u></b>	TUG dTUG	BOX & EX improved significantly BOX & EX improved significantly
		<b><u>Gait</u></b>	GaitRite Walkway 6MWT	BOX & EX improved significantly BOX & EX improved significantly
		<b><u>Balance</u></b>	BBS ABC	BOX & EX improved significantly EX improved significantly and more than BOX
		<b><u>QoL</u></b>	PDQL	BOX & EX improved
[20] Combs et al., 2011	BL, & every 12w	<b><u>Mobility</u></b>	TUG	Improvement in majority of P at 12w, and in all at 36w
		<b><u>Gait</u></b>	6MWT GaitRite Walkway	Improvement in majority of P at 12w, and in all at 36w Gait speed increased for all P at 24w. Cadence increased, stride length increased, step width decreased in mild PwP by 12w, 24w, & 36w but no change for moderate-severe PwP until 24w and 36w
		<b><u>Balance</u></b>	FRT BBS ABC	Improvement in all P at 24w Improvement in all P at 12w Improvement in most P at 24w
		<b><u>QoL</u></b>	PDQL	Improvement in majority of P at 12, 24, & 36w
		<b><u>Disease Severity</u></b>	UPDRS ADL subscale UPDRS Motor Examination subscale	All P showed decreases in the ADL subscale overtime Minority improved by 36w

<p>[21] Blacker et al., 2021</p>	<p>NS</p>	<p><u>QoL</u> <u>Physical/Mental Exertion</u> <u>Sleep &amp; Fatigue</u> <u>Mood</u> <u>Safety</u> <u>Retention &amp; Adherence</u></p>	<p>Not specified Borg scale PD Scales (unspecified) PD Scales (unspecified) Discomfort scales Not specified</p>	<p>Protocol for a feasibility study – no findings yet to report</p>
<p>[22] Benoit et al., 2020</p>	<p>BL, 12-16mo</p>	<p><u>Balance</u> <u>QoL</u> <u>Functional Strength</u> <u>PD Severity</u> <u>Adherence</u></p>	<p>FAB, STS PDQ-39 TUG Hoehn &amp; Yahr NS</p>	<p>NS, NS NS NS NS NS</p>
<p>[23] Shearin et al., 2020</p>	<p>NS</p>	<p><u>Gait</u> <u>Balance</u> <u>Fine Motor Skills</u> <u>Gross Motor Skills</u> <u>Functional Strength</u></p>	<p>Zenomat Walkway with/without dual task condition 4SST 9 Hole Peg Test Box and Blocks STS from floor</p>	<p>Significant improvement in self-selected gait speed Significant improvement in gait with dual task. Significant improvement No significant improvement Significant improvement Significant improvement</p>
<p>[24] Ghaffar et al., 2019</p>	<p>BL, 12w, 24w, 36w</p>	<p><u>QoL</u> <u>Depression</u></p>	<p>PDQ-39 PHQ-9</p>	<p>Improvement Results were significant</p>

		<b><u>Disease Severity</u></b>	UPDRS-II	Difference between BL, 12w and 36w
		<b><u>Cognition</u></b>	MoCA	NS
[25] Ghaffar et al., 2019	BL, 6mo, 12mo	<b><u>Reaction Time</u></b>	SRTT	Boxers showed a greater decrease in response time than non-boxers
[26] Pino et al., 2019	BL & END (12w)	<b><u>Mobility</u></b>	TUG DGI 6MWT	NS Significant improvement NS
		<b><u>Balance</u></b>	MiniBESTest RT US FRT	Significant improvement Significant improvement Significant improvement NS
		<b><u>QoL</u></b>	PDQ-39	Improvement
[27] Larson et al., 2018	BL, 12-14w, 24w	<b><u>Mobility</u></b>	TUG	Small improvement at 12w
		<b><u>Gait</u></b>	10MWT	Small improvement at 12w
		<b><u>Balance</u></b>	BBS	Small improvement at 12w
		<b><u>QoL</u></b>	PDQ-39	Small improvement at 12w
		<b><u>Disease Severity</u></b>	UPDRS I UPDRS II	Small improvement at 12w and 24w Small improvement at 12w
		<b><u>Falls</u></b>	FES-I	Slight decrease in fall frequency
[28] Riemann et al., 2017	BL, 6w	<b><u>Balance</u></b>	Modified clinical test of sensory interaction and balance (for both)	Slight improvement in physical functioning.
		<b><u>QoL</u></b>	PDQ-39 (for PwP) SF-36 (for CARE)	Showed a positive correlation between physical & quality of life outcomes, and a statistically significant change from baseline. Little to no change from pre-test and post-test scores
		<b><u>Cognition</u></b>	SCOPA-COG (for PwP)	Slight improvement between pre-test and post-test scores
		<b><u>Strength</u></b>	Three speed isokinetic testing for knee flex/ext	Slight improvement in physical functioning

			and upper extremity push/pull (for both)	
		<b><u>Hand-eye Coordination</u></b>	Point-Click test, Modified clinical test of sensory interaction (for both)	Slight improvement in physical functioning
[29] Denney et al., 2016	BL, 4w, 6w	<b><u>Mobility</u></b>	NS	Preliminary results indicate that there are no adverse events, PwP are enthusiastic to attend, self-reported improvements in symptoms, and PwP are achieving 60-80% of target HR. Results suggest feasibility.
		<b><u>Balance</u></b>	NS	
		<b><u>Upper-Limb Performance</u></b>	NS	
[30] Domingos et al., 2016	After every session	<b><u>Participation Experience</u></b>	Observations, Satisfaction Survey	Learning combinations with BoxMaster was easier No adverse events (e.g. falling) Participants were satisfied
[31] Combs et al., 2013	BL, 6 mo, 12 mo	<b><u>Gait</u></b>	6MWT, Fast and Comfortable 10MWT	Boxers increased gait endurance greater than non-boxers Boxers had significantly greater comfortable 10 meter walking speed than non-boxers No differences in fast walking speed between groups Neither group had significant changes in walking function over the 12mo period
[32] Patel et al., 2022	BL, 12w	<b><u>QoL</u></b>	PDQ-39, SE-ADL	No change No change
		<b><u>Disease Severity</u></b>	MDS-UPDRS III modified version	Improved significantly
		<b><u>Non-motor Symptom Severity</u></b>	MDS Non-Motor Rating scale	Improved significantly
		<b><u>Depression</u></b>	HDRS	Improved significantly
		<b><u>Apathy</u></b>	LARS	No change
[33] McLeod et a., 2019	BL, follow up assessments NS	<b><u>Physical Activity</u></b>	NS	No significant difference in BOX or EX
		<b><u>Cognition</u></b>	NS	More improvement in BOX
[34] Meinert & Hatkevich et al., 2019	Once	<b><u>Speech</u></b> <b><u>Social Skills</u></b> <b><u>Mental Health</u></b>	Interviews were conducted for all outcomes	Six main themes: Positive effect on speech, Improved comfort level in engaging in social occupations, Positive effect on mood, Positive effect on role function in relationships, Improved well-being, self-perceived health, social connectedness, Positive effect of a community-based group exercise environment

[35] Clack et al., 2017	BL, 6w	<b><u>Balance</u></b>	NS (for both)	Slight improvement in physical functioning.
		<b><u>QoL</u></b>	PDQ-39 (for PwP) SF-36 (for CARE)	Showed positive correlation between physical & cognitive functioning, and patient reported quality of life outcomes. Little to no change.
		<b><u>Cognition</u></b>	SCOPA-COG (for PwP)	Showed positive correlation between physical & cognitive functioning, and patient reported quality of life outcomes.
		<b><u>Strength</u></b>	NS (for both)	Slight improvement in physical functioning.
		<b><u>Hand-eye Coordination</u></b>	NS (for both)	Slight improvement in physical functioning.
[36] Siebert et al., 2017	Every 3 mo	<b><u>Mobility</u></b>	NS	Improvement in speed and precision
		<b><u>Gait</u></b>	NS	Improvement in speed and precision
		<b><u>Balance</u></b>	NS	Improvement in speed and precision
		<b><u>Fine Motor Skills</u></b>	NS	Improvement in speed and precision
[37] Gobert et al., 2021	Every 6-8w	<b><u>Mobility</u></b>	TUG, 5xSTS	NS 5xSTS was stable but weakly correlated to SLS and inversely related to daily step count.
		<b><u>Gait</u></b>	NS	NS
		<b><u>Balance</u></b>	SLS, 4SST	SLS weakly correlated to 5xSTS 4SST inversely related to daily step count.
		<b><u>QoL</u></b>	PDQ-8	NS
		<b><u>Sleep</u></b>	Activity trackers	NS
		<b><u>Grip Strength</u></b>	NS	Improvements in both left and right hands
		<b><u>PD Symptoms</u></b>	UPDRS	NS
[38] Gobert & McDowell, 2020	NS	<b><u>Mobility</u></b>	TUG, 4SST	Preliminary results indicate a significant relationship between exercise dosage and motor outcome variable over time.
		<b><u>Gait</u></b>	10MWT	
		<b><u>Balance</u></b>	SLS posturography	
		<b><u>Grip Strength</u></b>	NS	
		<b><u>Daily activity</u></b>	Wrist activity trackers	

[39] Denney et al., 2019	BL, 3w, 6w, 12w	<b><u>Mobility</u></b>	TUG, dTUG	NS Significant improvement
		<b><u>Balance</u></b>	SR	NS
		<b><u>Sleep</u></b>	PDSS, ESS	Improvement in sleep quality Reduction in daytime sleepiness
		<b><u>Depression</u></b>	HDRS	Significant improvement
		<b><u>Upper Limb Performance</u></b>	NS	NS
[40] Pascal, 2018	BL, every 4w	<b><u>Mobility</u></b>	Performance and score on Dance-Dance Revolution	PwP in mild stages of PD demonstrated improvement in reaction time (more steps completed, more scores rated as perfect, increased overall score). PwP in moderate stages of PD demonstrated no change in steps completed, but had more steps rated as perfect or very good
[41] Pascal et al., 2018	BL, every 4w	<b><u>Gait</u></b>	Zeno Walkway PKMAS Gait Analysis software	Preferred walking velocity was maintained in all P Fast walking velocity was maintained or improved in large majority of P Gait symmetry was improved in 90% in large majority of P
		<b><u>Balance</u></b>	TUG 5xSTS	No significant change No significant change
[42] Shearon et al., 2018	Before and after the boxing session	<b><u>Cognition</u></b>	MoCA	Improved
		<b><u>Fall Risk</u></b>	TUG	No change
		<b><u>Functional Strength</u></b>	STS	More chair stands after the boxing session than before
[43] Foster et al., 2013	BL, 6mo	<b><u>Balance</u></b>	FAB, TUG Sit and Reach Test	>75% of boxers improved in one or more of these outcomes at the end of 6 months participation
		<b><u>Participation Experience</u></b>	Anecdotes from caregivers and trainers	Anecdotally PwP also became more positive, outgoing, and enjoyed socializing.
		<b><u>Strength</u></b>	TUG Davies Test	>75% of boxers improved in one or more of these outcomes at the end of 6 months participation
		<b><u>Coordination</u></b>	Jump Rope Test Purdue Peg Board Test	>75% of boxers improved in one or more of these outcomes at the end of 6 months participation
[44] Diehl et al., 2011	BL, 12w	<b><u>Balance</u></b>	BBS ABC FRT	Both groups improved. Only EX improved. Neither Improved.

		<b><u>QoL</u></b>	PDQL	Both groups improved significantly.
[45] Hall et al., 2022	Once	<b><u>Gait</u></b> <b><u>Balance</u></b> <b><u>Coordination</u></b> <b><u>Independence at home</u></b>	All outcomes were measured using a likert questionnaire	94% reported improved walking 50% reported improved balance, 44% did not report improved balance. 94% reported improved coordination, including 100% of mild PwP 100% of stage 2 PwP reported improved independence at home
[46] Henige et al., 2022	BL, 1mo	<b><u>Physical Activity</u></b>	International Physical Activity Questionnaire	Majority decreased in vigorous intensity physical activity, while the rest increased. Majority increased in moderate intensity physical activity, while the rest decreased. Majority increased in walking time, while the others decreased. Majority decreased in sitting time while the others increased.
[47] Sloane, 2022	Every 3w	<b><u>Participation</u></b> <b><u>Experience</u></b>	Interviews, Observations	Punching gave release and empowerment, the community became a family, boxing generated inner agency, respect was fostered among boxers and coaches, lack of visibility in the community created awkward tension for female fighters
[48] Ricossa et al., 2021	NS	<b><u>QoL</u></b> <b><u>Experience of Fine Motor Aspects of Boxing</u></b>	PDQ-39 NS	This is a protocol for a future study, not results have been generated yet.
[49] Bignal, 2020	Once	<b><u>Participation</u></b> <b><u>Experience on Home-Life</u></b>	Semi-structured interviews	Three main values identified: Psychological benefits (increases confidence, boosts psychosocial health, anxiety, depression), Sense of community (feeling understood and supported, gateway into new relationships, comradeship), Framework to developing new routines (new routines, well-balanced life-style)
[50] Hoime et al., 2018	BL, 11w	<b><u>Gait</u></b> <b><u>Balance</u></b> <b><u>QoL</u></b> <b><u>Fall Risk</u></b> <b><u>Strength</u></b> <b><u>Agility</u></b> <b><u>Cognition</u></b> <b><u>Endurance</u></b>	GaitRite Mini BESTest, PDQ-39 TUG 4SST 5xSTS, cTUG 6MWT	7 P decreased and 3 P increased in comfortable and fast walking speed. 3 P decreased and 5 P increased in backwards walking speed, while 2 P did not test. 5 P reported maintenance or improvement in overall score 50% reported improved PDQ-39 scores 20% reported improvement in bodily discomfort. Nothing else was statistically significant 30% reported a reduction in falls, one reported an increase in falls 2 P decreased speed, 3 P increased speed, and 5 P did not test. 5 P showed improved scores, 5 P showed decline in score 30% showed improvement 7 P declined in distance walked, 3 improved in distance walked

[51]  
Bunyan et  
al., 2017

NS	<b><u>Gait</u></b>	10MWT	Improvement in both groups
	<b><u>Balance</u></b>	Sway Balance phone app	No difference
	<b><u>QoL</u></b>	SF-36	Improvement in both groups
	<b><u>Strength</u></b>	Dynamometer	Improvement in both groups
	<b><u>Fatigue</u></b>	Multidimensional Fatigue Inventory	Improvement in both groups

General acronyms used: \* BL: Baseline. BP: Boxing Program. END: End of program. “mo”: Months. NS: Not specified. P: Participants. PD: Parkinson’s Disease. PwP: Person’s with Parkinson’s Disease. QoL: Quality of Life. “s”: Seconds. “w”: Weeks. Highlights: Peer-reviewed articles, conference abstracts, supplements, poster presentations, post-secondary student projects. Assessment acronyms used: 4SST: Four Square Step Test. 5xSTS: Five Times Sit to Stand. 6MWT: 6-Minute Walk Test. 10MWT: 10-Minute Walk Test. 30CST: 30-second Chair Stand. ABC: Activities Specific Balance Confidence Scale. ADL: Activities of Daily Living. BBS: Berg Balance Scale. BOX: Boxers. BP: Boxing Program. CARE: Caregivers. CES-D scale: Centre for Epidemiological Studies Depression scale. cTUG: Cognitive Timed Up and Go. DGI: Dynamic Gait Index. dTUG: Dual Timed Up and Go. EQ-5D: Euroqual-5D. ESS: Epworth Sleep Scale. FAB scale: Fullerton Advanced Balance scale. FES-I: Fall Efficacy Scale. FRT: Functional Reach Test. HDRS: Hamilton Depression Rating Scale. HR: Heart rate. LARS: Lilli Apathy Rating Scale. MoCA: Montreal Cognitive Assessment. MDC: Minimal Detectable Change. MCID: Minimal Clinically Important Detectable change. MDS: Movement Disorder Society. PDQ-8: Parkinson’s Disease Questionnaire-8. PDQ-39 scale: Parkinson’s Disease Questionnaire-39. PDQL: Parkinson’s Disease Quality of Life Questionnaire. PDSAFE: Parkinson’s Disease Sensory Attention Focused Exercise. PDSS: Parkinson’s Disease Sleep Scale. PHQ-9: Patient Health Questionnaire. RT: Romberg Test. SAS: The Starkstein Apathy Scale. SCOPA-COG: Scales for Outcomes in Parkinson’s Disease-Cognition. SE-ADL: Schwab & England Activities of Daily Living scale. SEE scale: Self-Efficacy for Exercise scale. SF-36: 36-Item Short Form survey. SLS: Single Leg Stance. SRTT: Serial Reaction Time Test. STS: Sit to Stand test. TUG: Timed Up and Go test. UPDRSI & II: Unified Parkinson Disease Rating Scale. US: Unipodal Stance test. vRSB: Virtual Rock Steady Boxing.



## Appendix B Form B-1: Ethics Certificates



**Date:** 5 October 2022

**To:** Dr. Andrew Johnson

**Project ID:** 121135

**Study Title:** The Lived Experience of Persons with Parkinson's Disease in Virtual Forms of Rock Steady Boxing

**Short Title:** Experiences of Virtual Rock Steady Boxing

**Application Type:** NMREB Initial Application

**Review Type:** Delegated

**Full Board Reporting Date:** November 4 2022

**Date Approval Issued:** 05/Oct/2022 17:52

**REB Approval Expiry Date:** 05/Oct/2023

Dear Dr. Andrew Johnson

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the above mentioned study, as of the date noted above. NMREB approval for this study remains valid until the expiry date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

This research study is to be conducted by the investigator noted above. **All other required institutional approvals and mandated training must also be obtained prior to the conduct of the study.**

**Documents Approved:**

Document Name	Document Type	Document Date	Document Version
Virtual Rock Steady Boxing Poster (2022 07 15)	Recruitment Materials	15/Jul/2022	1
Email Script, Initial (2022 07 15)	Recruitment Materials	15/Jul/2022	1
Email Script, Reminder (2022 07 15)	Recruitment Materials	15/Jul/2022	1
In-Person Recruitment Script (2022 07 15)	Oral Script	15/Jul/2022	1
Qualtrics Export - Screening	Online Survey	15/Jul/2022	1
Qualtrics Export - Contact Info	Online Survey	15/Jul/2022	1
Interview Guide (2022 07 15)	Interview Guide	15/Jul/2022	1
Verbal Consent (2022 09 16)	Verbal Consent/Assent	16/Sep/2022	1
LOI initial (2022 09 16)	Implied Consent/Assent	16/Sep/2022	1

No deviations from, or changes to the protocol should be initiated without prior written approval from the NMREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Kelly Patterson , Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

**Note:** This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).



**Date:** 25 October 2022

**To:** Dr. Andrew Johnson

**Project ID:** 121135

**Study Title:** The Lived Experience of Persons with Parkinson's Disease in Virtual Forms of Rock Steady Boxing

**Application Type:** NMREB Amendment Form

**Review Type:** Delegated

**Full Board Reporting Date:** November 4 2022

**Date Approval Issued:** 25/Oct/2022 12:55

**REB Approval Expiry Date:** 05/Oct/2023

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Dear Dr. Andrew Johnson,

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the amendment, as of the date noted above.

**Documents Approved:**

Document Name	Document Type	Document Date	Document Version
Virtual Rock Steady Boxing Poster (2022 10 07)	Recruitment Materials	07/Oct/2022	2

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Kelly Patterson , Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

*Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).*



**Date:** 18 November 2022

**To:** Dr. Andrew Johnson

**Project ID:** 121135

**Study Title:** The Lived Experience of Persons with Parkinson's Disease in Virtual Forms of Rock Steady Boxing

**Application Type:** NMREB Amendment Form

**Review Type:** Delegated

**Full Board Reporting Date:** December 2 2022

**Date Approval Issued:** 18/Nov/2022 14:44

**REB Approval Expiry Date:** 05/Oct/2023

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Dear Dr. Andrew Johnson,

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the amendment, as of the date noted above.

**Documents Approved:**

Document Name	Document Type	Document Date	Document Version
Interview Guide (2022 11 08)	Interview Guide	08/Nov/2022	2

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Kelly Patterson , Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

*Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).*

## Appendix B Form B-2: Annotated Interview Guide

### A. Introductory Questions

1. Please tell us about yourself
  - a. How old are you?
  - b. Is there a gender that you primarily identify with?
    - i. If either yes or no, please clarify
2. Can you describe your experience with Parkinson's disease?
  - a. When did you receive your diagnoses? How long ago? At what age?
  - b. In what ways have you felt the progression of the disease since then?
    - i. Physically, psychologically, socially?
3. What does physical activity mean to you?
  - a. What part of it is important to you?
  - b. Why are you motivated to be physically active?
  - c. What is important to you in an exercise program?

*Questions 1-3 are used as introductory ice breakers, as suggested by Adams (2015). Questions 2 & 3 are also used to get an idea of the context surrounding their experience and their interpretation, perception, and value of the concept of physical activity, which could aid in analysis of their later answers (Smith et al., 2021). Question 2 in particular closely mirrors a question posed in an interview guide used by Sheehy et al. (2017). This question provides an avenue in which the participants can talk about the several different dimensions in which their life may be impacted by Parkinson's Disease, thus providing a richer description of the context.*

### Rock-Steady Boxing Program Questions

4. In which program are you currently enrolled? (virtual or in-person?)
  - a. How long have you participated in Rock Steady Boxing (in both in-person and virtual)?
  - b. What brought you to participate in *virtual* Rock Steady Boxing?

- i. What influenced your decision to join?
  1. Social, physical, personal factors?
  2. What kind of outside support did you receive to attend virtual RSB?
    - a. From whom did you receive it?
    - b. In what ways did you receive it?

*Question 4 was inspired by Sheehy et al. (2017). We found this kind of question useful to uncover aspects of the participants original volition in joining virtual and in-person Rock Steady Boxing.*

5. Can you describe your typical *virtual* Rock Steady Boxing class experience?
  - a. What is the coaching like?
  - b. What are the exercises like?
  - c. What is the schedule like?
  - d. How often do you attend?
  - e. How long are the sessions?
  - f. Describe how you could modify exercise difficulty
6. How did you feel about joining an RSB program?
  - a. Tell me about your initial impressions of the virtual setting
  - b. Did you have expectations for the program before you joined virtual Rock Steady Boxing?
    - i. If yes, what were they?
      1. How did the program meet/not meet your expectations?

*Questions 5-6 are still within the ice breaker category but are designed to give an idea of what the participants experienced upon entering the virtual setting. These questions are intended to be open ended in order to avoid steering the conversation, however, prompts to the questions were still given to aid the participants if they weren't sure how to answer the questions (Smith et al., 2021). To follow the natural way that the interviews progressed, and to avoid confusion, the*

*interviewers asked questions 4-6 first from the viewpoint of the participants in-person experience, and then from the view-point of their virtual experience. As the researchers are also considering motivation, it was interesting then to examine the participant's description of their motivation and what it looked like at the beginning of their attendance, thus question 6 was asked.*

## **B. Virtual Setting Questions**

7. Describe what it was like to transition into the virtual setting.

*This gives the participant opportunity to give their relatively unprompted thoughts about the transition. This was aimed at giving the researchers a detailed description of the transition experience (Caelli, 2000).*

8. Describe some of the things that you liked about the virtual setting

- a. What did you gain from the virtual setting?
- b. What were some benefits?
- c. How did you feel about those [benefits]?
- d. In what ways were those [benefits] important to you (if applicable)?

9. Describe some of the things that you did not like about the virtual setting

- a. What did you experience within the in-person environment that you missed in the virtual setting?
  - i. Were those differences significant for you?
    1. If yes, in what ways?
- b. Describe some of the challenges that you faced in the virtual setting (if any)
  - i. How did you feel about those [challenges]?
  - ii. In what ways were those [challenges] significant to you (if applicable)

10. Did the virtual setting impact your interest in the Rock Steady Boxing program in general?

- a. If yes, can you describe this impact?

- b. Did you discontinue participation before in-person sessions were available?
  - i. If yes, can you tell me more about this?
  - ii. If no, why did you continue in the virtual?
    - 1. What motivated you to continue?
- c. Given the choice, would you rather participate in in-person or online Rock Steady Boxing?
  - i. Why?

11. Did the virtual setting impact your motivation to keep exercising?

- a. How so?

*Questions 8-11 are important to explore as it gives more information on the aspects that stood out to each individual either in positive or negative lights. This could offer insights into potential frustrations or advantages that might influence the type of motivation they experienced in the virtual setting (Deci & Ryan, 2015).*

12. In your opinion, did the virtual setting make RSB more accessible or less accessible?

- a. How so?

*Although this question appears to be straightforward, the researchers did not want to obtain a straight “yes or no” answer, they wanted to gain insight into how the participant’s viewed accessibility and if the virtual setting fit into their framework surrounding accessibility.*

### **Personal Experience**

13. In what ways did you feel like you were given choice within the program (if at all)?

- a. Did you make any suggestions to improve the virtual setting?
  - i. If yes, what were they?
    - 1. Were they implemented?

14. How did the virtual setting impact your home life?

15. In what ways did you feel more freedom in the virtual setting?

16. In what ways did you feel less freedom in the virtual setting?

*Questions 13-16 were inspired by Borrero et al. (2022) as they described that individuals felt their need of autonomy was supported when they were given choice and when their input surrounding class activities was validated. Question 14 was important to ask as virtual boxing classes take place in the home. Thus, the researchers wanted to understand if the virtual setting had impacted their autonomy and general experience in the home.*

17. Describe how you felt virtual RSB impacted your physical abilities

- a. Positively, negatively?
- b. Did you feel that the workouts were challenging you?
  - i. How so?
- c. Did you feel like you were getting stronger or weaker?
  - i. How so?

18. Did you feel competent and able to complete the virtual workouts?

- a. If so, why?
- b. If not, why not?

19. Do you have goals for your health?

- a. If yes, could you describe some of those goals?
  - i. What was your experience like trying to reach those goals in the virtual setting?
    1. How have you received feedback from the trainer (if at all)?
    2. Did you feel successful in reaching those goals?
- b. How were you able to track your progress?

*Questions 17-19 were posed in relation to understanding if the participants felt a sense of accomplishment, adequate challenge, feedback, and improvement. These aspects of experience are important to encourage competency (Ryan & Deci, 2000). Thus, the researchers wanted to explore if this was the experience individuals had in the virtual program. The researchers also wanted to understand how the participants felt about their own sense of competence, thus*



question 18 was posed as well. During the natural course of the interviews, these same questions were asked for the in-person setting.

20. Describe how the virtual setting impacted your social life (if at all)

a. Family, friends, coworkers

*Question 20 was inspired by Sheehy et al. (2017) and was used to uncover whether the virtual setting itself had changed relationships outside of Rock Steady Boxing. This is notable, as the experience of virtual Rock Steady Boxing has not yet been explored, and thus the question remained on whether bringing non-contact boxing into the home had impacted any relationships outside of the program.*

21. Tell me about your experience interacting with the coaches in the virtual setting

a. How did you feel about these relationships?

i. What were your first impressions?

ii. Have those impressions changed? In what way?

b. In what ways did these relationships impact your experience in virtual Rock Steady Boxing?

22. Tell me about your experience interacting with other participants in the virtual setting

a. How did you feel about these relationships?

i. What were your first impressions?

ii. Have those impressions changed? In what way?

b. In what ways did these relationships impact your experience in virtual Rock Steady Boxing?

*Questions 21 and 22 were posed in a way that allowed the participants to express their ideas and experiences however they choose, which is encouraged in interpretive phenomenological analysis interviews (Smith et al., 2021). Relationships towards the other boxers and coaches may be a different experience for each individual, and thus it was important to keep these questions open. These social interactions can be essential to experience, and can impact the support for relatedness (Deci & Ryan, 2015). We also wanted to know if their relationships with the other participants had changed when the setting changed, so it was important to establish an understanding of how the participants felt about the other individuals when they first joined.*

**Closing Question**

1. Is there anything else you would like to add before we end this interview?

*The closing question was asked in order to give the individual opportunity to add any other thoughts that may have developed throughout the course of the interview and achieve a substantive understanding about the individual's experiences, as suggested by Adams (2015).*

**Thank you statement**

Thank you for taking the time to participate in this study and provide your insight. As a reminder, we may want to contact you for a follow-up interview. Is that still OK? You are always free to decline participation when we call to schedule the follow-up.

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## Curriculum Vitae

**Name:** Laura Mulder

**Post-secondary Education and Degrees:** University of Guelph  
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