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Scoping review of yoga-based interventions for Parkinson's disease

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Abstract
Today, over 10 million people are living with Parkinson's Disease (PD). Research suggests this number will double by 2040. Although neurological in nature, negative psychological comorbidities emerge in PD patients as a result of progressive physical incapacitation characterized by tremors, slowness in initiating movements, rigidity, and postural instability. The literature suggests numerous benefits of exercise on PD outcomes; however, there is a dearth of research related to PD and yoga, despite evidence of its utility with other chronic diseases, including back pain, depression, and heart disease. The purpose of this study was to retrieve and examine yoga interventions tested for efficacy in Parkinson's disease and provide collective evidence. A search of studies in MEDLINE, CINAHL, and Google Scholar databases was conducted. The inclusion criteria included: (1) studies published in peer-reviewed journals; (2) time period between January 2015 and January 2020; (3) describing the evaluation of interventions; and (4) quantitative or mixed methods studies. Excluded were studies that were not in the specified time period or from specified databases, descriptions, qualitative accounts, protocols, periodicals, or from the grey literature. A total of 11 studies met the inclusion criteria (n=11). The majority of interventions reporting testing unspecified yoga (n=5), one Hatha yoga (n=1), one Power yoga (n=1), one Laughter Yoga (n=1), one Iyengar yoga (n=1), one high-speed yoga (n=1), and one mindfulness yoga (n=1). The most common duration of the interventions was 12 weeks (n=6) with one study holding one session (n=1), two lasting eight weeks (n=2), one for six months (n=1), and one for nine months (n=1). The most common evaluation design was the randomized controlled trial (n=8), followed by two quasi-experimental (n=2), and one pre-test post-test design (n=1). The most common outcome measure was the Unified Parkinson's Disease Rating Scale (n=6). All interventions reported improvements in either the physical or psychological comorbidities associated with PD. Based on this review, it can be concluded that yoga is a promising complementary mind-body approach for managing PD, with the possibility of slowing its progression and improving the maintenance of physical abilities of patients suffering from PD. Randomized control trials with large sample sizes that evaluate the physical and psychological effects of PD are recommended for further study.

Keywords: Parkinson's Disease, Yoga, programs, mind-body

1. Introduction
Parkinson's Disease (PD) is a growing public health concern as the population of those living with the disease is expected to double to 20 million by 2040 [1]. The prevalence of Parkinson's Disease increases with age; PD affects approximately 1% of older adults aged 65+ and 1–3% of those above 80 years old [2]. PD is a degenerative disorder affecting the central nervous system and is characterized by tremors, rigidity [3], and bradykinesia or slowness of movement [4]. Commonly reported by PD patients is freezing gait, an inability to progress forward when attempting to walk, which increases anxiety and risk of falls, while reducing self-efficacy and independence [5]. PD patients are also prone to sedentary and solitary lifestyles as a result of their progressive motor skill incapacitation, which, in combination with other symptoms of PD, further impairs their Quality of Life [1].
The current understanding of PD development is a result of an imbalance of free radicals and antioxidants in the body (oxidative stress), which leads to dopaminergic neuron cell degeneration [6, 7]. Dopamine, the neurotransmitter that allows communication between cells in the brain, plays a role in the control of body movement [8]. This loss in production of dopamine leads to the unmistakable physical manifestations of PD: bradykinesia, resting tremors, rigidity, and postural instability, as well as psychological – depression [7].
Common pharmacological treatments for PD management target dopamine replacement through the use of the dopamine precursor, 3,4-dihydroxy-l-phenylalanine (L-DOPA), to treat loss of motor function [9] In the advanced stages of this disease, and after long-term use of L-DOPA, these treatments cause an irregular spike in dopamine levels that reduces synaptic depotentiation (reduced ability to remove dopamine and bring the synapse back to its baseline) [10] - essentially desensitizing the synapse to dopamine. Ultimately, this leads to cognitive dysfunction, compulsive behaviors, and impulse control disorders [11].
Beyond the negative side effects of L-DOPA use [12], this treatment does not address the psychological symptoms of PD, including anxiety and depression; although psychological comorbidities are reported in at least a quarter to two-thirds of PD sufferers [1]. Research suggests that these psychological impairments create a feedback loop - leading to further disease progression and physical impairment, which, in turn, exacerbate anxiety and depression [1]. Recognizing the limitations of L-DOPA, other forms of care have been explored: psychotherapy has proven promising to treat the psychological symptoms of PD [13], and regular exercise benefits physical maintenance,

but neither address the entire disease [14]. Due to prolonged life expectancy, the progression of physical incapacitation, and negative psychological impact, it is imperative that alternative forms of care are explored.

While exercise is often recommended to prevent and manage chronic diseases, it may prove inappropriate for PD suffers due to the physical limitations related to the disease. Alternatively, yoga, a mind-body approach, has the potential to provide both the physical and psychological remedies that PD patients seek due to its roots in mindfulness, breathing techniques, and low physical impact postures. The practice of yoga has been associated with improved balance, agility, flexibility, strength, endurance, relaxation, and mental and emotional well-being [14]. Yoga practice also improves corporeal awareness and proprioception, abilities that cease in PD patients over time [5] Yoga also helps to reduce the fear of falling [12]. Despite the well-documented benefits of yoga on many chronic diseases, including back pain, depression, and cardiovascular disease, there is limited research examining yoga's efficacy as an alternative and/or complementary treatment for PD.

In this review, the research questions addressed included the following

1. Is yoga an efficacious form of therapy to treat the psychological, physiological, and physical symptoms of Parkinson's Disease?
2. Are the articles reviewed comprised of valid research studies from a methodological perspective?
3. Are there sufficient data to conclude the efficacy of yoga for Parkinson's Disease?

2. Methods

The inclusion criteria for this review included: (1) studies published in peer-reviewed journals; (2) studies from databases that included MEDLINE (PubMed), CINAHL, and Google Scholar; (3) period between January 2015 and January 2020; (4) describing the evaluation of interventions; and (5) quantitative or mixed methods studies. Excluded were studies that were not in the specified time period or from specified databases, descriptions, qualitative accounts or from the grey literature. We did not include dissertations, periodicals, protocols, or abstracts, which were more prevalent on Google Scholar, and ensured duplicate studies were not listed more than once. Using the search terms yoga and Parkinson's Disease, 45 articles were returned from MEDLINE and CINAHL which after distillation yielded six separate studies, and five additional ones were located from Google Scholar.

3. Results

A thorough review of the manuscripts resulted in 11 distinct studies meeting the inclusion criteria. One study[5] was found to be published in three separate journals; upon review, the duplicates were eliminated. For the remaining 11 articles, the year of publication, authors, country of origin, study design, sample size, age of participants, intervention modality and dosage, outcome measures, and salient findings are listed in Table 1. The studies are listed in ascending order by the year of publication.

Table 1: Summary of Yoga Interventions for Parkinson's Disease between January 2015 and January 2020 (n=11)

Year	Author/Country	Design, Sample, and Setting	Age	Intervention Modality	Intervention Dosage	Outcome Measures	Salient Findings
2015	Sharma NK, Robbins K, Wagner K, Colgrove YM; 15 United States	Randomized control trial (n=13) of subjects with stage 1-2 Parkinson's Disease randomized to a yoga or control group	50-88 years	Unspecified yoga	Twice-weekly yoga sessions for 12 weeks	Motor function, mood, daily activities, clinical measures of health-related QOL and physiological measures	Significant improvement in UPDRS scores (P = .006), diastolic blood pressure (P = 0.036) and average forced vital capacity (P = 0.03) was noted in the yoga group over time. Positive trends of improvement were noted in depression scores (P = 0.056), body weight (P = 0.056) and forced expiratory volume (P = 0.059). Yoga participants reported more positive symptom changes including immediate tremor reduction.
2016	Bega D, Stein J, Zadikoff C, Simuni T, Victorson D, Ring M, Jovanovic B and Corcos DM; 16 United States	Randomized control trial (n=17) of subjects with mild to moderate PD randomized in a single blind study to yoga or resistance exercise group	67.3 ± 9.8 years	Iyengar yoga	Twice-weekly yoga sessions for 12 weeks	Motor function, balance, freeze of gait, QOL, fatigue, anxiety, and depression	Both groups improved on mean motor function, balance, and QOL scores compared to baseline, although the between-group differences were not statistically significant. Yoga group saw statistically significant improvement in anxiety score (p=0.0297) and emotional and behavioral dyscontrol score (p=0.015) vs. exercise resistance group
2016	DeCaro DS,	Pre-test post-test	Participants	Laughter Yoga	One 45-min	Well-being measures	At the end of the session,

	Constantine Brown JL; 17 United States	design of subjects (n = 85) comprised of a convenience sample of adults diagnosed with Parkinson′s disease (n = 47) and accompanying caregivers (n = 38)	with PD=53-91 years; Caregivers= 42-86 years		session of Laughter Yoga	including enthusiasm, energy level, mood, optimism, stress level, level of friendship with group members, level of awareness about breathing, level of muscle relaxation, level of mental relaxation, and ability to laugh without a reason.	statistically significant improvements were reported on all nine domains of well-being with the exception of optimism for PD participants and stress for their caregivers.
2016	Ni M, Mooney K, Signorile JF; 18 United States	Randomized control trial (n=26) of subjects with mild to moderate PD randomized to a Yoga or control group	mean age yoga group 71.2 years (SD 6.5); mean age control group 74.9 years (SD 8.3)	Power Yoga	12-weeks of twice weekly power yoga classes	Bradykinesia, rigidity, muscular performance, well-being, social support, and QOL	Yoga group produced significant improvement in both upper and lower limbs bradykinesia scores, rigidity score, 1RM for all 5 machines and leg press power ($p<.05$). No significant changes in well-being scores between groups post-intervention.
2016	Ni M, Signorile JF, Mooney K, Balachandran A, Potiaumpai M, Luca C, Moore JG, Kuenze CM, Eltoukhy M, Perry AC; 3 United States	Randomized control trial (n=41) of subjects with Parkinson's Disease randomized to a high-speed yoga, power training (PWT), or non-exercise control group	mean age ± SD, 72.2 ± 6.5 years	Power Yoga	Two interventions were given twice weekly for 12 weeks	Functional reach, single leg stance (SLS), postural sway test, usual and maximal walking speed tests, 1 repetition maximum (RM), and peak power (PPW) for leg press, QOL	For the posttests, both training groups showed significant improvements ($P<.05$) in all physical measurements except functional reach on the more affected side, SLS, and postural sway compared with the pretests, no differences detected between the yoga program and PWT.
2018	Cheung C, Bhimani R, Wyman JF, Konczak J, Zhang L, Mishra U, Terluk M, Kartha RV, Tuite P; 19 United States	Randomized control trial (n=20) of subjects with mild-moderate Parkinson's disease severity randomized to a yoga or waitlist control group	49-75 years	Hatha yoga	Twice weekly 60-min group-based yoga sessions for 12 weeks	Oxidative stress, motor function, physical activity, cognitive function, sleep quality, and QOL	At 12 weeks, there were no major differences in blood oxidative stress markers between the two groups; however, participants' motor functions were significantly better in the treatment group vs. control, and significantly better than their baseline scores. Sleep and outlook, domains of QOL, were significantly worse at the end of 12 weeks for the treatment group vs. baseline.
2018	Kamal A; 20 United States	Quasi-experimental design (n=30) of PD subjects matched by age with PD control subjects not practicing yoga	Mean age=49.6 years of Parkinson's patients; mean age=53.3 years for age-matched control	Unspecified yoga	Nine-months of yoga practice	autonomic function and heart rate variability	Improvement of autonomic function of PD patients practicing yoga.
2018	Van Puymbroeck M, Walter AA, Hawkins BL, Sharp JL, Woschkolup K, Urrea-Mendoza E, Revilla F, Adams EV, Schmid AA; 5 United States	Randomized control trial (n=30) of subjects with Parkinson's Disease randomized to yoga or waitlist control group	mean age= 67.74 years	Unspecified yoga	Eight-week yoga intervention	Motor function, functional gait, postural stability, and balance control	Yoga group experienced improvements in motor function, postural stability, functional gait, and freezing gait, as well as reductions in fall risk. Participants in the wait-list control also significantly improved in postural stability, although their fall risk was not reduced.

2019	Any DA, Stroe A, Daniel DA 21; Romania	Quasi-experimental design (n=26) of subjects with PD or vestibular syndrome (VS) receiving either yoga or meditation (four groups)	(PD mean: 64,1; range: 60-68; control's mean: 63,6; range: 60-69)	Unspecified yoga; unspecified meditation/prayer	Daily 15-min practice of yoga or daily 10-min practice of meditation/prayer for six months	Depression (via Beck, Webster, and Mini-Mental State Exam [MMSE])	Yoga PD group, only 3 patients obtained higher scores (by 1 point) at the study's end; in the groups that practiced meditation/prayers, only one person of both PD patients and vestibular syndrome patients obtained a higher score.
2019	Kwok JYY, Kwan JCY, Auyeung M, Mok VCT, Lau CKY, Choi KC, Chan HYL; 22 Hong Kong, China	Randomized control trial (n=138) of adults with ith a clinical diagnosis of idiopathic PD who were able to stand unaided and walk with or without an assistive device to a yoga or resistance training exercise control group	aged ≥18 years	mindfulness yoga	Mindfulness yoga was delivered in 90-minute groups and resistance training exercise were delivered in 60-minute groups for 8 weeks	Anxiety, depression, motor skills, mobility, spiritual well-being, and PD-specific Quality of Life	Yoga group had significantly better improvement in outcomes than the resistance training group, particularly for anxiety ($P < .001$), depression ($P < .001$); perceived hardship ($P < .001$), perceived equanimity ($P < .001$); and disease-specific Quality of Life.
2020	Myers PSS, Harrison EC, Rawson KS, Horin AP, Sutter EN, McNeely ME, Earhart GM; 23 United States	Randomized control trial (n=26) of subjects with PD randomized to yoga or control group (a third group received mobile health via text message, but were not specified in the article)	Control=65 ± 8.7 years; Yoga=70.5 ± 8.7 years	Unspecified yoga	Twice-weekly 12-week yoga intervention	Balance (biomechanical constraints, stability limits/verticality, transitions/anticipatory, reactive, sensory orientation, and stability in gait), disease severity, anxiety, yoga satisfaction (for intervention group)	Control group saw significant improvement in overall balance score ($p = 0.040$) but not in any of the individual sections. The yoga group showed significant improvement in overall score ($p = 0.001$) as well as improvement in the following sections: stability limits/verticality ($p = 0.020$), transitions/anticipatory ($p = 0.010$), and sensory orientation ($p = 0.020$). No significant change in anxiety between or within groups baseline to post-test.

4. Discussion

A total of 11 articles met the inclusion criteria for this scoping review, of those the majority took place in the United States (n=9) [3, 5, 15, 16, 17, 18, 19, 20, 23]. followed by one in Romania (n=1) [21], and one in China (n=1).[22] All but one,[21] reported statistically significant improvements in either the psychological or physical symptoms of Parkinson's Disease, including motor function, anxiety, depression, balance, stability, Quality of Life, gait (freezing and functional), and bradykinesia, among others. Analysis of the studies and their significance can be found in the following paragraphs.

A majority of studies (n=9) measured the psychological factors associated with Parkinson's Disease, including anxiety, depression, and/or Quality of Life pre and post-intervention [3,1 5, 16, 17, 18, 19, 22, 21, 23] This is significant as the psychological symptoms of PD remain underdiagnosed and undertreated.[1] Six studies demonstrated a significant improvement in psychological measures at baseline versus post-intervention [15, 16, 17, 19, 22, 21]. Of the nine studies measuring psychological changes, only three instituted an exercise control with varying results. One study found a significant reduction in anxiety post-intervention for yoga participants ($p=0.02$) versus the resistance exercise control, although both groups improved on mean motor function, balance, and QOL scores compared to baseline [16], while another found significant improvements in anxiety ($p < .001$), depression ($p < .001$); and perceived hardship ($p < .001$) post-intervention versus the exercise control [22]. However, in a randomized control trial of PD patients to yoga or power training, although both groups reported significant improvements in physical measures ($p<0.05$), neither reported significant changes in well-being scores [3]. These results suggest that additional studies randomizing PD patients to yoga and exercise control groups must be completed to determine if yoga's mind-body techniques offer an advantage over other low-impact, non-spiritual exercises.

The majority of studies instituted randomized control trials (RCT) (n=8) [3, 5, 15, 16, 18, 19, 22, 23]. with two using quasi-experimental design [20, 21], and one using pretest-posttest design [17]. RCTs are considered the gold standard in research as they reduce errors related to selection bias, chance, and confounding factors [24]. To reduce threats to

internal validity, RCTs institute blinding of participants, data collectors, and data analyzers; however, only one study mentioned blinding the Research Assistant who collected the data, the scientists who performed the laboratory analyses, and the statistician who performed data analysis [19].

To further minimize threats to external and internal validity, RCTs must also ensure no significant baseline differences exist between groups. In this review, only two studies reported significant baseline differences [15, 18]. One study reported baseline differences in bodily pain and role limitations due to emotional problems in the two groups but reported significant improvement in Unified Parkinson's Disease Rating Scale scores (reduction) in the yoga group post-intervention versus baseline (p=0.006) [15] Another study reported a baseline difference in height but demonstrated a significant improvement in a number of physical modalities, including bradykinesia among the yoga group versus control [18]. In these cases, baseline differences may not threaten the validity of the results; however, the same cannot be said for quasi-experimental study designs.

Quasi-experimental design, where participants are matched or selected for intervention and control groups, cannot ensure that groups are truly comparable and that outcomes are not a result of unknown external factors or group differences [25]. Among the two studies instituting this design, one age-matched PD participants to either a yoga or comparison group and reported autonomic function improvements among the yoga group [20], while another matched patients with PD to a control group of patients with vestibular syndrome - splitting each of these groups in half so that two received yoga and two received meditation/prayer. This study reported slight improvements in psychological scores among three patients across all groups [21].

Beyond study design, the tools used to measure outcomes must be valid and reliable. Further, it is beneficial that the studies apply the same scales. The most common scale used (n=6) [5, 15, 16, 18, 19, 23]. was the Unified Parkinson's Disease Rating Scale (UPDRS), which measures an arrange of PD symptoms (motor and non-motor function) with an overall score range of 0 to 199 (199 being the worst). One study described minimal clinically important difference (CID) on the UPDRS scale (motor subscale only) as a change of at least 2.3 points and a moderate CID is 4.5-6.7 points [5]. This same study reported significant improvements - and moderately clinically important difference - in motor function, as measured by the UPDRS for the yoga group (p=0.0102), but not the control group [5]. Another RCT reported significant reductions in UPDRS scores related to motor symptoms; however, behavior and mood subsection scores were reduced with yoga, but not significantly [15]. One study reported UPDRS score improvements larger among the yoga group, although the differences were not statistically significant versus the control group post-intervention [16]. Another study limited its use of UPDRS to pre-intervention in order to determine baseline differences between the yoga and control groups [23]. Although the gold standard of PD assessment [5], UPDRS was used in only six studies examined here, and of those only three [15, 16, 18]. Used the non-motor subscales of the UPDRS. In order to better assess yoga's efficacy to treat both the psychological and physical impairments of PD, further research using the non-motor and motor subscales of UPDRS must be performed.

Among the 11 studies meeting the inclusion criteria, study duration and dosage varied widely from one session to nine months of yoga practice. However, the majority of studies ran from 8-12 weeks with at least once weekly yoga session [3, 5, 15, 16, 18, 19, 22, 23]. Interestingly, all of these studies were RCTs and reported significant improvements in yoga group scores across psychological and/or physical domains. To establish standards for yoga dosage and duration, particularly in the treatment of depression and anxiety, de Manicor and co-authors surveyed 24 yoga practitioners who recommended - for maximum benefit - five days/week of yoga practice for at least six weeks [26]. These recommendations do not take into account the particular needs of patients with PD, nor the feasibility of five days/week of yoga practice.

Feasibility is an important factor to consider when determining the efficacy, and later effectiveness, of yoga as a treatment for PD. Feasibility is the likelihood that subjects could meet the expectations of the intervention. Attrition rates can provide an assessment of study feasibility when no predetermined parameters are stated. One study defined feasibility as 70% of participants attending at least 75% of the classes. This study also reported poor yoga class attendance: with a total of 27 (16%) missed yoga classes compared to 14 (8%) missed resistance classes (p=0.04) and an attrition rate of 17% [16]. Another study reported no attrition and that participants in the yoga group attended an average of 22 classes out of 24. Of note, the dosage and duration for these two studies was the same (biweekly yoga for 12 weeks) [23]. Among the remaining articles, three did not mention attrition rates [3, 15, 20, 21], attrition was not possible for the one-session yoga class [17], and, for the remaining four studies, attrition was calculated (by dividing the drop out number by total enrolled *100) - ranging from 0% to 26% [5, 18, 19, 22]. Two out of four of these studies were also biweekly for 12 weeks [18, 19], while the others were eight weeks [5, 22]. Duration and dosage may not play a significant role in attrition as reasoning listed in these studies included work commitments, medical complications, and participants reporting that the intervention was not working or was not challenging. To remedy this, researchers may want to focus entirely on retired persons with large sample sizes and predetermined parameters for feasibility. Ensuring that participants understand that yoga is meant to be low-impact and for all levels of physical fitness may also reduce attrition rates.

4.1 Limitations of the studies

While most studies used the randomized controlled design, the sample sizes used in the studies in this review were generally small that restricts the statistical power and samples were not randomly selected. Hence, the generalizability of the results is rather limited. Also, few studies have been published in this area so consistency of evidence for causality cannot be established. Not all studies used the same outcome measures and reported the effect sizes thus making it difficult to comment on the strength of association. Furthermore, the duration of studies had a wide range therefore the dose-response relationship is also not attributable. It is hoped that in the future more studies will be conducted with standardized protocols and outcomes thereby making collective evidence amenable to meta-analysis.

4.2 Limitations of the review
This review does not claim to be a thorough systematic review but is a scoping review on this topic from limited databases in a limited time period. The results of this review may have been affected by publication bias which pertains to the fact that most of the time only studies with significant results get published and as such the conclusions that are drawn from this review may be a bit biased.

5. Conclusions
The goal of this review was to determine if there is sufficient data from valid studies available to draw conclusions regarding the efficacy of yoga to treat PD. Only 11 studies met the inclusion criteria; of those, eight instituted an RCT design and nine measured changes in non-motor symptoms associated with PD. In order to draw conclusions of yoga's efficacy for PD, more studies that institute RCT designs and apply the UPDRS scale (non-motor and motor subscales) are needed. To further determine if yoga's mind-body techniques play a statistically significant role in PD psychological symptom improvement, researchers should consider using a low-impact exercise group as a control for comparison. Although the study protocols varied greatly, it is important to note that all but one study reported some improvement in either the physical or psychological symptoms of Parkinson's Disease.

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