Yoga Interventions Used for the Rehabilitation of Stroke, Parkinson•s Disease, and Multiple Sclerosis: A Scoping Review of Clinical Research

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lifestyle, further increasing the risk of chronic functional decline.[2] Concurrent cognitive and psychosocial changes in emotion, personality, and behavior can negatively influence interpersonal relationships, impede reintegration into the community, and promote feelings of social isolation, anxiety, and depression.[3–5] Existing rehabilitation programs predominantly place emphasis on optimizing physical function while often overlooking the psychological manifestations of these neurologic illnesses.[3,6] This is significant given that high levels of psychological suffering have been repeatedly documented across all three conditions to not only be associated with higher levels of physical disability and increased morbidity,[3,7,8] but also to be a primary determinant contributing to increased health care costs and resource utilization.[3,9,10] Thus, there is an urgent need to explore alternative and adjunctive strategies that address both the physical and psychosocial challenges of living with these debilitating neurologic disorders.

The mind–body practice of yoga represents one promising therapeutic intervention that can be used across a variety of clinical settings and easily modified to meet the complex needs of neurologic patients.[11,12] Originating in India, yoga describes a spiritual practice that encompasses many different elements, including physical activity ( ), breath work ( ), meditation ( ), contemplative practice, and advice for living an ethical and disciplined lifestyle.[12] Therapeutic yoga or yoga therapy (YT) refers to the use of yoga to specifically address various health-related outcomes among clinical populations.[13] Yoga addresses the functional deficits that manifest in neurologic conditions through a variety of physiologic mechanisms related to either the physical component or the breathing and meditative techniques that are practiced in yoga.[11] The health-related benefits of exercise are well understood, and accordingly, the regular practice of yoga has been demonstrated to improve muscular strength and endurance, balance, flexibility, and motor coordination.[14] Breathing and meditation techniques used in yogic interventions have been reported to improve sensory awareness and interoception, increase parasympathetic activity, enhance the regulation of autonomic input, and modulate the body's pain response system.[15] In addition, the emphasis on mindful awareness and relaxation during the practice may contribute to the cognitive and psychological benefits described, such as an increased ability to sustain attention, enhanced executive function and problem solving, promotion of personal acceptance, and an improved ability to cope in the face of adversity.[3,11,14]

The holistic nature of yoga suggests it can simultaneously facilitate physical and emotional healing among those experiencing neurologic disorders.[11,14] Furthermore, yoga is cost-effective, feasible, and willingly accepted by the elderly,[16] a population that makes up the vast majority of patients affected by neurologic disease.[17] While there have been a number of recent studies investigating the use of YT for managing the consequences of stroke, PD, and MS, the optimal treatment dose required to maximize the effectiveness of YT has been rarely studied. In addition, the literature repeatedly fails to adequately describe how yoga protocols are developed and employed, making it difficult to apply the research findings in a clinical setting.[18] Given the aforementioned shortcomings of the field, a scoping review of the literature can provide a better understanding in determining how YT can best be implemented into neurorehabilitative care. Scoping reviews are particularly useful for exploring how research is conducted on a given topic while also identifying gaps for further investigation.[19] The primary objective of this scoping review was to provide a comprehensive overview of YT interventions that have been utilized in the clinical management of adults poststroke or living with PD or MS. A particular focus was placed on research that addresses the physical, cognitive, and psychosocial components of functional recovery. By compiling detailed descriptions of clinical yoga protocols into a single resource, the present study hoped to direct clinicians on best practices and guide researchers in further evaluating the efficacy of utilizing YT in neurologic rehabilitation.

Methods

Study design

The study was conducted following the methodological framework for scoping reviews laid out by Arksey and O'Malley.[19] A five-stage process was followed that comprised the following: (1) identifying the research question; (2) identifying relevant studies; (3) selecting the studies that correspond to the inclusion criteria; (4) data extraction; and (5) collating, summarizing, and reporting the results.

Search strategy and study selection

A comprehensive search strategy of published literature was used to ensure the inclusion of all relevant information. The choice of databases to be searched was recommended by a professional librarian at º«¹úÂâÎè University and included Medline (1946 to present), CINAHL (1937 to present), EMBASE (1947 to present), and PsycINFO (1806 to present). Studies published in English or French that evaluated the effect of yoga on physical, cognitive, and/or psychosocial health in individuals who were at least 18 years of age with a diagnosis of stroke, PD, or MS were included for eligibility. Other neurologic conditions as well as studies on multimodal interventions that combine yoga with other interventions were excluded. Interventions based on yoga, but not characterized as such, were excluded. There were no restrictions made with respect to the type of yoga used, nor the length, frequency, or duration of the intervention. No restrictions were made based on the clinical setting, study design, study location, or year of publication.

After completing the database searches, the articles were imported into Rayyan QCRI where the title and abstract of each article were screened by two independent researchers who categorized them as "included," "excluded," or "maybe." The researchers then proceeded to read the full-text articles from the "included" and "maybe" categories to determine whether they met the eligibility criteria. Any indecisions regarding the inclusion of a particular study was discussed by two independent researchers until a consensus was reached. If necessary, a third researcher was asked to assist in resolving any disagreements.

Data extraction

Two researchers independently extracted data from articles meeting the inclusion criteria using Microsoft Excel and then compared the obtained data to ensure consistency of reporting. The data were organized into tables and grouped by neurologic condition (Tables 1–3).

Table 1. Description of Included Studies That Used Yoga Therapy Interventions for Poststroke

Reference	Design and Sample	Participants	Intervention	Description	Outcomes	Findings and Conclusions
Bastille and Gill-Body (2004)[34]	Design: Single-subject case-study design Sample: $N = 4$ (♂: 1, ♀: 3) Objective: Investigate the effects of a yoga-based exercise program on balance, mobility, and QoL for people with poststroke hemiparesis	Dx: Stroke with hemiparesis Stage: Chronic (>9 months) Age: 60 (9.02)[a]	Frequency: 2 per week Session duration: 90 min Intervention period: 8 weeks Dose (total time): 24 h	Style of yoga: Hatha Structure: 5–10 min of education; 10–15 min of body awareness practice; 5 min of breathing exercises; 30–40 min of physical poses; 10–15 min of guided imagery and relaxation; 5 min of seated silent meditation; 5 min of personal expression verbally or through drawing.	Physical: BBS, TMB Multidimensional: SIS	Results: Two subjects demonstrated signi cant improvements in balance as measured by BBS; three subjects demonstrated signi cant increases in TMB. Conclusion: A yoga-based exercise program may be able to improve impairments and mobility limitations in people with chronic poststroke hemiparesis.
Chan et al. (2012)[35]	Design: RCT (pilot study) Sample: $N = 14$ (♂: 12, ♀: 2) Yoga (=8) Control (=6) Objective: Investigate whether supplementing exercise with a yoga program would provide further improvements in self-reported symptoms of depression and anxiety poststroke	Dx: Stroke with hemiparesis Stage: Chronic (>6 months) Age Yoga: 67.1 (15.4)[a] Control: 71.7 (12.7)[a]	Frequency Group: 1· per week Home: 4· per week Session duration Group: 90 min Home: 40 min Intervention period: 6 weeks Dose (total time): 25 h	Style of Yoga: Hatha Structure Group Classes: 10-min didactic activity on yoga-relevant topics; 30 min of modi ed practice; 5 min of practice involving gentle breathing with concentrated attention; 30 min of guided meditation (ga Nidra); and 15 min of group discussions. Home Practice: 10 min of Hatha yoga; and 30 min of Yoga Nidra.	Psychosocial: GDS-15, STAI-Y1, STAI-Y2	Results: Changes in depression and state anxiety did not signi cantly differ between treatment groups; greater clinical improvements observed in intervention group. Conclusion: Supports the notion that individuals with stroke-related disability may achieve additional mental-health bene ts from an integrative approach involving participation in a combined exercise and yoga program.

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Table 1. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Garrett et al. (2011)[13]	Design: Secondary analysis of RCT Sample RCT: N=22 Yoga (=10) Control (=12) 2 Analysis: N=9 (♂: 4, ♀: 5) Objective: Investigate the personal experiences and perceived outcomes of a yoga program for stroke survivors	Dx: Stroke with hemiparesis Stage: Chronic (9 months) Age: N/D	Frequency Group: 1· per week Home: 6· per week Session duration Group: 90 min Home: 35–42 min Intervention period: 10 weeks Dose (total time): 50–57 h	Style of Yoga: Hatha Structure: Didactic activity to educate participants about concepts in yoga and provide focus for the subsequent practices; 30-min yoga-based exercises; 10–12 min of breathing practices; 20–30 min of Yoga Nidra meditation; 8–10-min discussion and questions.	Multidimensional: Interview (interpretative phenomenologic analysis)	Results: Subjects revealed perceived physical improvements in strength, ROM, walking ability, feeling calmer, becoming connected, and possibility of accepting a different body. Conclusion: Yoga participation after stroke can provide a number of meaningful physical, psychological, and social bene ts.
Immink et al. (2014)[36]	Design: RCT Sample: N=22 (♂: 9, ♀: 13) Yoga (=11) Control (=11) Objective: Assess the ef cacy of a yoga intervention for motor function, mental health, and QoL outcomes in persons with chronic poststroke hemiparesis	Dx: Stroke with hemiparesis Stage: Chronic (9 months) Age: 59.6 (15.7[a])	Frequency Group: 1· per week Home: 6· per week Session duration Group: 90 min Home: 35–45 min Intervention period: 10 weeks Dose (total time): 50–60 h	Style of Yoga: Hatha Structure Group Classes: 10-min lecture on yoga concepts; 30 min of physical poses; 10–12 min of breathing exercises; 20–30 min of S A N A ; 8–10-min discussion and questions. Home Practice: 10–20 min of daily poses and breath work; 25 min of A N A .	Physical: MAS, BBS, 2MWT, CGS Psychosocial: GDS-15, STAI-Y1, STAI-Y2 Multidimensional: Informal interview	Results: Yoga intervention did not result in any signi cant improvements in objective motor function measures; signi cant improvements in QoL associated with perceived motor function, and decreases in state and trait anxiety. Conclusion: Yoga participation after stroke might bene t individuals in terms of their emotional well-being, QoL, and management of physical disability.

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Table 1. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Ji and Yu (2018)[37]	Design: RCT Sample: $N = 20$ (♂/♀: N/D) Objective: Explore the effects of yoga on cognitive ability and motor function of stroke patients and further elucidate the physiologic mechanism of yoga in therapeutic recovery	Dx: Stroke Stage: N/D Age Yoga: 61.2 (4.15)[a] Control: 61.3 (2.33)[a]	Frequency: 7 per week Session duration Stages 1 and 2: 30 min Stage 3: 60 min Intervention period: 12 weeks Dose (total time): 56 h	Style of Yoga: Adapted Yoga Structure: Stages lasted 4 weeks each Stage 1: Introduction to daily practice of adapted yoga poses and breathing patterns. Stage 2: Consolidate daily practice and increase complexity of yoga poses. Stage 3: Increase intensity of yoga practice and add exercises with yoga ball.	Physical: MBI, blood O_2 measurements, nerve excitability	Results: Signi cant increases in all components of blood O_2 measurements and higher scores on the MBI in the yoga group. Conclusion: Yoga exercise therapy can improve the cognitive ability of patients with stroke and promote recovery of motor function by increasing blood oxygen content in the brain.
Lynton et al. (2007)[38]	Design: Pilot study Sample: $N = 3$ (♂: 2, ♀: 1) Objective: Determine if a 12-week Kundalini Yoga practice leads to an improvement in aphasia and ne motor coordination in stroke patients	Dx: Stroke with aphasia Stage: Chronic (>6 months) Age: 68.7 (6.03)[a]	Frequency: 2 per week Session duration: 90 min Intervention period: 12 weeks Dose (total time): 36 h	Style of Yoga: Kundalini Structure: A series of physical exercises speci cally chosen to bene t individuals with aphasia; followed by an 11-min meditation consisting of spoken mantra; repeated each class.	Cognitive: CPT, BDAE Physical: O'Connor Tweezer, Dexterity Test Psychosocial: SF-36	Results: All three patients demonstrated a substantial improvement on dexterity outcome measures and a reduction in aphasia. Conclusion: Positive trends in this study suggest that further research should be done to examine the bene ts of Kundalini yoga in poststroke patients with speech and motor impairments.

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Table 1. (Continued)

Ref.	Design	Participants	Intervention	Dose	Outcomes	Results
Marshall et al. (2014)[39]	Design: Pretest/post-test Sample: N = 11 (♂: 9, ♀: 2) Stroke without aphasia (=6) Stroke with aphasia (=5) Objective: Explore whether UNB in uences measures of attention, language, spatial abilities, depression, and anxiety poststroke	Dx: Stroke with and without aphasia Stage: Chronic (4 months to 6 years) Age Stroke without aphasia: 58.2 (N/D)[a] Stroke with aphasia: 52.4 (N/D)[a]	Frequency: 6–7 per week Session duration: 5–40 min Intervention period: 10 weeks Dose (total time): 5–47 h	Style of Yoga: UNB Structure: 4 weeks of guided instruction and 6 weeks of individual practice. Participants were asked to close the left nostril using whichever hand was unaffected by the stroke and focused on extending the exhalation as twice as long as the inhalation.	Cognitive: ADP, COWAT, RTT, CPT, BJLOT Psychosocial: BDI-II, BAI	Results: UNB signi cantly decreased levels of anxiety in both groups; performance on language measures increased for individuals with aphasia. Conclusion: Preliminary evidence for improved affect and language, along with participant self-report of UNB bene ts, indicates that UNB may be a low-cost adjunct strategy to consider using for ameliorating certain poststroke effects.
Miller (2013)[40]	Design: Secondary analysis of RCT Sample: N = 9 (♂: 2, ♀: 7) Objective: Examine the effect of group therapeutic-yoga delivered in two dosing protocols (8 and 12 weeks) on walking recovery after stroke	Dx: Stroke Stage: Chronic Age: 63 (N/D)[a]	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Hatha Structure: Each session involved: breath work to promote awareness, chest expansion, and parasympathetic in uence; physical poses in sitting, standing, and supine for strength, exibility, and balance; and guided relaxation techniques.	Physical: 10-MWT, 6MWT, Spatiotemporal step parameters measured with GAITRite software	Results: Nonsigni cant improvements in walking distance between baseline and 12 weeks; negative change demonstrated in step length symmetry indicating more asymmetry. Conclusion: Yoga was mostly ineffective for walking recovery in this group, which may be due to a lack of task-oriented activities incorporated into the routine (i.e., transitional movements).

Table 1. (Continued)

R ( ) Ref.	D	P	I	D	O	P fi
Schmid et al. (2012)[41]	Design: RCT (pilot study) Sample: N = 47 (♂: 38, ♀: 9) Yoga (= 37) Control (= 10) Objective: Assess the impact of a yoga-based rehabilitation intervention on balance, balance self-ef cacy, FoF, and QoL after stroke	Dx: Stroke Stage: Chronic (>6 months) Age: 63.1 (8.8)[a]	Frequency: 2 per week Session duration: 60-min sessions Intervention period: 8 weeks Dose (total time): 16 h	Style of Yoga: Adapted (therapeutic) Structure: Modi ed postures with a focus on hip/ankle exibility and strength; breathing, and meditation; participants randomized to the yoga-plus group completed an additional 20-min relaxation audio recording.	Physical: mRS, BBS, ABCS Psychosocial: Dichotomous variable used to measure FoF Multidimensional: Stroke-speci c QoL scale	Results: No signi cant differences between groups; with-in group comparison demonstrated signi cant improvements in balance and FoF in yoga group. Conclusion: A group yoga-based intervention for people with chronic stroke has the potential in improving multiple poststroke variables.
Schmid et al. (2014)[42]	Design: Secondary analysis of RCT Sample: N = 47 (♂: 38, ♀: 9) Yoga (= 37) Control (= 10) Objective: Assess changes in physical functioning (i.e., measures of pain, ROM, strength, and endurance) after 8 weeks of a therapeutic yoga program	Dx: Stroke Stage: Chronic (>6 months) Age: 63.1 (8.8)[a]	Frequency: 2 per week Session duration: 60-min sessions Intervention period: 8 weeks Dose (total time): 16 h	Style of Yoga: Adapted (therapeutic) Structure: Standardized and progressive protocol comprised modi ed yoga postures, breathing, and relaxation in sitting, standing, and supine.	Physical: PEG, ROM, arm curl test (5 or 8 lbs), chair-to-stand test, 6MWT, modi ed 2-min step test	Results: Pain, neck ROM, hip passive ROM, upper extremity strength, and the 6-min walk scores all signi cantly improved after 8 weeks of engaging in yoga. Conclusion: A group therapeutic-yoga intervention may improve multiple aspects of physical functioning after stroke.

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Table 1. (Continued)

Ref.	Design	Participants	Intervention	Outcomes	Results
Wang (2018)[43]	Design: Quasiexperimental Sample: $N=64$ (♂/♀: N/D) Yoga (=33) Control (=32) Objective: Investigate the effects of yoga on recovery of motor ability and cranial nerves of stroke patients	Dx: Stroke Stage: N/D Age Yoga: 57 (5.27)[a] Control: 59.1 (4.98)[a]	Frequency: N/D Session duration: N/D Intervention period: 24 weeks Dose (total time): N/D	Style of Yoga: Adapted (therapeutic) Structure: Three-stage implementation of a progressive therapeutic yoga program Stage 1: beginner yoga practice Stage 2: yoga with combined exercise practice Stage 3: conventional yoga practice.	Physical: BBS, TUGT, One-leg standing, Nerve excitability test Psychosocial: SF-36	Results: No effect on QoL; signi cant improvement in balance, walking ability, and ability to stand on one leg demonstrated in yoga group; yoga exercises enhanced the amplitude of muscle movement potential. Conclusion: Yoga practice can effectively improve health outcomes in patients recovering from stroke.

[a]Age=mean (SD).

2MWT, 2-minute Walk Test; 6MWT, 6-minute Walk Test; 10MWT, 10-meter Walk Test; ABCS, Activities-speci c Balance Con dence Scale; ADP, Aphasia Diagnostic Pro les; BAI, Beck Anxiety Inventory; BBS, Berg Balance Scale; BDAE, Boston Diagnostic Aphasia Examination; BDI, Beck Depression Inventory; BJLOT, Benton Judgment of Line Orientation Test; CGS, Comfortable Gait Speed; COWAT, Controlled Oral Word Association Test; CPT II, Conner's Continuous Performance Test II; FoF, fear of falling; GDS-15, 15-item Geriatric Depression Scale; MAS, Motor Assessment Scale; MBI, Modi ed Barthel Index; mRS, Modi ed Rankin Scale; N/D, not de ned in study; PEG, Pain, Enjoyment of Life, and General Activity Scale; QoL, quality of life; RCT, randomized controlled trial; ROM, range of motion; RTT, Revised Token Test; SD, standard deviation; SF-36, short-form 36; SIS, Stroke Impact Scale; STAI, State-Trait Anxiety Inventory; TMB, Timed Movement Battery; TUGT, Timed Up and Go test; UNB, unilateral nostril breathing.

Table 2. Description of Included Studies That Used Yoga Therapy Interventions in Rehabilitation of Individuals with Parkinson's Disease

Ref.	Design	Participants	Intervention	Comparison	Outcomes	Results
Boulgarides et al. (2014)[44]	Design: Pre/post quasiexperimental (pilot study) Sample: $N=10$ (♂: 7, ♀: 3) Objective: Identify outcome measures that are responsive to change in individuals with PD after an 8-week adapted yoga program	Dx: PD Stage: H&Y Scale: Stage 1–3 Age: 65.7 (10.4)	Frequency: 1 per week Session duration: 60 min Intervention period: 8 weeks Dose (total time): 8 h	Style of Yoga: Adapted (therapeutic) Structure: Warm up activities such as gentle general movements; breath work; facial poses and vocal sounds; transition to standing, seated, and supine poses; concluded with meditation and deep relaxation.	Physical: mDGI, BBS, FRT, SRT, TSCS, SLB, AST Psychosocial: HADS Multidimensional: UPDRS	Results: Outcome measures that approached near signi cant improvement were for depression (HADS), lower extremity functional strength, and exibility (TSCS, SLB, SRT). Conclusion: Future research required to evaluate the usefulness of yoga practice for individuals with PD.
Cheung et al. (2018)[45]	Design: RCT (pilot study) Sample: $N=20$ (♂/♀: N/D) Yoga (=10) Control (=10) Objective: Examine the feasibility, acceptability, and effects of Hatha yoga on oxidative stress, motor function, and nonmotor symptoms in patients with PD	Dx: Idiopathic PD Stage: H&Y Scale: Stage 1–3 Age: 63.0 (8.0)	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Hatha Structure: Used protocol developed by Justice et al.[18]—focus on increasing ROM, improving balance/safety with transitions, and fostering mindfulness, acceptance, and self-love; classes included thematic discussions, seated guided meditation and breath work, physical and restorative poses.	Cognitive: MoCA Physical: mUPDRS, PDSS, oxidative stress, LAPAQ Multidimensional: UPDRS	Results: Motor function (mUPDRS scores) signi cantly improved in yoga group; no change in oxidative stress levels. Conclusion: Findings suggest yoga is a feasible and acceptable intervention in PD and may serve as an adjunctive method for improving motor function.

Table 2. (Continued)

Ref.	Design and Analysis	Participants	Intervention	Delivery	Outcomes and Measures	Results and Conclusions
Colgrove and Sharma (2012)[46]	Design: RCT (pilot study) Sample: $N = 13$ (♂: 6, ♀: 7) Yoga (= 8) Control (= 5) Objective: Assess the feasibility and effects on motor function of Iyengar-based Hatha yoga in people with PD	Dx: PD Stage: H&Y Scale: Stage 1–2 Age Yoga: 62.8 (13.2)[a] Control: 73.4 (6.5)[a]	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Iyengar-Based Hatha Structure: 5–10 min of deep breathing and relaxation; 40 min of ve to eight progressive physical postures held for 3–7 min; 10–15 min of meditation including breathing, visualizations, and positive af rmations.	Physical: BBS, ROM, strength, posture, postural sway and gait initiation Multidimensional: UPDRS	Results: Signi cant improvement in mUPDRS and BBS in yoga group; positive trend toward improvement in strength, ROM, exibility, and qualitative improvements in posture in yoga group. Conclusion: Yoga may be an effective intervention for improving motor function in individuals with PD.
DeCaro and Constantine Brown (2016)[47]	Design: Pretest/post-test (pilot study) Sample: $N = 86$ (♂: 36, ♀: 49) PD (= 47) Care (= 38) Objective: Explore if a single session of laughter yoga can bene t adults with PD and their caregivers	Dx: PD Stage: N/D Age PD: 70 (8.19)[a] Care: 65 (12.05)[a]	Frequency: Single session Session duration: 45 min Intervention period: Single session Dose (total time): 0.75 h	Style of Yoga: Laughter Yoga Structure: Developed by Dr. Kataria—utilized breathing techniques, laughter activities, core exercises, and meditation.	Multidimensional: HDYF	Results: Signi cant improvement in self-rated well-being for individuals with PD and their caregivers. Conclusion: Laughter yoga may be a valuable tool for individuals with PD who are suffering from low-mood.
Hall et al. (2011)[48]	Design: Case study Sample: $N = 1$ (♂: 0, ♀: 1) Objective: Investigate the effects of 8 weekly yoga sessions on balance, mobility, and reported QoL in an individual with PD	Dx: Idiopathic PD Stage: H&Y Scale: Stage 2 Age: 69 (N/D)[a]	Frequency: 1 per week Session duration: 60 min Intervention period: 8 weeks Dose (total time): 8 h	Style of Yoga: Adapted (therapeutic) Structure: Physical poses tailored to physical limitations of participants progressed from sitting to supine and prone to standing; focus on posture and alignment.	Physical: BBS, TUG, AROM, H&Y scale Multidimensional: PDQ-39	Results: Improvement on the BBS and TUG (not clinically signi cant); no change in QoL (PDQ-39); participant reported sense of enjoyment and relaxation. Conclusion: Larger sample sizes and individuals at different stages of disease are required to draw generalizable conclusions about the bene t of yoga in PD.

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Table 2. (Continued)

R ( )[Ref.]	D A	P	I	D	O	P fi A
Jasti et al. (2020)[49]	Design: Case study Sample: N = 1 (♂: 0, ♀: 1) Objective: Examine the impact of yoga therapy on self-empowerment, reducing the severity of symptoms, improving functional autonomy and well-being	Dx: Idiopathic PD Stage: H&Y Scale: Stage 5 Age: 55 (N/D)[a]	Frequency: 6 per week Session duration: 60 min Intervention period: 4 weeks Dose (total time): 24 h	Style of Yoga: Lifestyle-Based Program Structure: Combination of , meditation, chanting, relaxation techniques, devotional sessions, lifestyle counseling based on yoga philosophy, and dietary modi cations based on yogic principles.	Cognitive: Short-term memory on digit span test Physical: BBS, VAS (pain and symptoms), YPA Psychosocial: HAM-A, HAM-D Multidimensional: UPDRS	Results: BBS improved from 13 to 23; YPA improved from 15 to 32; scores on VAS for pain fell from 7 to 3; signi cant reductions demonstrated for UPDRS, HAM-A, and HAM-D in both the ON- and OFF-states. Conclusion: An intensive lifestyle-based yoga program may be bene cial adjunctive therapy for reducing tremor, bradykinesia, rigidity, and improving balance and QoL in patients suffering from PD.
Justice et al. (2018)[48]	Design: RCT Sample: N = 19 (♂/♀: N/D) Yoga (= 9) Control (= 10) Objective: Develop and test a biweekly 12-week yoga program to determine its safety and feasibility for people living with PD	Dx: PD Stage: H&Y Scale: Stage 1–3 Age: 63.0 (8.0)[a]	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Hatha and Vinyasa Structure: Classes included: thematic discussions; seated guided meditation and breath work; physical and restorative poses focused on increasing ROM/improving balance/safety with transitions; and fostering mindfulness, acceptance and self-love.	Feasibility/Safety: Adverse-event Reporting Satisfaction: 3- Survey Questions Multidimensional: Subjective Feedback	Results: The yoga program was safe, feasible, and enjoyable for the participants; to encourage safety, mats should be positioned next to the walls and extensive use of yoga props are recommended to aid with stability. Conclusion: This PD yoga protocol can be used as a template for future studies on the therapeutic use of yoga for PD.

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Table 2. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Khuzema et al. (2020)[50]	Design: RCT Sample:N=27 (♂: 19, ♀: 8) Yoga (=9) Tai Chi (=9) Control (=9) Objective: Determine whether 8 weeks of home-based Tai Chi or yoga is more effective than regular exercise on balance and mobility	Dx: PD Stage: H&Y Scale: Stage 2.5–3 Age Yoga: 68.1 (4.23) Tai Chi: 72.0 (5.22) Control: 70.9 (6.01)	Frequency: 5 per week Session duration: 30–40 min Intervention period: 8 weeks Dose (total time): 20–27 h	Style of Yoga: Adapted (therapeutic) Structure: Yoga exercise program included 6 poses (4 standing, 1 supine, and 1 prone) repeated 5 times each and progressively increased to 10; intensity ranged from 11 to 15 on the Borg Rate of Perceived Exertion Scale (i.e., light to somewhat hard).	Physical: BBS, 10-MWT, TUG	Results: All three groups showed signi cant improvement after 8 weeks in balance and functional mobility; no signi cant main effect between groups for both balance and stability. Conclusion: Yoga could be a potential therapy for improving balance and functional mobility for individuals with mild-to-moderate idiopathic PD.
Kwok et al. (2019)[51]	Design: RCT Sample:N=138 (♂: 65, ♀: 73) Yoga (=71) Control (=67) Objective: Compare the effects of yoga vs. stretching and resistance training on psychological distress, physical health, well-being, and QoL in patients with mild-to-moderate PD	Dx: PD Stage: H&Y Scale: Stage 1 Age: 63.6 (8.7)	Frequency Group: 1· per week Home: 2· per week Session duration Group: 90 min Home: 20 min Intervention period: 8 weeks Dose (total time): 17.3 h	Style of Yoga: Hatha Structure: Mindfulness yoga protocol with three themes: (1) introduction to mindfulness, (2) embracing mindfulness of the body and mind, and (3) cultivating loving-kindness and compassion. Progressive and stepwise delivery of 12 basic Hatha yoga poses with controlled breathing and mindfulness meditation exercises.	Physical: TUG Psychosocial: HADS, HWS Multidimensional: MDS-UPDRS, PDQ-39	Results: Yoga was superior to conventional exercise for managing anxiety, and depressive symptoms, perceived hardship, equanimity, and health-related QoL; yoga was as effective as conventional exercise for improving motor function. Conclusion: Mindfulness yoga is an effective treatment option for patients with PD to manage psychological distress and improve physical symptoms.

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Table 2. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Memarian et al. (2017)[52]	Design: Pretest/post-test Sample: N = 24 (♂: 14, ♀:10) Yoga (= 12) Control (= 12) Objective: Evaluate the effects of Laughter Yoga exercises on anxiety and sleep quality in patients with PD	Dx: PD Stage: H&Y Scale: Stage 1–3 Age: N/D (N/D)[a]	Frequency: 2 per week Session duration: 45 min Intervention period: 8 weeks Dose (total time): 12 h	Style of Yoga: Hatha Structure: Developed by Dr. Kataria—utilized breathing techniques, laughter activities, core exercises. and meditation.	Physical: PSQI Psychosocial: BAI	Results: Signi cant differences in average stress change and sleep quality following an 8-week laughter yoga program; improvements noted in subjective sleep quality and latency. Conclusion: Laughter yoga can signi cantly improve anxiety and sleep quality in patients with PD and may serve as a bene cial complementary therapy to standard treatment.
Myers et al. (2020)[53]	Design: RCT Sample: N = 26 (♂: 15, ♀: 11) Yoga (= 13) Control (= 13) Objective: Determine the feasibility and effect of a 12-week yoga intervention on balance, lower back pain, and anxiety	Dx: PD Stage: H&Y Scale: Stage 2–3 Age Yoga: 70.5 (8.7)[a] Control: 65.0 (8.7)[a]	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Beginner Vinyasa Structure: 5-min relaxation and guided meditation; 10 min of gentle spinal movements; 30–35 min of standing poses; 5–10 min cool down; 5 min of rest and relaxation. Progressively increased in intensity over 12-week intervention period.	Physical: BESTest, ROSW Psychosocial: BAI Multidimensional: MDS-UPDRS (part III)	Results: Yoga group showed signi cant improvements across individual balance systems; signi cant reductions in low-back pain; high levels of overall enjoyment; no signi cant changes observed in anxiety. Conclusion: Yoga is feasible for people with PD and is a nonpharmacologic intervention that can improve balance and low-back pain.

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Table 2. (Continued)

R ( ) Ref.	D A	P	I	D	O	P fi A
Ni et al. (2016)[54]	Design: RCT Sample: N = 37 (♂: 24, ♀: 13) Yoga (= 14) Power (= 13) Control (= 10) Objective: Compare the effects of power training and a high-speed yoga program on physical performances in older patients with PD	Dx: Idiopathic PD Stage: H&Y Scale: Stage 1–3 Age: 72.2 (6.5)[a]	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Power Vinyasa Structure: High-speed yoga session involving quick transitions from one pose to the next while connecting the breath to the movements.	Physical: BBS, TUG, SLS, 10-MWT, Mini-BESTest, FRT, SLS, 1-RM, PPW Multidimensional: MDS-UPDRS	Results: No differences detected between yoga program and power training; both groups reported alleviation of motor symptoms and signi cant improvements in balance, function, gait, leg muscle strength and power. Conclusion: A high-speed yoga program can improve physical performance in older persons with PD.
Sharma et al. (2015)[55]	Design: RCT (pilot study) Sample: N = 13 (♂: 6, ♀: 7) Yoga (= 8) Control (= 5) Objective: Determine whether a yoga intervention can improve physiologic outcomes and QoL in individuals with PD	Dx: PD Stage: H&Y Scale: Stage 1–2 Age Yoga: 62.8 (13.2)[a] Control: 73.4 (6.5)[a]	Frequency: 2 per week Session duration: N/D Intervention period: 12 weeks Dose (total time): N/D	Style of yoga: N/D Structure: N/D.	Physical: Modi ed FES, weight, resting HR, respiratory rate, BP, standard PFT Psychosocial: GDS, SF-36 Multidimensional: UPDRS	Results: Yoga group demonstrated signi cant improvement in UPDRS scores, diastolic BP, and average FVC; positive trends were observed in depression scores, body weight, FEV. Conclusion: Yoga may improve aspects of QoL and physiologic function in mild-to-moderate patients with PD.

(A)

Table 2. (Continued)

R ( ) Ref.	D A	P	I	D	O	P fi A
Taylor (2001)[56]	Design: Case Study Sample: N = 1 (♂: 0, ♀: 1) Objective: Report the clinical decision-making involved in using yoga therapy with a patient with PD	Dx: PD Stage: N/D Age: 59 (N/D)[a]	Frequency: 7 per week Session duration: 30 min Intervention period: 3 weeks Dose (total time): 10.5 h	Style of Yoga: Adapted (therapeutic) Structure: Involved breathing exercises and modi ed yoga postures in sitting, standing, and supine.	N/D	Results: Patient reported signi cant improvement in vocal projection, facial awareness, improved gait ef ciency, and emotional boost. Conclusion: Yoga therapeutics may have the potential to complement traditional neurologic physical therapy.
Van Puymbroeck et al. (2018)[57]	Design: RCT Sample: N = 27 (♂: 17, ♀: 10) Yoga (= 15) Control (= 12) Objective: Examine the impact of an 8-week yoga intervention on motor function, balance control, postural stability, and freezing of gait in persons with PD	Dx: PD Stage: H&Y Scale: Stage 1.5–3 Age: 67.7 (5.89)[a]	Frequency: 2 per week Session duration: N/D Intervention period: 8 weeks Dose (total time): N/D	Style of Yoga: Hatha Structure: Modi ed yoga postures in sitting, standing, and supine; breath work ( ); meditative techniques ( ), and deep relaxation.	Physical: Modi ed H&Y scale, Mini-BESTest, FGA, FoG Multidimensional: MDS-UPDRS	Results: Yoga group demonstrated clinical important differences in MDS-UPDRS scores and signi cant improvement in Mini-BESTest, FGA and FoG. Conclusion: A yoga intervention appears to improve motor function, postural stability, functional gait, and freezing of gait in patients with PD and thus may have the potential to reduce fall risk in this population.

(A)

Table 2. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Walter et al. (2019)[58]	Design: RCT Sample:N=27 (♂: 17, ♀: 10) Yoga (=15) Control (=12) Objective: Examine changes in nonmotor symptoms of fatigue, activity constraints, balance, balance con dence, fall management, and overall PD-speci c health-related QoL for individuals with PD following an 8-week standardized Hatha yoga intervention	Dx: PD Stage: H&Y Scale: Stage 1.5 Age: 67.6 (5.89)[a]	Frequency: 2 per week Session duration: 60 min Intervention period: 8 weeks Dose (total time): 16 h	Style of Yoga: Hatha Structure: Adapted sequence for PD to focus on balance, strength and mobility. Involved physical postures, breath work and meditation.	Physical: PFS-16. ACS, ABC, FMS, FCS Multidimensional: PDQ-8	Results: Yoga group demonstrated greater reduction in perceived constraints to activity, and improvement in measures of fatigue, belief in one's ability to manage falls, and health-related QoL. Conclusion: Yoga may be an effective complementary and integrative health approach to help improve nonmotor symptoms for people with PD.

[a]Age=mean (SD).

1-RM, 1 Repetition Maximum; ABC, Activities-Speci c Balance Con dence Scale; ACS, Activities Constraint Scale; AROM, active range of motion; AST, A sit-to-stand test; BAI, Beck Anxiety Inventory; BBS, Berg Balance Scale; BESTest, Balance Evaluations Systems Test; BP, blood pressure; FCS, Fall Control Scale; FEV, forced expiratory volume; FGA, Functional Gait Assessment; FMS, Fall Management Scale; FoG, Freezing of Gait Questionnaire; FRT, functional reach test; FVC, forced vital capacity; GDS, Geriatric Depression Scale; HADS, Hospital Anxiety and Depression Scale; HAM-A, Hamilton Anxiety Rating Scale; HAM-D, Hamilton Depression Rating Scale; HDYF, How Do You Feel Form; HR, heart rate; HWS, Holistic Well-Being Scale; LAPAQ, Longitudinal Aging Study Amsterdam Physical Activity Questionnaire; mDGI, Modi ed Dynamic Gait Index; MDS-UPDRS, Movement Disorders Society-Uni ed Parkinson's Disease Rating Scale; Mini-BESTest, Mini-Balance Evaluations Systems Test; Modi ed FES, Modi ed Falls Ef cacy Scale; Modi ed H&Y Scale, Modi ed Hoehn & Yahr Scale; mUPDRS, Motor part of the Uni ed Parkinson's Disease Rating Scale; N/D, not de ned in study; PD, Parkinson's disease; PDQ, Parkinson's Disease Questionnaire; PDSS, Parkinson's Disease Sleep Scale; PFS-16, 16-item Parkinson Fatigue Scale; PFT, Pulmonary Functions Test; PPW, Peak Power; PSQI, Pittsburgh Sleep Quality Inventory; QoL, quality of life; ROM, range of motion; ROSW, Revised Oswestry Disability Index; SD, standard deviation; SF-36, short-form 36; SLB, single leg balance; SLS, single leg stance; SRT, Sit and Reach Test; TSCS, 30-sec chair stand; TUG, Timed Up and Go; UPDRS, Uni ed Parkinson's Disease Rating Scale; VAS, Visual Analog Scale; YPA, Yoga Performance Assessment scale.

Table 3. Description of Included Studies That Used Yoga Therapy Interventions in Rehabilitation of Individuals with Multiple Sclerosis

R ( )[Ref.]	D	P	I	D	O	P fi
Ahmadi et al. (2013)[59]	Design: RCT Sample: N = 31 (♂: 0, ♀: 31) Yoga (= 11) Aerobic (= 10) Control (= 10) Objective: Compare the effects of 8 weeks of aerobic and yoga training on balance, ambulatory function, fatigue, and mood status in MS patients	Dx: MS Stage: EDSS: 1–4 Age: 35.2 (9.01)	Frequency: 3 per week Session duration: 60–70 min Intervention period: 8 weeks Dose (total time): 24–28 h	Style of Yoga: Hatha Structure: Classes incorporated postures, breath work, meditation, and relaxation techniques. Poses were held for 10–30 sec with 30–60-sec rest periods. Patients were supported for the majority of poses using props.	Physical: BBS, 10MWT, 2MWT, FSS Psychosocial: BDI, BAI Multidimensional: EDSS	Results: Signi cant improvements in balance score, walking endurance, FSS score, BDI score, and BAI score observed in both treatment groups; greater improvement in BAI scores observed in the yoga group compared with aerobic group. Conclusion: Treadmill training and yoga practice can both improve ambulatory function, fatigue, and mood status in individuals with mild-to-moderate MS.
Bhargav et al. (2016)[83]	Design: Crossover Sample: N = 18 (♂: 5, ♀: 13) Objective: Investigate the immediate effects of a CM yoga session on the cognitive domains of psychomotor performance, selective attention, short-term memory, executive functions, and immediate and delayed recall in patients with RRMS	Dx: Relapse-remitting and progressive MS Stage: EDSS: 0–6.5 Age: 51.5 (12.7)	Frequency: Two sessions Session duration: 30 min Intervention period: 2 sessions Dose (total time): 1 h	Style of yoga: CM Structure: Three yoga postures were interspersed with periods of three different types of relaxation. S (SR) was used as a control session for comparative analysis.	Cognitive: TMT-a/b, DSST, AVLT, WMS-R (Digit Span)	Results: Both CM and SR sessions improved scores on DSST, AVLT; signi cantly better performance on TMT-a/b and FDS after CM compared with SR; CM is better than SR in improving processing speed and working memory. Conclusion: Yogic relaxation techniques may have an immediate enhancing effect on processing speed, psychomotor performance, and recall of RRMS patients.

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Table 3. (Continued)

R ( )[Ref.]	D A	P	I	D	O	P fi A
Cohen et al. (2017)[84]	Design: Pretest/post-test (pilot study) Sample: N = 14 (♂: 0, ♀: 14) Objective: Determine the safety and feasibility effects on QoL, physical function, and motor performance of a yoga program designed for people with MS-related disability	Dx: MS (any subtype) Stage: SR-(MSDS) Scale: 3–6 Age: 53.5 (8.3)	Frequency: 2 per week Session duration: 90 min Intervention period: 8 weeks Dose (total time): 24 h	Style of Yoga: Hatha Structure: 10-min of yoga philosophy; 10 min of ; 50 min of with chair or wall support if needed; 20 min of relaxation and meditation techniques including mindfulness and visualization.	Cognitive: PASAT-3 Physical: MSW-12, T25FW, 6MWT, 9HPT, FTSST, MDRT, MEP, SF-36 MCS Multidimensional: MSQLI	Results: Signi cant main effect found on SF-36 MCS, MFIS, BLCS, PDQ, MHI, MSW-12, T25FW, NHPT, PASAT-3, 6MWT, FTSST, and MDRT-Back. Conclusion: Yoga is a safe and effective intervention and has the potential to bene t several QoL and physical performance outcomes in individuals with moderate MS-related disability.
de Oliveira et al. (2016)[60]	Design: RCT (pilot study) Sample: N = 12 (♂: 1, ♀: 11) Yoga (= 6) Control (= 10) Objective: Evaluate the in uence of a 6-month yoga program on postural balance and subjective impact of postural balance impairment on ADLs in people with MS	Dx: MS (any subtype) Stage: EDSS: 0–6 Age Yoga: 46.0 (8.0) Control: 45.0 (9.0)	Frequency: 1 per week Session duration: 60 min Intervention period: 24 weeks Dose (total time): 24 h	Style of Yoga: Hatha (Adapted) Structure: Postures addressed movements of the vertebral column and were carried out in seated, supine, and upright positions held for 30 sec each; followed by breath work; concluded with relaxation in supine position (N A).	Physical: BBS, IPBDLSQ Multidimensional: EDSS	Results: Signi cant improvement in BBS score (especially in subjects with high EDSS score), increased self-reported postural balance, and decreased in uence of postural balance impairment on ADLs from baseline to 6 months was observed in yoga group. Conclusion: Yoga training is bene cial for people with MS as it improves postural balance and decreases in uence of postural balance impairment on ADLs.

(A)

Table 3. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Doulatabad et al. (2012)[61]	Design: RCT Sample:N = 60 (♂: 0, ♀: 60) Yoga (= 30) Control (= 30) Objective: Investigate how yoga techniques can modify physical pain and QoL in women with MS	Dx: MS (any subtype) Stage: N/D Age: 31.6 (8[8])	Frequency: 2 per week Session duration: 60–90 min Intervention period: 12 weeks Dose (total time): 24–36 h	Style of Yoga: Ashtanga inspired Hatha Structure: Incorporated (1) slow moving ; (2) ; and (3) mind focus and establishment of control through meditation, extension, and quiescence R( ).	Multidimensional: MSQoL-54	Results: Yoga therapy resulted in a signi cant improvement in physical pain management and QoL compared with the control group. Conclusion: Yoga techniques can be used as a supplemental therapy to treat patients with MS as it strengthens physical power and improves mental status resulting in an improved QoL.
Ensari et al. (2016)[62]	Design: Pre-post quasi-experimental Sample:N = 14 (♂: 1, ♀: 23) Yoga (= 8) Walking (= 8) Control (= 8) Objective: Examine the effects of single bouts of treadmill walking and yoga compared with a quiet and seated-rest control condition on acute mood symptoms in individuals with MS	Dx: Relapse-remitting MS Stage: EDSS: 2–6 Age: 44.2 (8.2[8])	Frequency: One session Session duration: 30 min Intervention period: One session Dose (total time): 0.5 h (30 min)	Style of Yoga: Hatha Structure: 5 min of centering; 20 min of modi ed Hatha yoga for people with MS (nine postures including isometric exercises and muscle relaxation); 5 min of meditation and deep breathing.	Psychosocial: POMS	Results: Walking and yoga yielded comparable reductions in TMD scores and similar improvements in acute mood symptoms; walking (not yoga) resulted in an improvement in vigor. Conclusion: A single bout of exercise might be bene cial to induce mood-improving effects in people with MS and the modality of exercise might not matter if the goal is to improve overall acute mood symptoms.

(A)

Table 3. (Continued)

R ( )[Ref.]	D	P	I	D	O	P fi
Garrett et al. (2013)[63]	Design: RCT Sample: N = 242 (♂: 60, ♀: 182) Yoga (= 77) PT (= 80) FI (= 86) Control (= 71) Objective: Evaluate the effectiveness of community-based exercise interventions for people with MS who have minimal gait impairment	Dx: Relapse-remitting, primary progressive and secondary progressive MS Stage: GNDS Score: 0–2 Age Yoga: 49.6 (1.0[a]) PT: 51.7 (10.0[a]) FI: 50.0 (1.0[a]) Control: 48.8 (11.0[a])	Frequency: 1 per week Session duration: 60 min Intervention period: 10 weeks Dose (total time): 10 h	Style of Yoga: Hatha Structure: Classes generally began with breath work, relaxation or "body-centering," followed by a series of range of motion or stretching exercises and dynamic weight-bearing poses held between 30 and 90 sec; concluded with relaxation, deep breathing or	Physical: 6MWT Multidimensional: MSIS-29, MFIS	Results: All three exercise interventions led to signi cant improvement on the MSIS-29 psychological, MFIS total and physical subscale; Only PT-led and FI-led improved MSIS-29 physical and 6MWT. Conclusion: Exercise has a positive effect on the physical impact of MS and fatigue. The group nature of the classes may contribute to the positive effects seen on the psychological impact of MS.
Garrett et al. (2013)[64]	Design: Secondary analysis of RCT Sample: N = 121 (♂: 36, ♀: 84) Yoga (= 38) PT Led (= 41) FI Led (= 42) Objective: Collect and compare follow-up data (week 24) with post-treatment (week 12) and baseline (week 1) data for participants in the intervention group	Dx: Relapse-remitting, primary progressive and secondary progressive MS Stage: GNDS Score: 0–2 Age: 51.5 (9.2[a])	Frequency: 1 per week Session duration: 60 min Intervention period: 10 weeks Dose (total time): 10 h	Style of Yoga: Hatha Structure: Classes generally began with breath work, relaxation or "body-centering," followed by a series of range of motion or stretching exercises and dynamic weight-bearing poses held between 30 and 90 sec; concluded with relaxation, deep breathing or	Physical: 6MWT Multidimensional: MSIS-29, MFIS	Results: Positive effect of exercise on the physical impact of MS was not maintained 3 months postintervention; psychological well-being and impact of fatigue remained signi cantly improved from baseline. Conclusion: Delivering health-promoting interventions over the lifetime of people with chronic neurologic conditions is vital to maintaining sustained physical and mental health.

Table 3. (Continued)

R ( )[Ref.]	D A	P	I	D	O	P fi A
Guner and Inanci (2015)[65]	Design: Pretest/post-test Sample: N = 16 (♂: 2, ♀: 14) MS (=8) Control (=8) Objective: Determine the effects of 12 weeks of yoga therapy on fatigue, balance, and gait parameters in people with MS	Dx: RRMS Stage: EDSS: 0–6 Age Yoga: 38.4 (7[a]) Control: 33.9 (3.8[a])	Frequency: 2 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 24 h	Style of Yoga: Hatha (Adapted) Structure: Poses performed in sitting or supported by a chair/wall, and held for 10–30 sec with 30–60 sec rest periods in a room held at 16C - 17 C; concluded with 10-min deep relaxation ( ). Daily home practice was strongly encouraged.	Physical: FSS, BBS, Gait analysis using the Vicon 612 system with six cameras and two Bertec force plates	Results: Signi cant improvement observed in fatigue, balance, step length, and walking speed after 12-week yoga intervention; visible but nonsigni cant improvements in peak pelvic tilt, peak hip extension, and ankle power at push-off. Conclusion: Yoga therapy is a safe and bene cial intervention for improving fatigue, balance, and spatiotemporal gait parameters in patients with MS.
Hassanpour-Dehkordi and Jivad (2014)[66]	Design: Quasi-experimental RCT Sample: N = 61 (♂: 1 ♀: 60) Yoga (=20) Aerobics (=20) Control (=21) Objective: Compare the effects of regular yoga and aerobic exercise on QoL of patients with MS	Dx: MS Stage: N/D Age: 31.9 (N/D[a])	Frequency: 3 per week Session duration: 40 min Intervention period: 12 weeks Dose (total time): 24 h	Style of yoga: N/D Structure: N/D	Psychosocial: SF-36	Results: The mean score on the QoL questionnaire was signi cantly higher than that of the aerobic group, and the aerobic group showed signi cantly higher mean scores compared with the control. Conclusion: Yoga and aerobic exercise can improve QoL in patients with MS.

(A)

Table 3. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Hasanpour-Dehkordi (2016)[67]	Design: RCT Sample:N = 61 (♂: 1, ♀: 60) Yoga (= 20) Aerobic (= 20) Control (= 21) Objective: Investigate the in uence of yoga and aerobic exercise on fatigue, pain, and psychological status in patients with MS	Dx: MS Stage: N/D Age: 31.9 (N/D)[a]	Frequency: 3 per week Session duration: 60–70 min Intervention period: 12 weeks Dose (total time): 36–42 h	Style of Yoga: Hatha Structure: Stretching followed by standing, supine, prone-lying and sitting postures held for 10–30 sec with rest periods of 30–60 sec; breathing for concentration and relaxation; 10 min of deep relaxation. Home practice with predetermined poses was strongly encouraged.	Physical: RFS Psychosocial: SF-36	Results: Signi cant reduction in fatigue severity, decreased pain with physical function, increased physical and emotional roles, increased social function, and improved mental status were observed in both the yoga and exercise groups. Conclusion: Scheduled yoga classes can signi cantly enhance the overall general health of patients with MS.
Hasanpour-Dehkordi et al. (2016)[68]	Design: RCT Sample:N = 60 (♂/♀: N/D) Yoga (= 30) Control (= 30) Objective: Investigate the effects of yoga on physiologic indices, anxiety, social functioning, and QoL in MS patients	Dx: MS Stage: N/D Age: 30 (N/D)[a]	Frequency: 3 per week Session duration: 60–70 min Intervention period: 12 weeks Dose (total time): 36–42 h	Style of Yoga: Hatha Structure: Stretching followed by standing, supine, prone-lying, and sitting postures held for 10–30 sec with rest periods of 30–60 sec; breathing for concentration and relaxation; 10 min of deep relaxation. Home practice with predetermined poses was strongly encouraged.	Physical: VAS, FSS, Vital Signs Psychosocial: Spielberg Anxiety Inventory, SF-36	Results: Yoga signi cantly improved QoL and social functioning and signi cantly decreased fatigue intensity, pulse rate, blood pressure, anxiety, and pain. Conclusion: Yoga should be considered a possible adjunctive therapy for decreasing stress and anxiety. Yoga appears to be safe and should be encouraged to increase self-ef cacy, improve QoL, and promote social functioning in patients with MS.

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Table 3. (Continued)

R ( )Ref.	D	P	I	D	O	P fi
Hogan et al. (2014)[69]	Design: RCT Sample: N = 111 (♂: 40, ♀: 71) Yoga (=13) Group PT (=48) one-on-one PT (=35) Control (=15) Objective: Evaluate the effectiveness of yoga and physiotherapy interventions delivered in community settings for people with MS who use bilateral aids for gait	Dx: MS Stage: GNDS Score: 3–4 Age Yoga: 58 (N/D) Group PT: 57 (N/D)[a] 1 on 1 PT: 52 (N/D)[a] Control: 49 (N/D)[a]	Frequency: 1 per week Session duration: 60 min Intervention period: 10 weeks Dose (total time): 10 h	Style of Yoga: N/D Structure: Static postures (e.g., mountain pose, cat pose, and tailor pose); self-massage, relaxation, meditation, and breathing techniques.	Physical: BBS, 6MWT Multidimensional: MSIS-29, MFIS	Results: No signi cant improvements on MSIS-29 physical or psychological component scores and MFIS scores in the yoga group; signi cant decrease in 6MWT in yoga group. Conclusion: Physiotherapy interventions may be more effective for overall physical and psychological health than participating in yoga for people with MS who use bilateral support for gait.
Hosseini et al. (2018)[70]	Design: RCT Sample: N = 26 (♂: 12, ♀: 14) Yoga (=9) Resistance (=9) Control (=8) Objective: Compare the effects of home-based yoga training and RT on muscle strength, motor capacity, and balance in patients with MS	Dx: MS Stage: EDSS: 1–6 Age: 31.3 (9.07)[a]	Frequency: 3 per week Session duration: 60–70 min Intervention period: 8 weeks Dose (total time): 24–28 h	Style of Yoga: Hatha Structure: Stretching exercises with a progression to standing, prone-lying, and sitting postures held for 8–30 sec (depending on tolerance) with 30–60-sec rest periods; new poses were added to the program every 2 weeks.	Physical: 1-RM (leg press), 10MWT, 20-sec balance tests using computerized biodex (i.e., standing eyes open; standing eyes closed; single leg standing eyes open)	Results: Yoga had no signi cant effect on leg extensor muscle strength but RT increased it; functional capacity was not affected by either yoga or RT; single leg balance improved signi cantly in the yoga group. Conclusion: Both yoga and RT, when prescribed with regularity and controlled intensity and time, can have a positive impact on the lower limb strength and some degree of balance improvements in MS patients.

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Table 3. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Naja doulatabad et al. (2014)[71]	Design: RCT Sample:N = 60 (♂: 0, ♀: 60) Yoga (= 30) Control (= 30) Objective: Explore the effects of yoga techniques on physical activities and sexual function in women with MS	Dx: MS Stage: N/D Age: 31.6 (8.0)[a]	Frequency: 2 per week Session duration: 60–90 min Intervention period: 8 weeks Dose (total time): 24–36 h	Style of Yoga: Hatha Structure: Slow movements in supine, sitting, and standing; postures with an emphasis on mindful breathing and focus on speci c body parts; participants alternated between physical movement and mental activities interspersed with 10–15 min of rest in supine position.	Multidimensional: MSQoL-54	Results: Yoga caused signi cant improvements in physical activities requiring minimal to moderate exertion but did not minimize dif culty with more strenuous and heavy activities (i.e., stairs, walking through intersection); yoga improved sexual satisfaction. Conclusion: Yoga techniques may be bene cial in improving the physical and sexual function of women with MS.
Oken et al. (2004)[72]	Design: RCT Sample:N = 57 (♂: 4, ♀: 53) Yoga (= 22) Exercise (= 15) Control (= 20) Objective: Determine the effect of yoga and aerobic exercise on cognitive function, fatigue, mood, and QoL in patients with MS	Dx: MS Stage: EDSS: 0–6 Age Yoga: 49.8 (7.4)[a] Exercise: 48.8 (10.4)[a] Control: 48.4 (9.8)[a]	Frequency: 1 per week Session duration: 90 min Intervention period: 24 weeks Dose (total time): 36 h	Style of Yoga: Iyengar (Adapted) Structure: Nineteen modi ed supported poses held for 10–30 sec with rest periods of 30–60 sec; emphasis placed on breathing for concentration and relaxation; concluded with 10 min of deep relaxation, visualization, or meditation techniques in supine. Daily home practice was strongly encouraged.	Cognitive: SCWT, Modi ed Useful FoV task, PASAT, WMS-III, WAIS Physical: MSFC, T25FW, 9HPT, CSR, SL balance, MFI, Alertness (based on EEG) Psychosocial: POMS, CESD-10, SF-36, STAI	Results: No effect in either intervention on primary outcome measures of attention, alertness or mood; both active interventions showed signi cant improvement in secondary measures of fatigue. Conclusion: 6 months of yoga or exercise classes may have a bene cial effect on levels of fatigue in patients with MS.

(A)

Table 3. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Patil et al. (2012)[73]	Design: Pretest/post-test Sample: N = 16 (♂: 1, ♀: 10) Objective: Evaluate the effect of integrated yoga for NBD in patients with MS	Dx: MS Stage: EDSS 0–7.5 Age: 46.7 (11.2)[a]	Frequency: 7 per week Session duration: 120 min Intervention period: 3 weeks Dose (total time): 42 h	Style of Yoga: Therapeutic Structure: Loosening and strengthening postures; guided relaxation techniques; breath cleansing technique; strong contractions of pelvic oor muscles; voluntary regulation of breath; counseling.	Physical: PVR (ultrasound), MCL Psychosocial: UDI-6 Multidimensional: IIQ-7	Results: Signi cant improvements in postvoid residual urine scores on micturition frequency checklist, IIQ-7, and urogenital distress inventory-6. Conclusion: Integrated yoga for bladder symptom is a safe and effective adjunctive therapy for patients with NBD in MS.
Powell and Cheshire (2015)[74]	Design: Case Study Sample: N = 1 (♂: 0, ♀: 1) Objective: To report the case study results of an individualized yoga program for one participant with MS, in terms of his/her experience of yoga, how yoga affected his/her particular symptoms of MS, and, to better understand the unique and changing needs of someone with MS in the context of yoga delivered on a one-on-one basis	Dx: Relapse-remitting MS Stage: N/D Age: 37 (N/A)[a]	Frequency: 1 per week Session duration: 60 min Intervention period: 24 weeks Dose (total time): 24 h	Style of Yoga: Hatha Structure: Sessions incorporated breath and body awareness practices; meditative and relaxation techniques; reappraisal of negative emotions with positive af rmations.	Multidimensional: Self-reported physical and psychological changes	Results: Participant experienced an increased awareness of negative thoughts and feelings about MS and how it affected her and her body; by the end of the program she reported experiencing improvements in muscle tone, strength, balance, psychological well-being and con dence. Conclusion: Yoga can provide physical bene ts and may be a means to help cope and manage symptoms associated with MS.

(A)

Table 3. (Continued)

R ( )[Ref.]	D A	P	I	D	O	P fi A
Pritchard et al. (2010)[75]	Design: Pretest/post-test (pilot study) Sample: N = 60 (♂/♀: N/D) MS (= 12) Cancer (= 10) Objective: Examine the effects of a 6-week N A meditation program on perceived stress in MS and cancer patients	Dx: MS Stage: N/D Age: N/D (N/D)[a]	Frequency: 1 per week Session duration: 90 min Intervention period: 6 weeks Dose (total time): 9 h	Style of Yoga: N A Structure: Included body scan meditation; breath work; exploration of sensations, emotions, and thought patterns; moving back and forth between feeling and witnessing; and sitting in awareness; daily home practice was encouraged, guided by CDs.	Psychosocial: PSS	Results: Both MS and cancer patients reported signi cantly lower levels of perceived stress at the end of the 6-week program. Conclusion: N A is an effective stress-reduction technique for cancer and MS patients. It is easier to perform than MBSR for many chronically ill patients with restricted physical capabilities. Yoga postures are not necessary to obtain the stress-reduction bene ts.
Razazian et al. (2016)[76]	Design: RCT Sample: N = 54 (♂: 0, ♀: 54) Yoga (= 18) Aquatic (= 18) Control (= 18) Objective: Investigate the in uence of yoga and aquatic exercise on fatigue, depression, and paresthesia in patients with MS	Dx: Relapse-remitting, progressive relapsing, primary progressive and secondary progressive MS Stage: EDSS: 0–6 Age: 33.94 (6.9[a])	Frequency: 3 per week Session duration: 60 min Intervention period: 8 weeks Dose (total time): 24 h	Style of Yoga: Hatha Structure: Sessions consisted of breathing exercises, meditation, sun salutations, a variety of increasingly demanding standing postures, supported head and shoulder stands, different twists and bends, and concluded with corpse pose.	Physical: FSS Psychosocial: BDI	Results: Fatigue, depression, and paresthesia decreased signi cantly in the yoga and aquatic exercise group. Conclusion: For females with MS and treated with standard immune regulatory meditation, exercise training such as yoga and aquatic exercises positively impact the core symptoms of MS, namely, fatigue, depression and paresthesia.

(A)

Table 3. (Continued)

R ( )Ref.	D A	P	I	D	O	P fi A
Salgado et al. (2013)[77]	Design: Pretest/post-test Sample: N = 22 (♂: 6, ♀: 16) Objective: Examine the effects of a comprehensive, 4-month yoga program on strength, mobility, balance, respiratory function, and QoL in individuals with MS	Dx: MS Stage: EDSS: 2.5–6.5 Age: 48.1 (10.5)[a]	Frequency Group: 5 days intensive Home: 3· per week Session duration Group: N/D Home: 72-min session Intervention period: 18 weeks Dose (total time): 64.8 h	Style of Yoga: Ananda Structure: Included yoga postures, af rmations, energizing exercises, breath work, and meditation. Home practice: Included 20 min of energizing exercises, 33 min of yoga postures, 9 min of deep relaxation, and 10 min of meditation and af rmation.	Physical: 30CST, BBS, 2MWT, PEF, 10MWT Multidimensional: EDSS, MSQLI	Results: Signi cant improvements in functional strength, balance, and PEF and a trend toward improvement in mental health and QoL outcomes were detected following the intervention. Conclusion: Yoga can have a positive impact on physical functioning and QoL for person with mild-to-moderate MS.
Velikonja et al. (2010)[78]	Design: RCT Sample: N = 20 (♂/♀: N/D) Yoga (=10) Climbing (=10) Objective: Investigate the effects of sports climbing and yoga on spasticity, cognitive impairment, mood change, and fatigue in patients with MS	Dx: Relapse-remitting, progressive relapsing, primary progressive and secondary progressive MS Stage: EDSS: 0–6 Age: N/D (N/D)[a]	Frequency: 1 per week Session duration: N/D Intervention period: 10 weeks Dose (total time): N/D	Style of Yoga: Hatha Structure: Included stretching and strengthening exercises to build muscle strength and endurance; breathing exercises to relax musculature and center the mind.	Cognitive: TOL, NAB (mazes subset), d2 tests Physical: MAS* Psychosocial: CES-D Multidimensional: EDSS, MFIS	Results: Yoga did not reduce spasticity or effect executive functions, mood, or fatigue; an increase in selective attention was observed in the yoga group. Conclusion: Yoga might improve some symptoms of MS and should be considered a possible adjunctive therapy.

(A

Table 3. (Continued)

R ( )Ref.	D	P	I	D	O	P fi
Young et al. (2018)[79]	Design: RCT Sample: N = 81 (♂: 15, ♀: 66) Yoga (= 26) M2M (= 27) Control (= 28) Objective: Examine the effects of two exercise interventions, a novel dance-based program termed M2M, and an adapted yoga program, on the physical and psychosocial outcomes in people with MS	Dx: MS Stage: PDDS Score: 0–6 Age Yoga: 48.4 (9.95)[a] M2M: 49.7 (9.40)[a] Control: 47.3 (10.3)[a]	Frequency: 3 per week Session duration: 60 min Intervention period: 12 weeks Dose (total time): 36 h	Style of Yoga: Hatha Structure: Based on a 3-mountain format, which included a warm-up phase, work phase, and cool-down phase. Classes included a series of stationary poses in sitting or standing (isometric contraction and relaxation techniques) that progressed in dif culty; concluded with relaxation.	Physical: TUG, 6MWT, FTSST Multidimensional: PROMIS Pain Interference Short Form 8a	Results: Yoga participants had improved mobility, but it was not statistically signi cant; no signi cant differences were observed in FTSST, fatigue, pain interference, and walking endurance in the yoga group compared with the controls. Conclusion: No signi cant improvements were observed in participants undergoing a 12-week adapted yoga intervention.

[a]Age = mean (SD).

1-RM, 1 Repetition Maximum; 2MWT, 2-minute Walk Test; 30CST, 30-second Chair Stand Test; 6MWT, 6-minute Walk Test; 9HPT, 9-Hole Peg Test; 10MWT, 10-m Walk Test; ADLs, activities of daily living; AVLT, Auditory-Verbal Learning Test; BAI, Beck Anxiety Inventory; BBS, Berg Balance Scale; BDI, Beck Depression Inventory; BLCS, Bladder Control Scale; CES-D, Center for Epidemiological Studies Depression Scale; CESD-10, 10-Item Center for Epidemiological Studies Depression Scale; CDs, compact discs; MCT, Mindfulness-Based Cognitive Meditation; CSR, Chair Sit and Reach; DSST, Digit Symbol Substitution Test; EDSS, Expanded Disability Status Scale; EEG, electroencephalogram; FDS, forward digit span; FIS, Fatigue Impact Scale; FSS, Fatigue Severity Scale; FTSST, Five Times Sit-To-Stand Test; GNDS, Guy's Neurological Disability Scale; IIQ-7, Incontinence Impact Questionnaire-7; IPBDLSQ, In uence of Pain and Balance on Daily Living Structured Questionnaire; M2M, movement-to-music; MAS*, Modi ed Ashworth Scale; MBSR, mindfulness-based stress reduction; MCL, Micturition checklist; MDRT, Multidirectional Reach Test; MEP, maximal expiratory pressure; MFI, Multidimensional Fatigue Inventory; MFIS, Modi ed Fatigue Impact Scale; MHI, mental health inventory; Modified FoV task, Modi ed Useful Field of View Task; MS, multiple sclerosis; MSDS, Multiple Sclerosis Documentation System; MSFC, Multiple Sclerosis Functional Composite; MSIS-29, Multiple Sclerosis Impact Scale 29; MSQLI, Multiple Sclerosis Quality of Life Inventory; MSQoL-54, Multiple Sclerosis Quality of Life-54; MSW-12, 12-item Multiple Sclerosis Walking Scale; N/A, not applicable; NAB, Neuropsychological Assessment Battery; N/D, not de ned in study; NHPT, Nine-Hole Peg Test; PASAT-3, Paced Auditory Serial Addition Test; PDDS, Patient Determined Disease Steps; PDQ, Parkinson's Disease Questionnaire; PDSS, Patient Determine Disease Steps Scale; PEF, peak expiratory ow; POMS, Pro le of Mood States; PROMIS, Patient-Reported Outcomes Measurement Information System; PSS, Perceived Stress Scale; PT, physiotherapist; PVR, post void residual urine volume; QoL, quality of life; RFS, Rhoten Fatigue Scale; RRMS, relapsing-remitting MS; RT, resistance training; SCWT, Stroop Color and Word Test; SD, standard deviation; SF-36, short-form 36; SF-36 MCS, short-form Health Status Survey Mental Component Summary; SLB, single-leg balance; SR, supine rest; MSDS, Multiple Sclerosis Documentation System; STAI, State-Trait Anxiety Inventory; T25FW, Times 25-Foot Walk; TMT-a/b, Trail Making Test a and b; TMD, mood disturbance; TOL, Tower of London Test; TUG, Timed Up and Go; UDI-6, Urogenital Distress Inventory Physiological; VAS, Visual Analog Scale; WAIS, Wechsler Adult Intelligence Scale; WMS-III, Wechsler Memory Scales.

Results

Study selection

The database search yielded 1114 potentially relevant articles, of which 226 duplicate studies were removed. The remaining 888 studies were evaluated and screened for eligibility with a total of 50 articles meeting the inclusion criteria for the scoping review. The study selection process is outlined in Figure 1.

Study characteristics

The studies were all published between 2001 and 2020, with 44 of the 50 studies being published in the last 10 years. Across all three neurologic conditions, most studies investigated the impact of yoga on physical functioning (=37), followed by psychosocial outcomes (=22), and cognitive factors (=8). Commonly used physical outcome measures included the Berg Balance Scale (BBS; =15),[20] either the 6-minute or 10-meter walk test (6MWT/10MWT; =11),[21,22] and the Timed Up and Go test (TUGT; =6).[23] Fourteen of the included studies looked at the influence of yoga on measures of anxiety and depression using an assortment of standardized instruments such as the Beck Anxiety and Depression Inventories (BAI/BDI).[24,25] Population-specific measures such as Stroke Impact Scale (SIS; =1),[26] the Unified Parkinson's Disease Rating Scale (UPDRS; =8),[27] the Expanded Disability Status Scale (EDSS; =4),[28] or the Multiple Sclerosis Impact Scale (MSIS; =4)[29] were often administered to assess the subject's baseline status and progression.

The YT interventions were generally administered by a certified yoga instructor (=28), a registered yoga therapist (=7), or a physical therapist with a personal background in yoga (=5). The majority of YT programs involved a combination of traditional and adapted postures, breathing exercises, meditation, and relaxation techniques that progressed in difficulty over time. To adapt the yogic postures to the neurologic population, the equipment identified in the studies included chairs, yoga mats, yoga balls, yoga blocks, straps, horizontal bars, blankets, sandbags, cushions, eye pillows, and bolsters. Many studies began each session with a didactic component such as a group discussion on topics of mindfulness or yogic principles and ended the sessions with deep relaxation techniques such as or yoga .

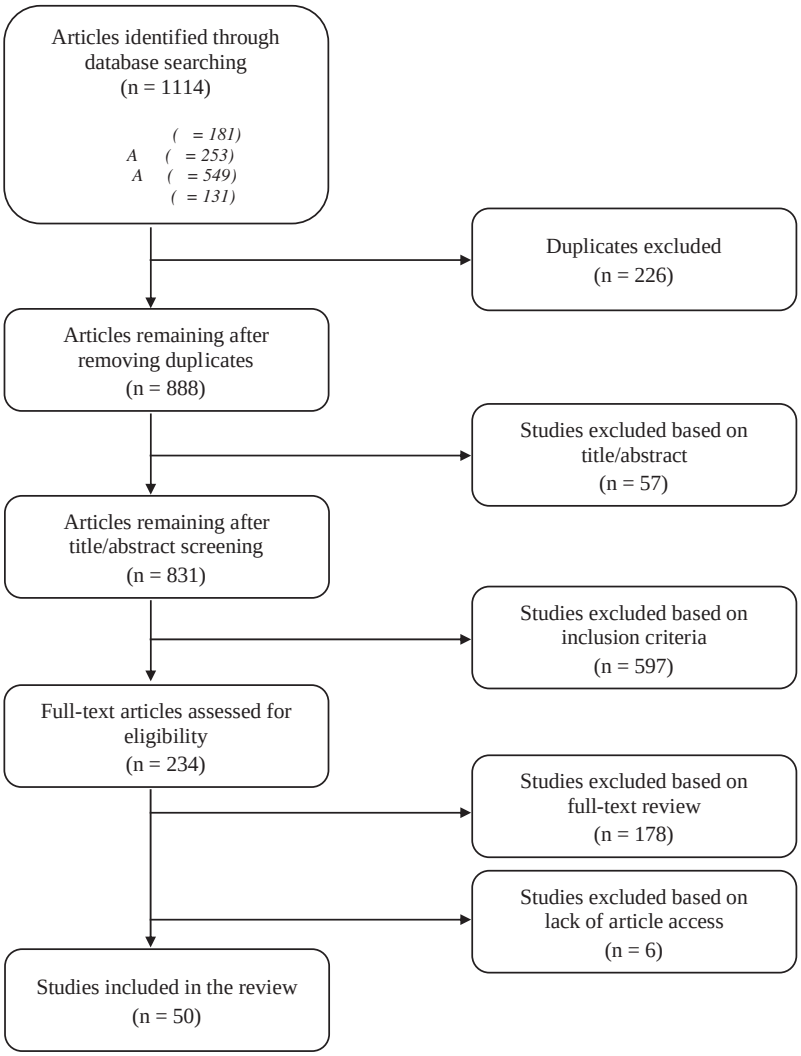

FIG. 1. Process of identification and selection of studies included in this review.

Group classes in a community setting were more commonly administered compared with one-on-one therapeutic sessions or individual home practice. Prerecorded audiotapes, videos, or instructional handouts were often provided to guide and aid individual home practice.

Stroke

Eleven studies investigating the use of yoga-based interventions for patients in the chronic stage of poststroke recovery were included in this review (Table 1). Across the studies, participants were on average 61.7 (standard deviation [SD] 4.9) years old and participated in YT after having completed their postacute rehabilitation. Nine studies delivered a Hatha or adapted yoga protocol, one investigated the effects of unilateral nostril breathing, and one study explored the use of Kundalini yoga (Appendix A1). The intervention parameters varied between studies. Five studies implemented 60- or 90-min yoga sessions twice per week. The length of the intervention period ranged between 6 and 24 weeks and was most frequently administered on a weekly basis for 8 weeks (=3), 10 weeks (=3), or 12 weeks (=3). Three studies combined a weekly 90-min group session with a shorter 40-min individual home practice that was carried out four or six times per week. The average dose or total treatment time of YT delivered across the 11 studies for patients' poststroke was 26.5 h (~1590 min).

Parkinson's disease

Sixteen studies investigated the use of yoga-based interventions for patients with PD afflicted by mild, moderate, and severe neurologic impairments (Table 2). All studies used the Hoehn and Yahr Scale to describe the symptoms and level of disability of the participants.[30] Subjects were on average 66.7 (SD 4.9) years old and were predominantly at or below stage 3 on the Hoehn and Yahr Scale. Eleven studies delivered a Hatha or an adapted yoga protocol, one investigated the effects of laughter yoga, another looked at the impact of high-speed power yoga, and one administered a comprehensive yoga-based lifestyle program. Yoga classes varied in length between 30- and 90-min sessions and were administered between one and seven times per week. The most common parameters were 60-min sessions delivered twice per week (=6). The intervention period ranged from a single session to 12 weeks with seven studies delivering an 8-week intervention and six studies delivering a 12-week intervention. The average dose or total treatment time of YT delivered across the 16 studies for patients with PD was 17.4 h (~1042.5 min).

Multiple sclerosis

Twenty-three studies investigating the use of yoga-based interventions for patients with MS were included in this review (Table 3). On average, subjects were 43.8 (SD 8.4) years old with various clinical courses of the disease. Eleven studies used the EDSS score to determine the stage of disease, while others used years since diagnosis or standardized instruments such as the Multiple Sclerosis Documentation System (MSDS),[31] the Guy's Neurological Disability Scale (GNDS),[32] or the Patient Determined Disease Steps (PDDS).[33] The most common type of yoga used in clinical research was Hatha yoga or an adapted-Hatha protocol (=17). A few studies explored Iyengar yoga (=1), Ananda yoga (=1), yoga Nidra (=1), and cyclic meditation (=1). As in the two previous conditions, the intervention parameters varied between studies. Sessions most commonly lasted between 60 and 90 min (=17) and were performed one to three times weekly (=20). Session structure is particularly important in this population to avoid fatigue during YT. Allowing patients to take 30- to 60-sec breaks between poses can avoid overexertion in patients with MS.[7,65,70] The treatment period ranged from two sessions to 24 weeks with the most common intervention lasting 12 weeks (=7), 8 weeks (=4), 10 weeks (=4), and 24 weeks (=3). The average dose or total treatment time of YT delivered across the 23 studies for patients with MS was 23 h (~1390 min).

Discussion

The question of dose

The parameters and types of yoga varied across the included studies, and to the best of our knowledge, the effective treatment dose is yet to be investigated in literature. When prescribing yoga in a neurologic population, there is a consensus that increased frequency leads to improved clinical outcomes. Patients will tend to notice physical improvements first, while positive cognitive and psychosocial changes are more likely to be elicited with continued adherence to a long-term yoga practice (i.e., 6–9 months).[80] The majority of yoga protocols described in this review implemented 60- to 75-min yoga sessions at a frequency of one to three times per week for an intervention period of 8–12 consecutive weeks. The average treatment doses across the three conditions were 26.5, 17.4, and 23 h for stroke, PD, and MS, respectively. The wide variety of interventional parameters employed highlights the necessity for the field to develop standardized yoga protocols to effectively investigate the optimal dose required to successfully manage neurologic impairments.

It is important to recognize that not all therapeutic effects arising from YT occur in a simple linear dose-dependent manner. The holistic benefits that stem from YT are complex and emergent in nature. Aspects of patient recovery may not be able to be quantified by traditional outcomes measures separated into discrete categories of functional recovery. Many patients who have gone through a yoga intervention often report subjective experiences such as feeling a greater sense of overall wellness or being more mindful in everyday life.[80] The therapeutic environment, peer-to-peer social interaction, and a culture of community and acceptance fostered within YT play a critical role in promoting patient recovery.[18,51] This complex interaction between a patient and the environment is greatly underresearched but is vital to establishing how best to integrate YT into neurorehabilitative care.

Yoga and stroke

A large proportion of YT research in the poststroke population has focused on improving balance, strength, and lower extremity range of motion.[36,41,42,80,81] One particular study centered its focus around the [illegible] technique of

alternate nostril breathing (ANB), to evaluate its effect on physical as well as cognitive functioning. ANB is thought to activate both hemispheres of the brain and has been linked to improvements in verbal and communication abilities, spatial orientation, cognition, and autonomic nervous system functioning.[39] While most of the included studies investigated the physical component of yoga, there has been less scientific inquiry into the psychosocial healing that yoga is capable of promoting. One of the first studies to describe the ability of yoga to help restore the mind–body connection in stroke survivors was carried out by Garrett et al.[13] Overall, the 11 studies included in this review support the notion that yoga is capable of impacting multiple body systems and functions and is an effective intervention that may positively influence the physical, cognitive, and psychosocial health of patients recovering from a stroke.

Yoga and PD

There is considerable support for yoga as a promising nonpharmacologic therapy that positively influences the motor and nonmotor symptoms that manifest in patients with PD.[45–47,50–55,57] Kwok et al. carried out one of the most rigorous clinical trials on yoga in PD to date and demonstrated that a mindfulness yoga intervention was as effective as a conventional exercise program in improving motor dysfunction and mobility.[51] Furthermore, patients who participated in the yoga intervention demonstrated significant reductions in anxiety and depressive symptoms, as well as greater improvements in psycho-spiritual health and health-related quality of life when compared with the exercise control group. The success of this intervention emphasizes the need for health care professionals to adopt a more holistic approach in neurologic rehabilitation. Integrating mindfulness-based activities into standard treatment may very well enhance the welfare of patients dealing with the physical challenges and psychological distress of living with a neurodegenerative condition.

Yoga and MS

Fatigue and chronic pain represent two of the most disabling symptoms that impact QoL in individuals living with MS.[4,82] Results of the included studies were unable to clarify whether or not yoga is an effective management strategy for fatigue and pain in MS patients. While multiple randomized controlled trials (RCTs) reported a positive interventional effect on fatigue and pain,[59,61,63,64,68,72,76] there were a few studies that observed no significant change in the targeted outcomes measures.[69,78,79] After comparing the yoga intervention protocols among all the studies, the above discrepancies are likely due to differences in the type of exercises and techniques implemented in each intervention, rather than the treatment dose. Although most of the studies administered Hatha yoga, the physical postures and emphasis on the meditative and breathing components varied from one study to the next, further emphasizing the need for the development of a standardized yoga intervention protocol to target specific symptoms of MS. Given that the successful management of chronic neurologic symptoms require an integrated bio-psychosocial approach, creating a yoga protocol that incorporates aspects of mindfulness, body awareness, thought monitoring, and restructuring to equip patients with strategies to manage and cope with fatigue and pain may prove to be more effective compared with general Hatha practice.

Implementing yoga into the neurologic rehabilitation setting

Administering yoga in a rehabilitation setting can start to bridge the gap between physical and occupational therapy and help to holistically address the mind, body, and spirit of patients and caregivers. In general, the therapeutic focus of most of the yoga interventions described in this study involved increasing range of motion, improving balance, carrying out safe transitions and transfers, reducing psychological stress, fostering mindfulness, and cultivating self-compassion and acceptance toward one's personal situation. What makes yoga such an effective and readily accepted choice of activity in a rehabilitation environment is that the practice can be adapted to accommodate almost any level of physical ability.[12] When working with individuals poststroke, or with PD or MS, the extensive use of props (e.g., chairs, bolsters, blocks, straps, sandbags, blankets) can provide full stability and comfort for patients throughout the practice.[80] Positioning yoga mats next to the wall with a chair can ensure adequate support for standing and balance postures. Placing sandbags on affected extremities during relaxation poses can help ease a spastic limb or reduce resting tremors. Providing a rolled-up blanket for under the neck can provide comfort for a patient stuck in rigid kyphosis.

Analysis of the included studies also revealed clinical recommendations specific to each pathology. For example, developing yoga protocols for patients poststroke should be carried out with the principles of stroke recovery in mind—that is, providing simple and concise verbal cues, incorporating contralateral movements to activate both hemispheres of the brain, and focusing on repetition to facilitate the brain's neuroplasticity.[80] When working with individuals with hemineglect or hemiparesis, therapists may need to provide hands-on or visual support for the participants' affected side to assist them in performing bilateral movements. Given that stiffness is one of the primary motor symptoms of PD, yoga postures that increase range of motion and flexibility, with a particular focus on the spine, hips, ankles, and shoulders, should be incorporated into every class. Furthermore, while upright postures are still encouraged, standing extension postures should be omitted from yoga sequences for patients with PD to avoid episodes of retropulsion.[18] YT for MS patients should be practiced in a setting that is at or below room temperature (20°C) because yoga in hot-humid conditions may decrease nerve conduction and aggravate symptoms of MS.[59,65] In addition, frequent rest periods of 30–60 sec in duration should be encouraged throughout the practice to avoid overexertion and fatigue.[65,70,72]

Study limitations

To effectively verify the pertinence of articles to include in this study, only articles written in English or French were screened and analyzed. As such, any relevant data published in other languages were omitted. Given the origins of yoga, it is likely that a plethora of research dating back thousands of years exists in Sanskrit, Hindi, Bengali, or other languages commonly used in India.

All relevant studies were included in this review regardless of their quality of evidence. Many of the studies reported in this article are case studies, pilot studies, pretest/post-test design, and RCTs with underpowered sample sizes and/or lacking quality matched controls. No speci c analysis of the effectiveness of YT in managing the pathology of stroke, PD, or MS was conducted. As a result, the purpose of this scoping study was not to evaluate and compare the effectiveness of different clinical yoga protocols, but rather summarize how different YT interventions have been implemented into the rehabilitative care for the three neurologic conditions of interest.

Excluding studies that used multimodal interventions that combined YT with other therapeutic modalities may have omitted relevant clinical yoga protocols from analysis. This decision was made to ensure that any inference by the authors about implementing YT into neurorehabilitative care was based solely on the principles and techniques applied in YT and not in uenced by concepts applied in other clinical interventions (e.g., cognitive behavioral therapy).

Conclusion

With psychiatric symptoms representing a common and often characteristic feature in a number of neurologic disorders,[3,7,8] it has become apparent that the eld of neurologic rehabilitation urgently needs to establish readily accessible and cost-effective programs that address both the functional and psychosocial needs of patients. The holistic nature of clinical yoga interventions, combined with its cost-effectiveness, accessibility, and adaptability, makes YT a suitable modality to use with a neurologic population. All studies described in this scoping review used different yoga protocols con rming the lack of speci c clinical guidelines available for implementing yoga into the rehabilitation of individuals affected by stroke, PD, or MS. The clinical recommendations emanating from the present study can help guide the eld toward developing a set of best practice guidelines to ensure the safe and effective administration of yogic interventions in a neurorehabilitative setting. Future researchers should keep in mind that the therapeutic bene ts of yoga are complex and emergent in nature and may not arise solely through linear dose-dependent mechanisms. Understanding the personal experiences of patients who partake in clinical yoga interventions is integral to understanding the positive in uence that YT has on the psychosocial well-being of neurologic patients. Implementing YT in neurorehabilitative care can help health care professionals integrate a more holistic approach that addresses the fundamental physical and psychological challenges of living with a chronic and debilitating neurologic disorder.

Authors• Contributions

Z.L. and A.Z. are the primary authors having contributed equally to this work, and drafted and revised the article. Z.L., A.Z., and S.S. collected, analyzed, and interpreted the data. M.-H.B. conceptualized and designed the study and assisted in revising the article. All authors approved the nal version.

Author Disclosure Statement

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Appendix

Appendix A1. Description of Different Yoga Types

Hatha Yoga

Hatha yoga is a combination of breath work, physical poses, and meditation. It focuses on controlled breathing and gentle static postures.

Yoga Nidra

Yoga Nidra focuses on deep relaxation through meditation that is guided verbally. This type of yoga is sometimes called "yogic sleep."

Kundalini Yoga

Kundalini yoga is a type of yoga that combines poses with breathing and chanting to reduce stress and increase energy. Classes focus on spiritual practice with physical poses.

Unilateral Nostril Breathing

Unilateral Nostril Breathing is a technique where inhalation and exhalation are done in one nostril, sometimes alternatively. This breathing technique can be used as an exercise alone or can be combined with other yoga techniques.

Laughter Yoga

Laughter yoga involves voluntary forced laughter and is thought to provide the same benefits as spontaneous laughing in terms of increased mood.

Iyengar Yoga

Iyengar yoga practice focuses on posture awareness and often uses props to modify these postures. Poses are held and practiced in a precise manner.

Ananda Yoga

Ananda yoga is based on relaxation, which is achieved through physical postures and pranayama, or breathing exercises.