

The therapeutic value of yoga in neurological disorders

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Abstract

Background: The ancient mind and body healing methods of yoga recently sparked fervor in the scientific community as an alternative and complementary means of therapy. Since the World Health Organization officially began promoting yoga in developing countries in 1978, yoga has been cited for its therapeutic potential and has been widely recognized in Western culture. However, as an increasing number of people practice yoga for remedial purposes, researchers raise two important questions: 1) Is yoga a valid complementary management and rehabilitation treatment modality? 2) What conditions show promise of treatment with this intervention?. **Objective:** This review article uses comprehensive scientific, evidence-based studies to analyze the efficacy of various basic and applied aspects of yoga in disease prevention and health promotion. It specifically intends to expose the effects of yoga in neurological disorders, particularly epilepsy, stroke, multiple sclerosis, Alzheimer's disease, peripheral nervous system disease, and fibromyalgia. **Materials and Methods:** Information was gathered from various resources including PubMed, Ovid, MD-Consult, USC, and U.C.L.A. libraries. Studies were selected and reviewed on the basis of sample size, control, randomization, double-blinding, and statistical analysis of results. **Results:** The practice of yoga and meditation demonstrates statistically encouraging physiological and psychological improvements in the aforementioned neurological disorders. However, there were certain flaws and inadequacies in the study designs employed to evaluate the same. A critical analysis of these studies is presented. **Conclusions:** With the aim to focus attention on this widespread yet largely unexamined treatment modality, this paper seeks to provide direction and support for further research necessary to validate yoga as an integrative, alternative, and complementary therapy.

Key Words

Neurology, physiology and treatments, yoga

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Ann Indian Acad Neurol 2012;15:247-54

Introduction

Yoga started roughly 5,000 years ago in the Indian subcontinent as part of the Ayurvedic healing science. According to one 2008 yogajournal.com report, 15.8 million Americans practice yoga. "yoga" derives from the Sanskrit word 'yukti' meaning "union," aiming to unify spirit (consciousness) with super spirit (God). The ancient Yogis recognized that to accomplish this highest state of yoga, a healthy body is essential. Yoga is a spiritual practice that utilizes mind (meditation) and body (exercises) to balance our systems. It explores the mind's abilities to affect the senses and the body. The National Center for Complementary Alternative Medicine thus classifies yoga as mind-body medicine.

Types of Yoga

Yoga is one of the six systems of Indian Vedic philosophy (*Darshan*). Maharishi Patanjali, rightly known as the "Father of Yoga," compiled and refined various aspects of yoga systematically in his "*Yoga Sutras*" (aphorisms), wherein he advocated the eight-fold path known as "*Ashtanga Yoga*" for an all-around development of human personality. These include - *Yama* [moral codes], *Niyama* [self-purification and study], *Asana* [posture], *Pranayama* [breath control], *Pratyahara* [sense control], *Dharana* [concentration], *Dhyana* [meditation], and *Samadhi* [super contemplation]. These are formulated on the basis of multifarious psychological understanding of human personality.

Other aspects of yoga philosophies are broadly classified into four streams namely Work, Worship, Philosophy, and Psychic control. "*Karma Yoga*," the path of work, promotes pleasure in labor without indulging in thoughts of success or failure. A free mind allows the task to be done in a skillful manner. "*Bhakti Yoga*," the path of worship, is a systematic method of engaging the mind in the practice of divine love. This attitude of love softens our emotions and tranquilizes our mind. "*Gyana Yoga*," the path of philosophy, is a systematic way of enlightening the mind about the realities of life by contemplation. This will strip

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10.4103/0972-2327.104328

off the garb of Avidya (ignorance) from our mind as it goes to its natural state of rest. "Raja Yoga," the path of psychic control, is a systematic process of culturing the mind. It is based on the eight-fold path set by Patanjali.

Evidence-Based Studies on Yoga for Health Promotion and Disease Prevention

Yoga is a science as well as an art of healthy living. The traditional practice of yoga was primarily concerned with personal enlightenment. Today, the focus has shifted towards a holistic treatment modality for various somatic or psychological dysfunctions. In our review, numerous studies exhibited the various health-promoting and disease-preventing effects of yoga.

Barnes^[1] demonstrated improvements in cardiovascular reactivity with a transcendental meditation program. He observed significant reductions in resting systolic blood pressure (BP) in adolescents with high normal BP. A reduction in reactivity of BP, heart rate, and cardiac output to simulated stressors reflects the beneficial effects of yoga at rest and during stressful states. Successful cardiovascular risk factor modification was also achieved by Schmidt^[2] using a "Kriya" yoga program. Among the 106 participants, an average decrease of 1.88 in the body mass index (BMI) was observed. Among the male subjects, observed early on were statistically significant average reductions in total cholesterol (from 181 to 166 mg/dl), LDL (from 117 to 102 mg/dl), and LDL/HDL ratio from 2.7 to 2.2. A commitment to an intensive yoga therapy can thus reduce various cardiovascular risk factors to levels which rival those attained by prescription drugs. This was further exemplified in a study involving yoga in a combined relaxation therapy, wherein 20 patients with high blood pressure on medication attended three 30-minute yoga sessions per week for 3 months with blood pressure recorded at the beginning and end of each session. At the start of the trial, their average mean pressure (diastolic blood pressure plus one-third of pulse pressure) was 121 mm Hg, compared to their average mean pressure of 101 mm Hg at the conclusion of the trial. Of those 20 patients, 5 were able to stop using their anti-hypertensive drugs, and 7 others were able to reduce their dosage by 33 to 60 percent.^[3] These findings demonstrate how patients can promote their own health and avoid adverse effects of drugs while taking an active part in health promotion.^[3]

Pranayama (yogic breathing exercises) have been associated with significant improvements in the respiratory function, especially with the measure of vital capacity. Improvements were seen in healthy individuals, asthmatics, and chronic smokers.^[4] The respiratory changes with yoga were also compared with a regular exercise program,^[5] in which the yoga group improved in maximum oxygen uptake and decreased perceived exertion after maximal exercise testing. Another study by Arambula^[6] showed reductions in respiratory rates from an average twelve breaths per minute to five breaths per minute during meditation, with a predominance of abdominal/diaphragmatic breathing.

The calming effect of yoga on cardiovascular and respiratory parameters has been linked to a reduction in the autonomic

arousal.^[3] Autonomic effects such as decreased heart rate and blood pressure, with an elevation of mean skin temperature, were observed after three months of daily yoga training by Shridharan.^[7] Changes in the dopamine-beta-hydroxylase activity, monoamine oxidase, and adrenal steroids further demonstrate a shift towards parasympathodominance with yoga. This is further supported in a randomized control study by Infante,^[8] in which no differences were recorded between morning and evening epinephrine and dopamine levels in individuals practicing yogic meditation, showing a tighter control in the daily hormonal rhythm. Similar effects were also observed by Bhargava,^[9] who recorded autonomic responses in BP and heart rate, while holding breath at different phases of respiration. As the subjects practiced *Nadi-Shodhana Pranayama* (Yogic breathing routines) for a month, the new recordings showed a tendency to decrease both BP and heart rate. Pranayama appears to alter autonomic responses to breath-holding by increasing vagal tone and decreasing sympathetic discharges.^[9]

The practice of yoga is also associated with some profound biochemical changes. This was demonstrated in a one-year trial of yoga training, after which military personnel participants reported significant reductions in perceived exertion. These individuals became more efficient in dealing with oxidative stress by increasing the metabolism of glutathione, increasing the production of antioxidant enzymes, and eliminating per-oxidation products more efficiently.^[10] In another study, the ability to achieve higher work rates with reduced oxygen consumption was exhibited by athletes in a two-year *Pranayama* yoga program. Efficient energy substrate utilization with significant increases in pyruvate and pyruvate-lactate ratio at rest, and reduced blood lactate levels were also observed.^[11] Desai^[12] showed reductions in blood urea and increases in creatinine and tyrosine after one minute of *Kapalabhati*, a fast-breathing (120/min) technique of *Hatha Yoga*.

Improvements in motor function such as upper- and lower-extremity torque, sustained lower-extremity isometric muscle contraction, shoulder flexibility, and spinal flexibility were observed by Tran^[13] in a two-month *Hatha Yoga* program. Dash and Telles^[14] also observed improved motor speed in a 30-second finger-tapping test in subjects after eight hours of daily yoga activity for 30 days, compared with a group that received no intervention. There is a great potential for specific yoga programs to be used in the rehabilitation of musculoskeletal injuries and for healthy individuals to maintain and increase muscle tone.

Yoga has also been used to provide relief from stressful psychological states. Rao demonstrated significant reductions in anxiety, depression, perceived stress, and cortisol levels in 88 breast cancer subjects practicing Yogic meditation compared to controls.^[15] *Sudarshan Kreeya* (Yogic Breathing exercise) has shown to enhance mood in people with melancholic depression, comparable to the use of Imipramine, a tricyclic anti-depressant.^[16] Yoga has proved to be a viable alternative in reducing drug use and criminal activities among methadone clinic patients who are either resistant to, or unable to receive group psychotherapy.^[17]

Utilization of Yoga in Neurological Disorders

Numerous studies have been performed to validate the use of yoga as a complementary alternative treatment modality in various neurological disorders.

Epilepsy

According to the 2009 WHO Epilepsy fact sheet, there exist over 50 million worldwide documented cases of epilepsy. With the possibility of lifelong seizures, treatments usually involve management therapy. Patients with epilepsy who do not respond to conventional anti-seizure medications may find results in alternative treatment modalities, such as yoga. We evaluated three non-randomized and two randomized studies to assess the effects of yoga in patients with Epilepsy. Rajesh *et al.* performed a prospective, non-randomized clinical trial, in which patients with drug-resistant epilepsy adhered to a twice-daily yoga meditation protocol. 19/20 subjects reported a decreased frequency of seizures within three months, and 6 of those 19 demonstrated significant reductions (< 50% reduction in seizure frequency). Additionally, patients usually report stress as a factor that increases the likelihood of auras or a seizure episode.^[18] Panjwani^[19] demonstrated that patients with epilepsy responded to *Sahaja Yoga* in reducing stress, in a randomized controlled study. This provides hope to patients with refractory epilepsy that non-pharmaceutical techniques may be successful in reducing seizure frequency.

Furthermore, Sirven^[20] surveyed the use of Complementary and Alternative Medicine (CAM) treatments including yoga among Epilepsy Foundation of Arizona (EFAZ) members. The survey questioned the type of therapy used, level of seizure control, and their perceptions on the various CAM treatments for seizures. Results showed that 42% of all respondents had tried CAM for non-seizure conditions, and 44% had used CAM for their seizures. Yoga was reported as effective in seizure control in 57% of participants. All CAM modalities were partly perceived to be beneficial; however, botanicals, stress reduction, and yoga were reported as being the most helpful.

A pilot, non-randomized trial created with a specific yoga Meditation Protocol was evaluated for its efficacy in reducing seizures among patients with complex partial seizures who did not respond to anti-epileptic drugs (AED), including carbamazepine, clobazam, clonazepam, lamotrigine, phenobarbital, phenytoin, and valproic acid.^[21] This twice-daily yoga meditation with weekly yoga class regimen demonstrated significant reductions, in seizures in 19/20 patients diagnosed with epilepsy, within three months. Furthermore, six patients were seizure-free during the next three months of intervention.^[21] Although this trial was limited by its small sample size and lack of randomization, the addition of a yoga regimen to AED treatment would divulge the utility of yoga in refractory patients with epilepsy.

In a randomized controlled trial, involving 18 patients with EEG-diagnosed epilepsy, yoga showed therapeutic effects of decreasing seizure index along with an improvement in quality of life. Subjects participated in professional and group yoga sessions including booster sessions 6 and 12 months

post-treatment. Results of yoga therapy demonstrated a significant reduction in seizure index and a significant increase in quality of life over time.^[22] Augmenting yoga to help people with epilepsy presents an inexpensive, non-invasive, enjoyable, and potentially cross-cultural, supplementation to epilepsy control and quality of life improvement.^[22]

Stroke Prevention and Rehabilitation

According to the WHO, stroke is currently the second most common cause of adult mortality in the US, and is responsible for almost 5.8 million deaths each year worldwide. Furthermore, in low-mid income countries, stroke is the second leading cause of cognitive and physical disabilities, according to a 2009 report on stroke published in the "The Lancet." Since strokes occur suddenly with effects lasting a lifetime, methods to prevent strokes and to help patients rehabilitate are needed, one of which, with increasing fervor, is yoga. In our review of over 20 different studies employing yoga in patients with a CVA, we found that eliciting relaxation through mediation was useful in both stroke prevention and post-stroke rehabilitation. Relaxation promotes positive effects on carotid atherosclerosis,^[23] hypertension,^[24,25] diabetes,^[26] and coronary artery disease,^[27-29] which are all identified risk factors associated with stroke occurrence^[30] or reoccurrence.^[31] Bell and Seyfer have described specific adaptations of yoga postures that can be utilized by people with limited mobility due to neurological conditions such as multiple sclerosis and stroke.^[32]

Bastille^[33] investigated the effects of a yoga-based exercise program on balance, mobility, and quality of life for people with chronic post-stroke hemi paresis. A single subject study design assessed the primary outcome variables of balance {Berg Balance Scale [BBS]}^[34,35] and timed mobility {Timed Movement Battery [TMB]}.^[36] A secondary outcome variable was perceived quality of life {Stroke Impact Scale [SIS] Version 2.0}.^[37] All subjects demonstrated some positive effects in the primary and secondary outcome variables. A pilot study^[38] with 12 weeks of *Kundalini Yoga* practice showed improvements in aphasia as well as fine motor coordination in post-stroke patients. More qualitatively compared to the previously-mentioned studies, in a recent preliminary study, 10 and 12 participants were blindly and randomly allocated into either a yoga intervention group consisting of *asanas* (physical practices) and *pranayama* (breathing practices) or a wait-list control group, respectively. Results of the ten-week yoga program, based on experiences and reported accounts, showed improvements in bio-psychosocial health among the yoga group compared to the control group. Emerging trends included greater sensation, feeling calmer, and becoming connected with mind and body, as well as improvements in perceived physical strength, range of movement, body awareness, gait, balance, energy, concentration, confidence, and stress. This study illustrates the positive physical and psychosocial impact yoga can instill in stroke victims.^[39] These findings lend support to the growing evidence that improvements in impairments and mobility limitations can be achieved, in people with chronic post-stroke hemiparesis, through yoga-based exercises.^[40-44]

Multiple Sclerosis

Multiple sclerosis (MS) is a debilitating and demyelinating disease that damages the myelin sheath surrounding the spinal cord. The disease presents with varying degrees of severity affecting cognitive, motor, and sensory functions. There is no cure. Yet, therapies exist with the goal of slowing the progression of the disease to control symptoms and to regain or maintain an appropriate quality of life. With some medications resulting in adverse side effects and poor toleration, many patients seek alternative methods of management, one of which being yoga. In 1997, an anonymous poll sent to 129 MS diagnosed patients in Germany reported that 63% of patients used some form of alternative therapy, nearly half of these being some form of yoga meditation.^[45] This was an astounding finding in that patients were taking an active part in their treatment and having positive outcomes in managing their chronic disease. Two randomized and one non-randomized study is reviewed for the effects of yoga in MS.

In one randomized prospective study, yoga was compared to sport climbing for its' therapeutic value in treating MS. These are two forms of aerobic exercises assessed for their effects on spasticity, cognitive impairment, depression, and fatigue.^[46] A 17% improvement in selective attention was demonstrated using yoga as a complementary treatment ($P = 0.005$), while it did not have significant reductions in fatigue, sport climbing did reduce the same by 32.5% ($P = 0.015$).^[46] These findings suggest that yoga as well as other forms of aerobic exercise can play a role in improving mobility, activity, and mental function in those with MS.

Oken^[47] went on further to assess whether a specific type of yoga was more effective than a typical aerobic exercise. The benefit of yoga sessions was compared with an aerobic exercise regime and a control group among 69 MS patients, in a randomized, controlled, 6-month intervention.^[47] The results showed an improvement in Energy and Fatigue category ($P < 0.001$) in Short Form 36 Health Survey in both the yoga group and the aerobic exercise group. This first reported randomized controlled trial of yoga in MS demonstrates that a 6-month intervention in yoga therapy improved fatigue to a comparable program in traditional exercise.^[47] These studies suggest that yoga may be comparable to other forms of exercise in relieving symptoms of fatigue; however, there are different types of yoga, and more specific investigations are needed to determine the effects of yoga on MS symptoms and mechanisms.

Alzheimer's Disease

Meditation has great potential for preventing cognitive and memory decline because of its stress reducing effects.^[15,48,49] Stress is related directly to the levels of cortisol in the body, which in turn is well-known for its toxic effects on the hippocampal cells^[50,51] critical for the normal memory function.^[52-54] This claim is further substantiated by various studies, which concluded that hypercortisolemia in Alzheimer's appears related to the clinical progression of the disease, but not to aging or length of survival.^[55,56] Thus, a stress-induced hypercortisolemia can further aggravate Alzheimer's; however, a regular practice of meditation can, through stress reduction

and reduction of serum cortisol levels,^[15] provide benefit to patients with Alzheimer's. Currently, very limited studies have been conducted with Alzheimer's patients relating the effect of yoga with preventing cognitive and memory decline, and further research is needed in this area.

Peripheral Nervous System Disorders

Yoga has also shown benefit in peripheral nervous system disorders. Malhotra^[57] recruited 20 diabetic neuropathy patients for 40 days of yoga sessions and kept 20 other patients in a control group in a non-randomized controlled study on nerve conduction velocity. Results exhibited improvements among the test group in right and left hand median nerve conduction velocities from 52.81 +/- 1.1 m/sec to 53.87 +/- 1.1 m/sec and 52.46 +/- 1.0 to 54.75 +/- 1.1 m/sec, respectively, whereas the velocities in the control group continued to deteriorate. Furthermore, a better glycemic control was also achieved by the individuals practicing yoga.

The effectiveness of *Hatha Yoga* has been studied in improving symptoms of Carpal Tunnel Syndrome (CTS) in a randomized, controlled trial. Garnfinkel *et al.*^[58] studied 42 individuals with CTS who were given eight weeks of *Hatha Yoga* sessions with a control group receiving a wrist splint to supplement their current treatment. In conclusion, the subjects in yoga groups had statistically significant improvements in grip strength (increased from 162 to 187 mm Hg) and pain reduction (decreased from 5.0 to 2.9 mm), but changes in grip strength and pain were not significant for control subjects. Additionally, the yoga group had a significant improvement in Phalen's sign as well (12 improved versus 2 in control group). The study established that a yoga-based regimen was more effective than wrist splinting and no supplementary treatment in relieving some symptoms of carpal tunnel syndrome.

Fibromyalgia

Fibromyalgia is a condition of heightened generalized sensitization to sensory input presenting as a complex of symptoms including pain, sleep dysfunction, and fatigue. The pathophysiology of the disorder could include dysfunction of the CNS pain modulatory systems, dysfunction of the neuroendocrine system, and dysautonomia.^[59] The following is a review of three randomized controlled studies to understand the effects of yoga in patients with fibromyalgia. Carson *et al.*^[60] studied the effects of a comprehensive yoga intervention on a sample of 53 female participants with fibromyalgia syndrome (FMS). This randomized controlled trial placed participants in either an eight-week yoga of Awareness program consisting of gentle poses, meditation, breathing exercises, coping methods, and group discussions or in a waitlist that consisted of standard care. Clinically significant results show that the yoga was helpful in a wide range of fibromyalgia symptoms that include improvements in pain, fatigue, stiffness, sleep problems, depression, memory, anxiety, tenderness, balance, vigor, and strength. In addition, participants also exhibited psychological changes in coping with pain through greater utilization of adaptive pain strategies such as problem solving, acceptance, relaxation, and activity engagement, and decreased use of maladaptive strategies such as confrontation, self-isolation, disengagement, and catastrophizing.

Goldenberg^[61] demonstrated statistically significant improvements in fibromyalgia manifestations with a meditation-based Stress Reduction Cognitive Behavioral Treatment (SR-CBT) program in a randomized controlled trial involving 79 FMS patients. After 10 weeks of intervention, symptoms improved in 67% of the participants in the test group compared to 40% in controls. The program led to a reduction of 16% in the mean visual analog scale [VAS] and of 11% in the mean Fibromyalgia Impact Questionnaire (FIQ) scores of the test subjects compared to the controls. These represent improvements in global well-being, pain, sleep, fatigue, tiredness upon awakening, and overall functional status among fibromyalgia patients. Furthermore, psychological status (SCL-90-R) also improved by 32% among tests compared to controls.

Da Silva^[62] studied the effects of yoga and addition of *Tui Na* (Chinese Massage therapy) in patients with fibromyalgia. Forty FMS women were recruited and randomized into two groups: yoga/*Tui Na* and yoga only. After 8 weeks of this intervention, both groups showed improvements in the form of reductions in the FIQ ($P = 0.007$) and ($P = 0.009$), yoga/*Tui Na* and yoga only, respectively, and VAS ($P < 0.001$), both groups, pain scores. Additionally, the yoga group was able to maintain these improvements in pain perception on follow-up as well. Yogic techniques could thus be used as valid adjunct therapeutic methods for sustained benefits to FMS patients.

Discussion

Yoga is emerging as a widely practiced complementary and integrative therapy. This paper brings to light the utility of yoga as a non-invasive means of treating many disorders and improving the overall quality of life. Its efficacy in various neurological disorders has been described in this review; however, these studies had certain shortcomings. These reflect areas where significant gaps in research exist and provide direction for those wishing to exploit the great potential that this field promises.

The goal of this review paper was to evaluate the credibility of yoga as a complementary treatment and management modality in different neurological disorders. Although our review provided some insight into the benefits of yoga in various neurological disorders, most of the studies reviewed were only in the initial stages of understanding the clinical (or symptomatic) benefits of yoga. Furthermore, most of these trials had inadequacies in their study designs. Therefore, until studies involving double-blinding and randomization with larger samples are employed, these benefits cannot be substantiated to draw proven conclusions of the benefits of yoga. Once that has been achieved; however, the next phase would be to observe and understand the actual physiological changes and the modifications in pathology occurring with the practice of yoga. Until that time, a discussion or classification of the benefits of yoga would be highly speculative. However, it is of utmost importance to understand these shortcomings in the study designs used till date, for guiding investigators wishing to pursue this cause further. A critical analysis of the studies reviewed is presented.

As with any emerging treatment modality, establishing the most effective method is difficult. In commencing this review

article, the first problem recognized was the broad classification of yoga. Many studies used the term yoga liberally without specifically identifying the type of yoga under investigation. There are four classes of yoga with numerous subtypes under each. Among the various articles reviewed, only a few provided detailed descriptions of the yoga programs enlisted. A meta-analysis requires a thorough description of each program for optimal comparison of study results. The sequence of yoga postures can be ascertained from a sequence of posture names, but more detailed descriptions are essential to future studies seeking to replicate or generalize the results. A standardization of yoga exercises for research purposes would reduce interpretative confusion and normalize the field. As the use of therapeutic effects of yoga continues to be assessed, it is imperative that a detailed description of the type of yoga used is defined.

Studies of neurological disorders, like epilepsy, have shown improvements attributed to yoga. However, it is important to recognize that behavioral modification and altered lifestyle may have accounted for the improved outcomes. The study by Sirven *et al.*^[20] exhibited that the percentage of individuals who benefited from yoga was among the highest in all CAM modalities, but the number of individuals actually following the regimen was not very high. It would be interesting to see whether the effects would be amplified with a strict regimen followed closely by all subjects.

Bastille *et al.*^[33] demonstrated the benefits of yoga among post-stroke patients, but the measures tested were not very sensitive. For instance, the Berg Balance Scale (BBS) was not very sensitive to changes that may occur in some people with high-level balance deficits, a finding previously reported in another study.^[63] An example of this was observed in one of the subjects of the study. The subject had a mean BBS baseline score that was just 4 points from the maximum possible score before the intervention began. Thus, in future studies, it is recommended that other measures, which are more sensitive to changes in postural stability, such as the Dynamic Gait Index^[64] or measures of postural sway, be used. Furthermore, the Timed Movement Battery appears to be an appropriate measure of timed mobility, but this does not provide any information about the factors that may be influencing speed of movement. In addition, limited information is available to determine the clinically meaningful changes in TMB scores. The inclusion of additional impairment measures is recommended to clarify the relationship between changes in impairments and changes in speed of performing movement tasks. This will elucidate the effects of yoga on flexibility, muscle force, endurance, and motor function in people with chronic post-stroke hemiparesis. Most importantly, all such studies measuring the benefits of yoga-based exercise programs should be done with larger samples and control subjects to offer better statistical support.

In the study by Oken,^[47] yoga and aerobic exercise were effective in relieving fatigue in MS patients. However, the mechanism of action of these improvements is unclear and may not relate directly to either yoga or aerobic exercise. Socialization, placebo, and self-efficacy effects may have influenced the results. Both interventions had an element of socialization that may have contributed to some benefits. Prior investigators have also commented on the lack of an adequate social control

group in similar exercise intervention studies as a placebo effect may account for some of the findings.^[65] One study has already shown that psychological benefits of an aerobic exercise intervention in a group of healthy young adults could be increased simply by informing subjects that the exercise program was specifically designed to improve psychological well-being.^[66] The issues of placebo effect and self-efficacy, both of which may have a significant impact,^[67,68] are difficult to adequately control in non-blind behavioral interventions. Additionally, the absence of statistically significant effects on the mood and cognitive measures needs to be interpreted cautiously, because there is a possibility that enhanced mood contributed to these improvements in quality of life and fatigue. This issue is still open to further investigation.

An important observation made in this review is that most of these studies were conducted in India where the philosophy and practice of yoga originated. The samples reviewed mostly focused on one geographical region where yoga is particularly ingrained in the culture. Generalizing these findings to other parts of the world and to different populations remains difficult. Only a very small number of studies have actually addressed variables of interest specific to minorities in the United States (Blacks, Hispanics, and Asians). These populations are distinct in their respective vulnerabilities to physical inactivity and specific disorders like type 2 diabetes etc.^[69,70] Future studies, such as double-blind controlled ones, should assess the therapeutic value of yoga in US minority populations as well.

In the preliminary study for CTS, the yoga-based regimen was more effective than wrist splinting and no supplementary treatment control in relieving some symptoms and signs.^[58] However, as with most of the studies done with complementary therapies, this study was limited by small sample size and lack of generalization. The participants in the study continued to observe improvements in their CTS symptoms even after the yoga treatment was terminated. Further studies are needed to ascertain whether a single course of yoga intervention with occasional reinforcement can be effective for long-term relief. Since health problems such as CTS are the leading cause of lost earnings in the workplace, continued evaluations of outcomes are needed to assess long-term effects of yoga on CTS symptoms, lost time from work, and patient satisfaction.

Another aspect, which remains to be determined, is the optimal intensity and duration required to maximize the effectiveness of yoga programs. Because the metabolic equivalent of yoga is low, it can be said that increasing the frequency will increase the benefits; however, these factors cannot be judged as many articles did not clarify the intensity or usage level of the yoga program studied. Moreover, most of the studies focused only on the short-term health benefits of yoga with very few including follow-up data; thus, a more comprehensive understanding is still needed in the maintenance aspect of yoga to achieve long term effects. It remains to be determined whether more intensive training can improve the likelihood of adopting and maintaining an active yoga practice in long run. It is necessary to have well-designed studies with larger sample sizes to determine the validity of yoga as an effective therapy for neurological disorders. Furthermore, since yoga is a physical activity, it remains difficult to perform large scale randomized controlled trials and even more difficult to

sustain blindness over the course of months. Despite the many shortcomings in the literature, the potential of yoga in treating neurological disorders remains vast. Yoga as a prophylaxis can be used as an important tool for health promotion and disease prevention with minimal cost.

Conclusion

Our review of medical literature found that yoga has been widely used for health promotion and disease prevention and as a possible treatment modality for neurological disorders. Yoga has also been used as an adjunctive treatment modality for carpal tunnel syndrome, multiple sclerosis, epilepsy, post-stroke paresis, and neuropathy of type two diabetes. Ongoing research is underway for treatment of fibromyalgia, headache, migraine, Parkinson's disease, chronic back pain, and many other disorders. However, most of the studies reviewed had inadequacies in their study design, especially with regards to the sample sizes and the employment of controls, randomization, and double blinding. Efforts must be made by future investigators to cover these gaps in research to be able to draw more meaningful conclusions about the benefits of yoga. Efforts must also be made to translate and disseminate research findings in yoga so that the best therapy can be paired with its' respective disorder. Additional research on the safety and efficacy of CAM therapies, including research on potential negative interactions between CAM therapies and conventional treatments such as medications, will bring forth the true value of yoga in neurological disorders and other disciplines of medicine.

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How to cite this article: Mishra SK, Singh P, Bunch SJ, Zhang R. The therapeutic value of yoga in neurological disorders. *Ann Indian Acad Neurol* 2012;15:247-54.

Received: 29-08-11, **Revised:** 26-01-12, **Accepted:** 09-07-12

Source of Support: Nil, **Conflict of Interest:** Nil