OPEN ACCESS

Current Research in Complementary & Alternative Medicine

Field T. Curr Res Complement Altern Med 7: 223.

www.doi.org/10.29011/2577-2201.100223

www.gavinpublishers.com

GAVIN PUBLISHERS

Review Article

Yoga Therapy Research: A Narrative Review

Tiffany Field*

University of Miami/Miller School of Medicine and Fielding Graduate University, USA.

***Corresponding author:** Tiffany Field, University of Miami/Miller School of Medicine and Fielding Graduate University, USA.

Citation: Field T (2023) Yoga Therapy Research: A Narrative Review. Curr Res Cmpl Alt Med 7: 223. DOI: 10.29011/2577-2201.100223

Received Date: 19 December 2023; **Accepted Date:** 26 December 2023; **Published Date:** 28 December 2023

Abstract

This narrative review on yoga therapy research that was published during the years 2020 to 2023 includes 58 papers. The publications of this period are primarily systematic reviews and meta-analyses of randomized controlled trials. Many of these (15%) are focused on yoga reducing anxiety and depression during pregnancy. Pediatric research has included yoga for motor and cognitive performance in youth and adult research has been focused on yoga for depression, migraines, diabetes and cancer. Surprisingly, studies on older adults including yoga for cognitive dysfunction and for Parkinson's comprise a significant number of the yoga publications (18%). Other studies include comparisons of Tele-yoga and in-person yoga and different yoga styles. Underlying mechanism research suggests that increased parasympathetic activity occurs following yoga as well as a reduction in cortisol and pro-inflammatory cytokines. Methodological problems continue to relate to the combined assessment of multiple yoga styles and their differing intensity and the more frequent measurement of psychological versus physical effects, although the mechanism studies highlight the positive physical effects of yoga.

This narrative review involved entering the terms yoga and the years 2020-2023 into PubMed and PsycINFO. The search yielded 349 papers for the last four years. However, following exclusion criteria, including case studies, non-English papers and study protocols, this review is a summary of the research reported in 58 papers. The recent literature on yoga is predominantly focused on the reduction of anxiety and depression during pregnancy and on improving cognitive function in older adults including those with Parkinson's. Other research involves yoga for youth for motor skills and cognitive performance and for adults to reduce depression, migraines and cancer symptoms as well as historical trends in the research and comparisons of different yoga styles including traditional yoga, exercise yoga and restorative yoga. This narrative review is accordingly divided into sections on research trends, comparisons of yoga styles, different age groups and conditions, potential underlying biological mechanisms and methodological limitations.

Research Trends

In a paper entitled "A PubMed–based exploration of the course of yoga research 1948 to 2020" different types of yoga research are given for each of several time periods [1]. One per cent of the yoga research from 1948 to 2020 occurred during the period 1948 to 1970 and was focused on the exceptional abilities of yoga practitioners. Seven percent of the research was published during the years 1971 to 2000 and was focused on health and therapy. Ninety-two percent of the research was published during the subsequent years 2001 to 2020 and was focused also on health and therapy but with fewer randomized controlled trials compared to systematic reviews and meta-analyses. More specifically from 1981 to 1990 the health and therapy articles were primarily on asthma, stress and diabetes. In the period 1991 to 2000, the focus was again on stress and asthma but also on anxiety. From 2011 to 2020, the the studies were predominantly on stress, depression, and pain. In this historical review on yoga research, the publications during the time periods were also specified for the country and the

type of research. From 1971 to 1980 most of the research came from the UK and they were predominantly randomized controlled trials. From 1981 to 1990 most of the research came from the US and again randomized controlled trials were the most prevalent. From 1991 to 2000 most of the randomized controlled trials came from India and systematic reviews were most frequently from the UK. And from 2001 to 2020, most of the papers were authored by researchers from the US and they were based on randomized controlled trials and systematic reviews and publications from the UK that were primarily meta-analyses.

In a paper entitled "A comprehensive review of yoga research in 2020", 1149 citations were found in PubMed and 46 met criteria [2]. Most of the papers in this review were on non-communicable diseases primarily focused on mental health and neuropsychological problems including anxiety, stress, depression, migraines, and balance.

As can be seen in the current review, most of the publications from 2020-2023 are systematic reviews and meta-analyses. And research on prenatal depression and older adults have been the most frequent topics. An entire paper called "CLARIFY, 2021" has been published as a 21-item list on guidelines for publishing yoga research [3] which will help inform future publications.

Comparisons Yoga Styles

In a paper, entitled "Characteristics of yoga providers and their sessions and attendees in the UK", 407 yoga providers were surveyed [4]. The yoga providers ranged in age from 45 to 64 (69%), were female (93 %), white (93%), held group sessions for a mean of four per week and individual sessions for a mean of two per week. The yoga styles included Hatha (28%), Iyengar (26%) and Vinyasa (15%). The sessions were comprised of poses or asanas (59%) breathing or pranayama (18%), and meditation or dhyana (12%). The yoga practitioners attended for mental health reasons (41%), hypertension (25%), and heart disease (9%). Seventy-three percent of the participants disclosed their health conditions.

In a similar paper entitled "Not all yoga styles are the same: an international survey on characteristics of yoga classes", 968 yoga teachers (77% female, mean=44 years) from 64 countries were surveyed [5]. The prevalence of traditional yoga (hatha or ashtanga) was 71%, exercise (vinyasa or power) was 18% and therapy yoga (restorative or gentle) was 11%. All styles included poses. Exercise yoga involved a greater amount of time on poses and less time on non-physical components (breath, meditation, relaxation and chanting). Poses occurred 50% time in traditional yoga, 61% time in exercise and 54% time in therapy yoga.

Heart rate responses have also been studied during different vinyasa yoga sequences in yoga practitioners (N= 40, mean age=31) [6]. Not surprisingly, heart rate was significantly lower during the restorative segments versus sun salutation, crescent lunge, balancing, standing and back–bending.

In a paper entitled "Effect of Teleyoga before Covid–19 and during the pandemic: a narrative review", seven studies were included (N=391) [7]. The majority of the randomized controlled studies included in this review came from the US with the UK, Canada and India closely behind. Collectively, they suggested that yoga practice was accompanied by a decrease in dyspnea, stress, anxiety and depression.

When satisfaction with online versus in-person yoga during COVID-19 has been surveyed, mixed results were found [8]. In this online survey of Australian participants, in- person yoga was noted to have better mental health/mood effects, physical satisfaction, and energized feelings. In contrast, online yoga was also thought to have mental health/ mood advantages but in addition it was considered more convenient and affordable.

Benefits and adverse effects associated with yoga practice have been assessed in yoga practitioners (N= 3,135) [9]. Benefits reported by 95% of the sample included physical, mental and cognitive effects. Adverse effects were reported as soreness and pain, muscle injuries, and fatigue, but only by 2% of the sample. The benefits correlated with months of yoga, time in yoga per week, number of yoga techniques practiced and awareness maintained during yoga. Orthorexia nervosa (as in a drive for thinness and concern regarding food quality), has also been noted as an adverse effect by yoga practitioners (N= 469) [10].

Prenatal Yoga

Prenatal depression is a significant problem as it is predictive of adverse pregnancy outcomes including prematurity and low birth weight [11]. Yoga effects have been assessed in several randomized controlled trials. In one of the earliest of these, prenatal yoga was noted to reduce both depression and anxiety as well as the negative outcomes of prematurity and low birth weight [12]. Since then a significant literature has evolved on yoga reducing the negative effects of prenatal depression.

At least three systematic reviews and meta-analyses have appeared in the recent literature summarizing the many randomized controlled trials on prenatal yoga. In one of these, 93% of the randomized controlled trials showed a greater reduction in prenatal anxiety, depression and stress in the yoga versus control groups [13]. However, the authors concluded that many of these were low quality studies. In another systematic review and meta-analysis on 12 randomized controlled trials (N=594 women), both prenatal depression and anxiety were again notably decreased in the yoga versus the control groups [14]. And, in yet another systematic review and meta-analysis on 13 randomized controlled trials (N= 379 participants), prenatal depression and anxiety were

decreased in the yoga versus waitlist control groups, but only in prenatally depressed women not in those who were not depressed [15].

In another meta-analysis in which 16 studies met criteria, although only five were randomized controlled trials, a decrease was noted not only in prenatal depression and anxiety but also in stress and pain [16]. In these trials, increased immunity was also noted. This was not surprising given that immune function, specifically increased natural killer cell number, has been reported following decreased cortisol levels that typically accompany decreased depression [11].

Infertility in women has also been accompanied by elevated anxiety and depression. In a systematic review entitled "The effects of yoga on pregnancy stress and anxiety in infertile individuals", 24 yoga studies from 9 different countries were reviewed [17]. These included three hatha yoga, one vinyasa yoga and 20 mixed yoga studies. The authors reported a significant decrease in stress, anxiety and depression, but surprisingly did not note changes in infertility.

Other problems related to depression during pregnancy include sexual function and body image. In a randomized controlled trial entitled "The effect of yoga on sexual function and body image in primiparous pregnant women", Female Sexual Function Index scores decreased after yoga (N=140 pregnant Turkish women) [18]. However, surprisingly, no changes were noted on body image as indicated by scores on the Body Exposure During Sexual Activity Questionnaire.

Heart rate variability and cardio-respiratory synchronization have also been assessed following prenatal yoga. Based on the association between depression and sympathetic dominance, a reduction in depression following yoga would be expected to correlate with parasympathetic dominance. In a study that assessed both heart rate variability and cardiorespiratory synchronization following yoga (N=69), 90-minute yoga classes were held weekly, and assessments were made once per trimester before and after yoga or a control condition (30-minute moderate intensity walk) [19]. Heart rate variability increased following yoga, suggesting a shift towards parasympathetic dominance, and greater synchronization was noted between heart rate and respiration. The shift to parasympathetic dominance (increased vagal activity) was not surprising given that stimulation of pressure receptors under the skin, as in yoga, typically increases vagal activity [20].

Heart rate was monitored in both pregnant women and their fetuses in a study entitled "Fetal and maternal responses to yoga in the third trimester" (N=20 pregnant women at 35 weeks gestation) [21]. In this research, maternal and fetal heart rate were monitored during a 20-minute rest period, during 50 minutes of yoga, 10 minutes of meditation and 20 minutes of recovery. A repeated measures analysis of variance showed that maternal heart rate increased during yoga as compared to rest (90 to 102 bpm) and then decreased during meditation (85 bpm) and recovery (88 bpm). The maximum heart rate was 125 beats per minute. Although uterine activity increased, no change was noted in fetal heart rate. The latter finding is consistent with an earlier study also reporting no change in fetal heart rate [22], possibly because fetal heart rate is less variable in the late weeks of pregnancy, and although uterine activity may increase, fetal activity may be very limited.

Labor has also been positively affected by prenatal yoga. For example, in a randomized controlled trial (N=84 women), six 60-minute training sessions were given pregnant women at 26 to 37 weeks gestation [23]. The women not only had less anxiety regarding labor but also less pain at two hours dilation and two hours later. In addition, the first stage and the total length of labor were shorter. Shorter labor was also reported in a systematic review and meta-analysis on 31 randomized controlled trials (N=2,217 pregnant women) [24]. An increased odds of a vaginal birth was also noted for women who received 12 or more yoga sessions. Not surprisingly, those women also reported reduced anxiety, depression and stress.

Effect	First Author
Decreased anxiety, depression and stress	Villar-Alises
Decreased depression and anxiety	Wang
Decreased depression and anxiety only in depressed	Lin
Decreased depression, anxiety, stress and pain	Kwon
Increased immunity	Kwon
Decreased stress, anxiety and depression in infertility	Yildirim
Increased sexual function	Karaahmet
Parasympathetic dominance	Zebeljan
Decreased heart rate	Gavin
Less anxiety and pain during labor and shorter labor	Mohyadin
Increased odds vaginal birth	Corrigan

Table 1: Prenatal yoga.

Yoga for Youth

Pediatric yoga has been studied in the context of motor function in kindergarten children and attitudes towards yoga and cognitive function in adolescents. Other research is focused on premenstrual syndrome and pediatric oncology.

In a randomized controlled trial on motor skills in kindergarten children (N=54, mean age=5), three groups of children were

compared including a yoga group, a physical education group and an inactive control group [25]. The yoga and physical education groups received two 30-minute sessions per week for 12 weeks. Based on the Eurofit Physical Fitness Test battery, the yoga group had greater arm and leg strength, flexibility, speed and balance. Given that the yoga group was more active, it's not surprising that they had greater fitness than the physical education group. They also had higher global self-esteem scores on the Rosenberg Self-esteem Scale which likely related to their better performance on the physical fitness battery. Given its positive effects, it is surprising that physical education programs in general do not include yoga and as early as kindergarten.

The need for parental approval is always a limitation of research on youth. The attitudes toward research are also a consideration when studying youth as they have limited knowledge about research and may also have limited patience. In a study entitled "Teens' perspectives on yoga as a treatment for stress and depression", 22 adolescents engaged in focus groups watching hatha yoga videos [26]. The adolescents were asked about whether they attended yoga sessions and if not why not. The reasons adolescents gave for not attending yoga classes were their "self-consciousness about being in a class" and their "transportation problems". But for these reasons, they could participate in yoga online classes.

In a study on cognitive function in adolescents (N=36 adolescents in India), yoga classes were provided for one hour five days a week for 12 weeks [27]. At the end of the yoga program, better performance was noted on digit span forward and backward and letter–number sequencing tests. Given these positive effects of yoga practice on cognitive functions, it should be offered in school systems at the earliest ages.

Premenstrual syndrome is a universal problem for adolescent women. In a systematic review and meta-analysis evaluating the effectiveness of yoga in managing premenstrual syndrome, 11 studies were included [28]. Although the studies were heterogeneous in design as well as in the yoga protocols and outcome measures, they generally showed that yoga was beneficial in the management of premenstrual syndrome. Unfortunately, the variability on protocols and outcome measures makes it difficult to draw conclusions about how to treat conditions like premenstrual syndrome.

Hematologic and oncologic diseases are prevalent conditions for youth. In a study entitled "Yoga as a complementary and alternative therapy in children with hematologic and oncologic disease", 7 to 17-year-old youth and their parents were seen during a single bedside yoga session [29]. The children reported a decrease in pain following yoga but no change in anxiety, and the adolescents and their parents reported a reduction in anxiety but no change in pain. This inconsistency between the experiences of children and adolescents is surprising and difficult to interpret unless the children are more focused on the more physical effects and adolescents have a longer experience with pain and have anticipatory anxiety.

In a review of eight studies on pediatric oncology conducted during the years 2010 to 2020, recruitment ranged from 34 to 55% and retention at 70% [30]. The effects of yoga included decreased anxiety and pain and increased physical functioning. Although these results are consistent with the previous results, they are limitedby the studies being non-randomized controlled trials.

Effect	First Author
Increased strength, flexibility, speed, balance in kindergarten	Jarraya
Increased cognitive performance in adolescents	Shetty
Better management premenstrual syndrome	Pal
Decreased pain in children with cancer	Fukuhara
Decreased anxiety in adolescents with cancer	Fukuhara
Decreased anxiety and pain and increased physical function In youth with cancer	Spectpr

Table 2: Yoga for youth.

Yoga for Adults

Yoga research on adults has been focused on depression, substance use, tension and migraine headaches and back pain. In addition, research has been conducted on adults with eating disorders, hypertension, multiple sclerosis and cancer.

Effect	First Author
Decreased depression	Forseth, Bieber, Brinsley
Decreased tension-type headaches	Anheyer (2020)
Decreased frequency and duration of migraine headaches	Wu, Moonaz
Decreased back pain	Anheyer (2022)
Decreased binge eating and bulimia	Borden
Decreased weight, cardiovascular risk factors and stress and increased physical fitness in obesity	Batrakoulis
Improved glycemic control, oxidative stress, inflammatory response and sleep quality	Viswanathan
Reduced substance use, anxiety and pain	Walia
Reduced systolic and diastolic blood pressure in hypertension	Nalbant
Reduced fatigue in adults with multiple sclerosis	Shohani
Reduced physical fatigue and depression in adults with cancer	Zetzl
Reduced inflammatory cytokines and oxidative stress in breast cancer	Jain
Reduced depression and anxiety in adults with cancer	Gonzalez

Table 3: Yoga for adults.

Depression

The prevalence of depression is significant at most stages of life but especially in adulthood. Yoga has effectively reduced depression at all stages. Three publications on yoga decreasing depression during adulthood were found in this recent literature. In a randomized controlled trial (N=30), a group who received yoga twice a week for more than six months was compared to a non-yoga group [31]. The yoga group had lower scores on the Perceived Stress Scale and on the Beck Depression Inventory. Although there were no group differences on inflammation markers, the sample was relatively small making it difficult to determine group differences.

In a randomized controlled trial for patients with major depression disorder, ashtanga yoga was provided three times a week for three months (N=83) [32]. The remission rates were greater for the yoga group versus a waitlist control group. This finding is not surprising given that the waitlist control group was not experiencing any intervention. Although waitlist control groups are often the comparison groups, active control groups would yield more information about prevention/intervention. Interestingly, greater improvement was noted at the beginning of the intervention, perhaps because the yoga effects are immediate and the participants then experience an habituation of those effects

In a systematic review and meta-analysis on the effects of yoga on depressive symptoms in people with mental disorders, 13 studies met inclusion criteria (N=632 participants) [33]. Not surprisingly, a greater decrease in depression was noted in the yoga groups versus the waitlist control and treatment as usual groups. This effect is more notable of course in those with mental disorders but also when study results are combined in meta-analyses.

Pain

Yoga has been notably effective for many pain syndromes in many research studies. Recent publications on yoga for pain have included two on migraine headaches, one on tension headaches and one on low back pain. In a systematic review and meta-analysis, headaches were said to be the sixth leading cause of disabilities across the globe [34]. Having searched the literature on Medline/PubMed, Scopus, Cochrane Library and PsycINFO, the authors reported that yoga decreased headache frequency, duration, and pain. However, these effects were noted only for tension-type headaches, not migraine headaches.

In a meta-analysis on five randomized controlled trials (N= 356), a decrease in headache frequency was noted, but the intensity of pain did not decrease [35]. In contrast, in a meta-analysis reported in a paper entitled “Effectiveness of yoga therapy for migraine treatment”,five databases (PubMed, EMbase, Web of Science, EBSCO and Cochran Library) yielded six randomized controlled trials suggesting that both frequency and duration of migraine headaches decreased [3].

Back pain has also been relieved by yoga in several studies. In a systematic review and meta-analysis on 32 studies on yoga for 2,702 back pain participants, a yoga group was compared to a passive control group as well as an active group [36]. The yoga group experienced less pain intensity and less pain–related disability as well as better mental health and better physical function than the inactive control group. However, there were no differences between the yoga and active control groups except that the yoga group had more sustained mental health benefits, possibly because of the meditative component in the yoga protocol. That the yoga and active control groups did not differ on pain and physical function was not surprising given that those groups were receiving stimulation of pressure receptors under the skin which would lead to pain -relief by the release of serotonin, the brain's anti-pain neurotransmitter.

Diseases

A number of different diseases have been the focus of yoga research in this recent literature. They include eating disorders, obesity, diabetes, substance use, hypertension, multiple sclerosis, and cancer.

Eating Disorders. In a review on eating disorders research entitled "Yoga and eating disorder prevention and treatment", the analysis of 11 randomized controlled trials (N=754 participants) suggested a small effect of yoga on global eating disorders and a moderate to large effect for yoga reducing binge eating and bulimia [37]. In another review entitled "Psychophysiological adaptation to yoga practice in overweight and obese individuals", 22 articles were included (N =1178 overweight / obese individuals) [38]. Yoga effectively reduced weight. cardiovascular risk factors and stress and increased physical fitness.

Diabetes. In a study entitled "Effective yoga intervention on biochemical, oxidative stress markers and sleep quality among subjects with type two diabetes in south India", a randomized controlled trial was performed on yoga versus simple physical exercises (N= 300) [39]. The yoga and physical exercise sessions were held for 50 minutes five days per week. The yoga group showed a decrease in body mass index, glucose, lipid levels, IL–6, TNF–alpha and improvement in adiponectin and sleep quality. As the authors suggested, these data showed that yoga led to improved glycemic control, oxidative stress, inflammatory response, and sleep quality.

Substance Use. in a systematic review of yoga for substance use research, seven of eight studies showed that yoga led to less anxiety, pain and substance use [40]. The authors referred to yoga practice as "opioid substitution therapy".

Hypertension. In a systematic review and meta-analysis paper entitled "Context, structure and delivery characteristics of yoga interventions for managing hypertension", 34 randomized controlled trials were included [41]. Yoga effectively reduced both systolic blood pressure and diastolic blood pressure. In 13 of the 20 effective interventions, three components of yoga were incorporated including asanas, pranayama and dhyana and they were of similar duration. The most common yoga protocol was 45-minute sessions held seven days a week for 12 weeks in a center-based supervised program. The authors suggested, however, that some of the randomized controlled trials were of low, methodological quality due to their inadequate reporting.

Multiple Sclerosis. In a systematic review and meta-analysis to determine the quality of life and fatigue in patients with multiple sclerosis, three types of groups were compared including yoga, exercise and control groups (N=693) [42]. The overall results suggested that there was less fatigue in the yoga versus control groups. However, the yoga and exercise groups did not differ, as might be expected because of the stimulation of pressure receptors under the skin by both yoga and exercise.

Cancer. In a randomized controlled trial on yoga with patients experiencing different types of cancer (N=172), participants were randomly assigned to a yoga group or a waitlist control group [43]. The yoga group received eight weekly 60-minute sessions. The yoga participants experienced a reduction in general fatigue, in physical fatigue and in depression. Those with greater attendance and lower baseline fatigue experienced greater improvement. Women with breast cancer had the greatest improvement.

In a paper entitled " Long-term yogic intervention improves Symptomatic Scale and Quality of Life by reducing inflammatory cytokines and oxidative stress in breast cancer", 96 women experiencing stage ll/lll cancer and receiving chemotherapy and/or radiotherapy were given yoga [44]. After a yoga program of five days per week for 48 weeks, decreases were noted in inflammatory cytokines (interferon-Y and TNF-alpha).

In a systematic review and meta-analysis on 26 studies on depression and 16 on anxiety in people with cancer, both depression and anxiety were reduced [45]. Significant effects were noted for all variables including different types of cancer, treatment status, duration and frequency of yoga classes.

Yoga for Older Adults

Yoga has been provided for older adults for several different reasons. They include cognitive function, verbal fluency, physical fitness, frailty, sleep issues, and comparisons between yoga and cognitive behavior therapy for some of these problems.

Hatha yoga has been given to older adults to improve cognitive function [46]. In a small sample (N=15) who practiced for at least two years, increased executive function and reaction time were noted. However, no group differences were reported for episodic memory and sustained attention.

Yoga has been compared to cognitive behavior therapy for its effects on older adults. In a study entitled "Long-term effects of cognitive behavior therapy and yoga for worried older adults", cognitive behavior therapy (CBT) by phone was compared with yoga (N= 500 adults greater than 60-years-old) [47]. Both the yoga and the CBT groups experienced decreased worry, anxiety, sleep problems, depression, fatigue and pain. In addition, both groups had better physical function and social participation scores based on the PROMIS scale and lower worry scores on the Penn State Worry Questionnaire. That CBT via phone could be as effective as yoga was surprising except that the individually practiced yoga may have felt isolating and may have resulted in less compliance and adherence than in the therapist guided CBT.

In another study, verbal fluency was assessed in physically inactive older adults [48]. Hatha yoga was compared with exercise and waitlist control groups. Greater fluency was noted in the two active yoga and exercise groups, as might be expected.

In a meta-analysis on the effects of yoga on physical fitness in older adults, 12 studies were included [49]. Moderately positive effects were noted for muscle strength, balance, mobility and lower body flexibility. However, no effects were noted for cardiorespiratory endurance or upper body flexibility. These results are not surprising because most of the yoga classes for older adults do not feature downward facing dog because of concerns about upper body arthritic joints and most of the poses that are included such as the warrior poses primarily involve lower body flexibility.

In a systematic review on frailty in older adults, 33 studies were included (2,384 participants) [50]. Iyengar and chair yoga were the most frequently appearing styles in this literature review. Iyengar yoga is often used with older adults because the poses are held rather than moving more rapidly as in Vinyasa and chair yoga has been frequently used because of balance concerns. Across studies, gait speed, lower extremity strength and endurance were notably improved in the yoga groups compared to the inactive control groups. As in many yoga studies inactive control groups have been used. However, they are not good comparison groups as the positive effects of yoga would always be expected.

Yoga therapy has also been offered for improving sleep quality in older adults [51]. In this sample, the participants (N=96 adults, 60-75-years old) received three sessions of yoga per week for three months. Following this program, the yoga group had better sleep quality and less constipation than the waitlist control group. Both the improved sleep quality and less constipation would be expected based on the increased vagal activity following yoga [20]. Stimulation of the pressure receptors under the skin lead to increased vagal activity which relaxes the nervous system enabling better sleep quality and stimulates gastric activity resulting in less constipation.

The Psychological and physical health of in general has been for older adults In an integrative review on six studies [52]. In that review, hatha yoga was the most frequently offered style. There was reportedly high adherence to the yoga sessions that in general improved psychological and physical health. This included reduced anger, anxiety and fear of falling and improved well-being, self-efficacy, executive and immunological function as well as greater strength and balance.

Parkinson's is one of the most prevalent diseases in older adults. A few studies on yoga for older adults with Parkinson's have appeared in the recent literature. The primary focus has been on depression. In a review of three randomized controlled trials, two of them showed reduced depression, and one of them showed no worsening of depression [53]. In a critical review of seven studies, depression was decreased along with anxiety [54]. In this group of studies, improvements were also noted in motor function, gait and balance. In a very exhaustive review of 19 systematic reviews on 74 trials and 80 meta-analyses, a few forms of movement were explored including quigong, tai chi and yoga [55]. In this review, yoga as well as quigong and tai chi were noted to improve balance. It was surprising that most of the yoga studies on Parkinson's focused on depression rather than enhancing balance and movement which are reputedly the causes of the depression in those experiencing this disease.

Effect	First Author
Increased executive function and reaction time	Baklouti
Increased verbal fluency	Welford
Increased muscle strength, balance, mobility and lower body flexibility	Shin
Decreased frailty and increased gait speed and lower body strength	Lowenthal
Improved sleep quality and decreased constipation	Ganesh
Reduced anger, anxiety and fear of falling and improved well-being, Self-efficay, executive function and immunological function, strength, balance	Martens
Decreased worry, anxiety, sleep problems, depression, fatigue and pain	Danhauer
Increased physical function and social participation	Danhauer
Reduced depression in Parkinson's	Sagarwala
Reduced depression and anxiety in Parkinson's	Mailankody
Improved balance	Garcia-Munoz

Table 4: Yoga for older adults.

Potential Underlying Biological Mechanisms

Potential underlying biological mechanisms or at least correlates of yoga effects include increased parasympathetic activity and decreased pro-inflammatory cytokines. A number of studies that were focused on diseases noted that decreased symptoms following yoga were related to increased parasympathetic activity (increased heart rate variability or vagal activity). Other studies have specifically focused on parasympathetic activity as a potential underlying mechanism for the effects of yoga. The reduction of inflammation has also been the focus of potential underlying biological mechanisms for yoga effects.

Typically, yoga practitioners have been compared to non-practitioners in the parasympathetic activity studies. In one study, for example, 40 yoga practitioners were compared with 40 non-practitioners [56]. The practitioners were noted to have lower heart rate and greater heart rate variability in a supine resting position. In addition, their systolic blood pressure was less variable and was negatively correlated with heart rate variability. Surprisingly, this negative correlation was not noted for diastolic blood pressure.

In another study entitled "The psychophysiological profile and cardiac autonomic reactivity in long-term female yoga practitioners", recordings were made at baseline as well as during and following stressful experimental conditions (specifically a Stroop color and word test and mental arithmetic test designed to assess the delay in reaction time between congruent and incongruent stimuli) [57]. In this study, yoga practitioners were compared to runners as well as a sedentary control group. Yoga practitioners had a lower respiratory rate compared to both groups which is not surprising as yoga is less strenuous than running and may have been less anxiety-provoking than being sedentary in this stressful situation. But both the yoga and runners' groups had a lower heart rate and diastolic blood pressure than the sedentary group. And, heart rate variability returned to baseline for the yoga and the runners' groups. That the yoga practitioners had lower respiratory rate than the runners but similar heart rate and diastolic blood pressure is difficult to interpret. Nonetheless, the combined results suggest that both yoga practitioners and runners have higher stress thresholds.

Reductions in cortisol and inflammatory cytokines have also been noted as potential underlying effects of yoga. In a randomized controlled trial (N=41), yoga therapy was compared to cognitive behavior therapy for its effects on sleep and cortisol levels [58]. Better sleep quality and lower cortisol levels were reported following yoga as compared to cognitive behavior therapy. Both the decreased cortisol levels and enhanced sleep quality following yoga versus cognitive behavior therapy likely derived from increased parasympathetic activity following the stimulation of pressure receptors during yoga [59].

In a study on 25 biomarkers of 4023 participants from 13 countries, yoga sessions of varying durations were given to healthy participants and clinical patients [60]. The 25 biomarkers (nine among healthy participants, 14 among patients and 2 among pregnant women) changed favorably. Those biomarkers that consistently decreased were the stress hormone cortisol and the pro-inflammatory markers IL-6, and TNF-alpha. Similar results

were reported in a systematic review on 11 randomized controlled trials [61]. In that review, yoga effectively reduced the same pro–inflammatory markers in each of the trials.

Mechanism	First Author
Decreased heart rate and greater heart rate variability and systolic blood pressure less variable	Anasuya
Decreased respiratory rate, heart rate and diastolic blood pressure	Lin
Decreased cortisol and improved sleep quality	Datta
Decreased cortisol, IL-6 and TNF-alpha	Shah

Table 5: Potential underlying mechanisms.

Methodological Limitations

This literature on yoga therapy research has differed from that reviewed in 2020 by including primarily systematic reviews and meta-analyses instead of randomized controlled trials [20]. Although that suggests that a significant body of research has accumulated, many of the studies included in those reviews and meta-analyses were highly variable on the styles of yoga, the samples and the measures. Further, many were not randomized controlled trials. In addition, while some of those studies had active controls, most had waitlist control "treatment as usual" control groups. More randomized controlled trials are needed with yoga being compared to active control groups to distinguish the effects of yoga as compared to those of other forms of exercise. And, different types of yoga need further comparison than just being labeled traditional yoga (hatha or ashtanga), exercise (Vinyasa or power) or therapy yoga (restorative or gentle). Further, comparisons are also needed to document the differential effects of poses (asanas), breathing (pranayama) and meditation (dhyana) as well as comparing the poses themselves, the different breathing exercises and different meditation styles to determine their therapeutic effects.

Most of the studies published between 2020 and 2023 were conducted before 2020 so they are not representative of the COVID online or the more current online yoga therapy effects. The few studies comparing online with in-person yoga suggest differential effects with in-person yoga being more therapeutic and online yoga being more convenient and cost-effective. Long-term effects may be greater for online yoga if it is more convenient and cost-effective and therefore more frequently practiced, but longitudinal comparisons have not appeared in this literature.

Most of the research is focused on highly experienced practitioners or clinical samples, for example, prenatally depressed women. These are convenience samples that can be readily recruited from yoga practices, hospitals and medical centers. As such, the findings have often been confounded by the expertise of the yoga practitioners or yoga being an add-on therapy for the clinical samples. For example, yoga has frequently been added to physical therapy or cognitive behavior therapy. Without assessing these as separate therapy groups, the results are confounded. In addition, the focus on clinical samples in yoga research has led to yoga being a primarily interventive rather than preventive therapy. Yoga instructors could be invited to collaborate with researchers as their classes could provide rich databases that would enable comparisons of students across varying levels of experience.

Despite these methodological limitations, this recent literature on yoga has supported the earlier research. This review and earlier reviews highlight the positive effects of yoga therapy.

References

1. Chetry D, Telles S, Balkrishna A (2021) A PubMed-Based Exploration of the Course of Yoga Research from 1948 to 2020. Int J Yoga Therap 31:Article_22.
2. Dutta A, Aruchunan M, Mukherjee A, Metri KG, Ghosh K, et al., (2022) A Comprehensive Review of Yoga Research in 2020. J Integr Complement Med 28:114-123.
3. Moonaz S, Nault D, Cramer H, Ward L (2021) CLARIFY 2021: explanation and elaboration of the Delphi-based guidelines for the reporting of yoga research. BMJ Open 11:e045812.
4. Nalbant G, Lewis S, Chattopadhyay K (2022) Characteristics of Yoga Providers and Their Sessions and Attendees in the UK: A Cross-Sectional Survey. Int J Environ Res Public Health 19:2212.
5. Mandlik GV, Nguyen B, Ding D, Edwards KM (2023) Not All Yoga Styles Are the Same: An International Survey on Characteristics of Yoga Classes. J Integr Complement Med 29:321-326.
6. Cheruka CA, Sherman SA, Davis KK, Kline CE (2023) Oxygen Consumption and Heart Rate Responses in Different Vinyasa Yoga Sequences. Int J Yoga Therap 33:Article 2.
7. Ruchi D, Saloni M, Ramesh K, Indrajeet S, Sunil K, et al., (2023) Effect of Teleyoga Before COVID-19 and During Pandemic: A Narrative Review. Recent Adv Antiinfect Drug Discov 18:178-187.
8. Brinsley J, Smout M, Davison K (2021) Satisfaction with Online Versus In-Person Yoga During COVID-19. J Altern Complement Med 27:893-896.
9. Telles S, Sharma SK, Chetry D, Balkrishna A (2021) Benefits and adverse effects associated with yoga practice: A cross-sectional survey from India. Complement Ther Med 57:102644.
10. Domingues RB, Carmo C (2021) Orthorexia nervosa in yoga practitioners: relationship with personality, attitudes about appearance, and yoga engagement. Eat Weight Disord 26:789-795.
11. Field T, Diego M, Dieter J, Hernandez-Reif M, Schanberg S, et al., (2004) Prenatal Depression Effects on the Fetus and the Newborn. Infant Behavior & Development 27:216-229.
12. Field T, Diego M, Delgado J, Medina L (2013) Yoga and Social Support Reduce Prenatal Depression, Anxiety, and Cortisol. J Bodyw Mov Ther 17:397-403.

13. Villar-Alises O, Martinez-Miranda P, Martinez-Calderon J (2023) Prenatal Yoga-Based Interventions May Improve Mental Health during Pregnancy: An Overview of Systematic Reviews with Meta-Analysis. Int J Environ Res Public Health 20:1556.

14. Wang G, Liang C, Sun G (2022) Yoga's Therapeutic Effect on Perinatal Depression: A Systematic Review and Meta-Analysis. Psychiatr Danub 34:195-204.

15. Lin IH, Huang CY, Chou SH, Shih CL (2022) Efficacy of Prenatal Yoga in the Treatment of Depression and Anxiety during Pregnancy: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health 19:5368.

16. Kwon R, Kasper K, London S, Haas DM (2020) A systematic review: The effects of yoga on pregnancy. Eur J Obstet Gynecol Reprod Biol 250:171-177.

17. Demir Yıldırım A, Güngör Satılmış İ (2022) The Effects of Yoga on Pregnancy, Stress, and Anxiety in Infertile Individuals: A Systematic Review. Holist Nurs Pract 36:275-283.

18. Yildiz Karaahmet A, Sule Bilgic F, Yilmaz T, Dinc Kaya H (2022) The effect of yoga on sexual function and body image in primiparous pregnant Women: A randomized controlled single-blind study. Eur J Obstet Gynecol Reprod Biol 278:100-106.

19. Žebeljan I, Lučovnik M, Dinevski D, Lackner HK, Moertl MG, et al., (2022) Effect of Prenatal Yoga on Heart Rate Variability and Cardio-Respiratory Synchronization: A Prospective Cohort Study. J Clin Med 11:5777.

20. Field T (2020) Yoga therapy research: A narrative review. Journal of Yoga and Physiotherapy 8:49-71.

21. Gavin NR, Kogutt BK, Fletcher W, Szymanski LM (2020) Fetal and maternal responses to yoga in the third trimester. J Matern Fetal Neonatal Med 33:2623-2627.

22. Figueiredo B, Pinto CC, Pacheco A, Field T (2017) Fetal Heart Rate Variability Mediates Prenatal Depression Effects on Neonatal Neurobehavioral Maturity. Biol Psychol 123:294-301.

23. Mohyadin E, Ghorashi Z, Molamomanaei Z (2020) The effect of practicing yoga during pregnancy on labor stages length, anxiety and pain: a randomized controlled trial. J Complement Integr Med 18:413-417.

24. Corrigan L, Eustace-Cook J, Moran P, Daly D (2020) The effectiveness and characteristics of pregnancy yoga interventions: a systematic review protocol. HRB Open Res 2:33.

25. Jarraya S, Jarraya M, Nouira S (2022) Effect of Yoga on Motor Skills and Self-Esteem in Kindergarten Children: A Randomized Controlled Trial. Int J Yoga Therap 32:Article 10.

26. Uebelacker LA, Wolff JC, Guo J, Feltus S, Caviness CM, et al., (2021) Teens' perspectives on yoga as a treatment for stress and depression. Complement Ther Med 59:102723.

27. Shetty L, Reddy GG, Krishnan P, Toby I, Ts S, et al., (2022) Effects of Yoga on Cognitive Functions Among Adolescents. Adv Mind Body Med 36:4-7.

28. Pal A, Nath B, Paul S, Meena S (2022) Evaluation of the effectiveness of yoga in management of premenstrual syndrome: a systematic review and meta-analysis. J Psychosom Obstet Gynaecol 43:517-525.

29. Fukuhara JS, O'Haver J, Proudfoot JA, Spies JM, Kuo DJ (2020) Yoga as a Complementary and Alternative Therapy in Children with Hematologic and Oncologic Disease. J Pediatr Oncol Nurs 37:278-283.

30. Spector D (2021) Yoga in the Pediatric Oncology Population: A Review of the Literature. J Pediatr Oncol Nurs 38:410-419.

31. Forseth B, Polfuss M, Brondino M, Lawlor MW, Beatka MJ, et al., (2021) Association between yoga, physiologic and psychologic health: A cross sectional study. Complement Ther Clin Pract 43:101350.

32. Bieber M, Görgülü E, Schmidt D, Zabel K, Etyemez S, et al., (2021) Effects of body-oriented yoga: a RCT study for patients with major depressive disorder. Eur Arch Psychiatry Clin Neurosci 271:1217-1229.

33. Brinsley J, Schuch F, Lederman O, Girard D, Smout M, et al., (2021) Effects of yoga on depressive symptoms in people with mental disorders: a systematic review and meta-analysis. Br J Sports Med 55:992-1000.

34. Anheyer D, Klose P, Lauche R, Saha FJ, Cramer H (2020) Yoga for Treating Headaches: a Systematic Review and Meta-analysis. J Gen Intern Med 35:846-854.

35. Wu Q, Liu P, Liao C, Tan L (2022) Effectiveness of yoga therapy for migraine: A meta-analysis of randomized controlled studies. J Clin Neurosci 99:147-151.

36. Anheyer D, Haller H, Lauche R, Dobos G, Cramer H (2022) Yoga for treating low back pain: a systematic review and meta-analysis. Pain 163:e504-e517.

37. Borden A, Cook-Cottone C (2020) Yoga and eating disorder prevention and treatment: A comprehensive review and meta-analysis. Eat Disord 28:400-437.

38. Batrakoulis A (2022) Psychophysiological Adaptations to Yoga Practice in Overweight and Obese Individuals: A Topical Review. Diseases 10:107.

39. Viswanathan V, Sivakumar S, Sai Prathiba A, Devarajan A, George L, et al., (2021) Effect of yoga intervention on biochemical, oxidative stress markers, inflammatory markers and sleep quality among subjects with type 2 diabetes in South India: Results from the SATYAM project. Diabetes Res Clin Pract 172:108644.

40. Walia N, Matas J, Turner A, Gonzalez S, Zoorob R (2021) Yoga for Substance Use: A Systematic Review. J Am Board Fam Med 34:964-973.

41. Nalbant G, Lewis S, Chattopadhyay K (2020) Content, Structure, and Delivery Characteristics of Yoga Interventions for Managing Hypertension: A Systematic Review Protocol. Int J Yoga 13:111-114.

42. Shohani M, Kazemi F, Rahmati S, Azami M (2020) The effect of yoga on the quality of life and fatigue in patients with multiple sclerosis: A systematic review and meta-analysis of randomized clinical trials. Complement Ther Clin Pract 39:101087.

43. Zetzl T, Renner A, Pittig A, Jentschke E, Roch C, et al., (2021) Yoga effectively reduces fatigue and symptoms of depression in patients with different types of cancer. Support Care Cancer 29:2973-2982.

44. Jain M, Mishra A, Yadav V, Shyam H, Kumar S, et al., (2023) Long-Term Yogic Intervention Improves Symptomatic Scale and Quality of Life by Reducing Inflammatory Cytokines and Oxidative Stress in Breast

Cancer Patients Undergoing Chemotherapy and/or Radiotherapy: A Randomized Control Study. Cureus 15:e33427.

45. Gonzalez M, Pascoe MC, Yang G, de Manincor M, Grant S, et al., (2021) Yoga for depression and anxiety symptoms in people with cancer: A systematic review and meta-analysis. Psychooncology 30:1196-1208.

46. Baklouti S, Aloui A, Baklouti H, Souissi N, Jarraya M (2022) Effects of Hatha yoga on cognitive functions in the elderly: a cross-sectional study. Libyan J Med 17:2080799.

47. Danhauer SC, Miller ME, Divers J, Anderson A, Hargis G, et al., (2022) Long-Term Effects of Cognitive-Behavioral Therapy and Yoga for Worried Older Adults. Am J Geriatr Psychiatry 30:979-990.

48. Welford P, Östh J, Hoy S, Rossell SL, Pascoe M, et al., (2023) Effects of Yoga and Aerobic Exercise on Verbal Fluency in Physically Inactive Older Adults: Randomized Controlled Trial (FitForAge). Clin Interv Aging 18:533-545.

49. Shin S (2021) Meta-Analysis of the Effect of Yoga Practice on Physical Fitness in the Elderly. Int J Environ Res Public Health 18:11663.

50. Loewenthal J, Innes KE, Mitzner M, Mita C, Orkaby AR (2023) Effect of Yoga on Frailty in Older Adults : A Systematic Review. Ann Intern Med 176:524-535.

51. Shree Ganesh HR, Subramanya P, Rao MR, Udupa V (2021) Role of yoga therapy in improving digestive health and quality of sleep in an elderly population: A randomized controlled trial. J Bodyw Mov Ther 27:692-697.

52. Martens NL (2022) Yoga Interventions Involving Older Adults: Integrative Review. J Gerontol Nurs 48:43-52.

53. Sagarwala R, Nasrallah HA (2020) The effects of yoga on depression and motor function in patients with Parkinson's disease: A review of controlled studies. Ann Clin Psychiatry 32:209-215.

54. Mailankody P, Varambally S, Thennarasu K, Pal PK (2021) The Rationale of Yoga in Parkinson's Disease: A Critical Review. Neurol India 69:1165-1175.

55. García-Muñoz C, González-García P, Casuso-Holgado MJ, Martínez-Calderón J, Heredia-Rizo AM (2023) Are movement-based mindful exercises (QIGONG, TAI CHI, AND YOGA) beneficial for stroke and Parkinson's disease? A scoping review. Complement Ther Med. 2023 Mar;72:102912.

56. Anasuya B, Deepak KK, Jaryal A (2021) Yoga Practitioners Exhibit Higher Parasympathetic Activity and Baroreflex Sensitivity and Better Adaptability to 40 mm Hg Lower-Body Negative Pressure. Int J Yoga Therap 31: Article 2.

57. Lin JR, Wu PT, Wu WL, Chang YK, Chu IH (2022) The Psychophysiological Profile and Cardiac Autonomic Reactivity in Long-Term Female Yoga Practitioners: A Comparison with Runners and Sedentary Individuals. Int J Environ Res Public Health 19:7671.

58. Datta K, Tripathi M, Verma M, Masiwal D, Mallick HN (2021) Yoga nidra practice shows improvement in sleep in patients with chronic insomnia: A randomized controlled trial. Natl Med J India 34:143-150.

59. Shah K, Adhikari C, Sharma S, Saha S, Saxena D (2022) Yoga, Meditation, Breathing Exercises, and Inflammatory Biomarkers with Possible Implications in COVID-19: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Evid Based Complement Alternat Med 2022:3523432.

60. Yeun YR, Kim SD (2021) Effects of yoga on immune function: A systematic review of randomized controlled trials. Complement Ther Clin Pract 44:101446.