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REVIEW

Yoga as a Therapy for Irritable Bowel Syndrome

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Abstract
The aim of this state-of-the-art narrative review is to evaluate the current evidence about the effectiveness of yoga as therapy for IBS and explore its potential mechanisms of action. The current literature suggests yoga is effective and safe and may target multiple mechanisms involved in treatment of IBS. Evidence from randomized controlled trials identified yoga as more effective compared to pharmacological treatment and equally effective as dietary interventions or moderate-intensity walking. Improvements were seen in both physical health (IBS symptom severity, gastric motility, autonomic and somatic symptom scores, and physical functioning) and mental health outcomes (depression, anxiety, gastrointestinal-specific anxiety, and quality of life). Given favorable changes in IBS-related physical and mental health outcomes, preliminary data supports yoga as beneficial in this population. However, the relatively low-quality evidence resulting from heterogeneity of study designs, interventions, and outcome measures limit our ability to make specific recommendations about the use of yoga as therapy for patients with IBS.

Keywords Irritable bowel syndrome · Quality of life · Physical and mental health · Yoga

Introduction

Irritable bowel syndrome (IBS) is a functional gastrointestinal (GI) disorder affecting 12% of the Canadian population [1]. The underlying causes of IBS are thought to be multifactorial, with both central and peripheral origins. Physical symptoms include abdominal pain, altered bowel habits, bloating, and flatulence [2]. IBS can be further classified into three subtypes based on stool consistency as either diarrhea predominant (IBS-D), constipation predominant (IBS-C), or IBS with alternating stool pattern or mixed (IBS-M). In addition to GI symptoms, patients with IBS frequently report decreased quality of life (QOL) resulting from psychological, most commonly depression and anxiety disorders, and chronic conditions such as chronic fatigue and fibromyalgia [3]. Twenty percent of patients with IBS have one or more diagnosed psychiatric disorder [4], and the prevalence of adverse early life events and suicidal ideation is higher

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among patients with IBS compared to the general population [5, 6]. The symptom burden of IBS results in reduced work productivity and increased absenteeism; work absenteeism is twofold greater among patients living with IBS compared to the general population [7].

Currently, there are few effective treatments for IBS. Clinical treatments focus on symptom relief targeting pathophysiology, such as accelerated transit time, visceral hypersensitivity, and dysbiosis of the gut microbiota. Evidence-based therapies to treat IBS symptoms consist of physical activity interventions, elimination diets, including but not limited to a low-FODMAP (fermentable oligo-, di-, monosaccharides, and polyols) diet [8], increasing dietary fiber [9], prebiotics and probiotics [10], and pharmacological therapies including antispasmodics [9], secretagogues [11], antidepressants [12], antidiarrheals [13], 5-HT_4 agonists [13], and antibiotics [10]. Overall, dietary and physical activity interventions [10, 14–16] and pharmacological therapies [17] have demonstrated the promising results in IBS. The main barriers to using these therapies are accessibility, difficulty in adherence, side effects, and challenges determining which therapy is effective for multi-symptomatic patients [18, 19]. A variety of therapies may be effective for some patients with IBS, but these therapies have been ineffective and have not demonstrated long-term efficacy.

Mind–Body Interventions

Up to 50% of people with IBS seek non-pharmacological treatments to manage their symptoms [20]. Mind–body interventions (MBIs) target psychological factors contributing to IBS symptoms and may be useful adjunctive treatments in IBS. Among MBIs, cognitive behavioral therapy (CBT) and hypnotherapy are the most widely accepted by IBS patients, with CBT tested more rigorously in multiple randomized controlled trials (RCTs) [21]. CBT helps patients make the connection between thoughts, emotions, and physical symptoms and to modify thinking behavioral patterns to enhance psychological and physical health [22]. CBT improves symptoms and psychological distress, leading to an improvement in QOL among patients with IBS [23, 24]. Similarly, gut-directed hypnotherapy research has also reported reductions in IBS symptoms and psychological distress, with improved QOL. Hypnotherapy directs patients to control physiological responses and symptoms not typically under conscious control [25]. Psychological treatments are moderately effective (e.g., demonstrate medium effect sizes) for relieving symptoms of IBS and have small effects on psychological distress and QOL [23, 24]. Treatments such as hypnotherapy or CBT programs have been poorly disseminated and few patients have access to these treatments. This warrants the investigation of alternative MBIs with increased accessibility.

Yoga is a *mind–body-breath* discipline that traditionally includes components of yogic postures or *Asanas*, structured breathing (*Pranayama*), and meditation (*Dyana*). There is evidence that yoga has physical benefits (reduced pain, improved energy levels, muscular strength, and flexibility) and mental health benefits (reduced stress, anxiety, and depression), while also developing body awareness for an overall improved sense of well-being [26–28]. Yoga may have a modulating effect on the nervous system by reducing the over active sympathetic nervous system found among IBS patients and increasing the parasympathetic response through the relaxing and calming effects of structured breathing and complete relaxation [29]. For these reasons, traditional yoga practices may be a beneficial therapy to improve IBS symptom management.

Yoga is increasingly popular in Western cultures. The US National Health Interview Survey from 2002 to 2017 found practicing yoga or similar MBIs such as tai chi or qigong increased from 5.8% in 2002 to 14.5% in 2017; most commonly among individuals with acute and chronic pain, arthritis, and depression [30]. According to a 2008 survey [18], yoga is a preferred therapy among 77% of IBS patients, surpassing hypnotherapy, acupuncture, homeopathy, and the use of suppositories. Here, we present a narrative review of yoga as therapy for IBS together with potential mechanisms of action.

Current Evidence for Yoga as Therapy

The limited studies examining the effectiveness of yoga to treat IBS symptoms suggest yoga is generally safe and beneficial. A meta-analysis of 301 RCTs in both healthy adults and those with a medical condition reported no differences in serious or non-serious adverse events between individuals practicing yoga, individuals who exercised, or those who received usual care [31]. A 2016 systematic review that consisted of six RCTs examining traditional yoga practice as therapy for adult and adolescent patients with IBS concluded that yoga was a safe and feasible treatment option for IBS patients [32].

Detailed methods and findings from four RCTs in adult patients with IBS are presented in Table 1 and discussed here. Taneja et al. [33] compared the effectiveness of an unsupervised yoga intervention including 12 postures and breathing twice a day for 2 months to loperamide 2–6 mg/day for 2 months in 22 males with diarrhea-predominant IBS. After 2 months, both groups showed improvements in the primary outcome of bowel symptoms scores with lower scores indicating less symptom frequency and severity (yoga: 1.55 ± 1.81; loperamide: 2.75 ± 1.48, $p < 0.001$; Talley's Bowel Disease Questionnaire) and secondary outcomes (anxiety $p < 0.05$, gastric motility $p < 0.01$, and physical

Table 1 Characteristics and findings from the selected studies

Study	Intervention	Comparison	Inclusion criteria	Assessments	Results (primary outcomes(s))	Results (secondary outcomes)	Attrition	Compliance	Adverse event outcomes
Taneja et al. [33] (India)	Average age of both groups = 30.9 ± 6.79 Yoga (12 asanas) plus pranayama (right-nostril breathing) twice a day for two months (n = 9)	Conventional group (loperamide 2–6 mg/day for 2 months) (n = 12)	Males only, 20–50, ROME II, IBS-D only	Baseline, 1 and 2 months	The overall autonomic symptom score showed a marginally significant decrease in yogic intervention groups as compared to the conventional group at 2 months Subsequent comparison between groups showed a significantly higher expiratory-to-inspiratory (parasympathetic reactivity) in the yoga group at 2 months	No significant difference between the groups with respect to bowel symptom score (TBDQ), state anxiety (STAI), gastric motility, and physical flexibility Both groups showed improvements in all these outcomes over time No differences emerged for the measures of autonomic reactivity	Yoga: 5% Conventional treatment: 0%	Not reported	Not reported

Table 1 (continued)

Study	Intervention	Comparison	Inclusion criteria	Assessments	Results (primary outcomes(s))	Results (secondary outcomes)	Attrition	Compliance	Adverse event outcomes
Kavuri et al. [34] (USA)	Average age = 45.8 ± 12.7 Remedial Yoga Module (body-breath-mind) supervised session 60 min three times per week for 12 weeks (n = 25)	Average age = 41.2 ± 12.8 Combination group (Yoga intervention and conventional treatment) (n = 26) Average age = 45.8 ± 12.9 Wait-list control group (current care and lifestyle plus advised to walk 60 min three times per week) (n = 27)	Male and female, 18 and above, ROME III criteria, all IBS types	Baseline, 6 and 12 weeks	Significant IBS-SSS and IBS-QOL improvement in yoga and combination groups when compared to the control group at week 6 and week 12 No significant difference between yoga and combination groups. Within group changes of yoga and combination showed significant improvements at week 6 and week 12	Significant improvements in yoga and combination groups in HADS and IBS-GAI compared to control group at weeks 6 and 12 Significant difference in the Autonomic Symptom Score between yoga and control groups, and combination and control groups at week 12 Medicine and supplement use decreased significantly during week 6 for yoga and combination groups compared to the control. In the sympathetic reactivity tasks, there were no changes within the group or between the groups in the diastolic blood pressure, heart rate, and blood pressure	Yoga: 24% Combination group: 21%	Yoga: 90% Combination group: 90%	Three participants (yoga = 2; combination = 1) complained of lower back pain that was aggravated. Pain alleviated within a week and the participants completed the program. No adverse events related to the intervention. Other reported adverse events prompted patients to discontinue the study (flu, cataract surgery, and other diagnoses). Death of a wait-list control group patient due to a cardiac arrest at home was also reported

Table 1 (continued)

Study	Intervention	Comparison	Inclusion criteria	Assessments	Results (primary outcomes(s))	Results (secondary outcomes)	Attrition	Compliance	Adverse event outcomes
Schumann et al. [35] (Germany)	Average age = Not reported Hatha yoga supervised group session 75 min twice weekly for 12 weeks. One weekly class consisted of yoga postures and yogic breathing, the second explored yoga philosophy and meditation, including mantra meditation and Yoga Nidra (deep sleep relaxation techniques). Also given 3.5-hour video for home practice. ($n=24$)	Average age = Not reported Low-FODMAP diet ($n=24$)	Male and female, 18–75, ROME III criteria, all IBS types	Baseline, 12 and 24 weeks	No statistically significant group differences at week 12 or at week 24 for IBS-SSS, but a statistical significance was found in the decrease of symptoms for both groups Significance within group improvements were observed in three of the five IBS-SSS categories in yoga including duration of pain, bowel satisfaction, and interference with life	No statistically significant between-group differences on the SF-36, except that the yoga group showed a statistically significant improvement in the physical component subscale The CPSS and PSQ did not reveal between-group difference, but within-group comparison showed statistically significant improvement for both groups Statistically significant between-group difference on only one IBS-QOL subscale (decreased at week 12 for the FODMAP group due to avoidance of some foods) Significantly lower scores on the HADS for the yoga group for the anxiety subscale after 12 weeks, but no between-group differences for the depression subscale No statistically significant between-group differences at week 12, but a significant difference at week 24 of the Yoga group for BAQ scores	Yoga: 5.81% FODMAP: 13.8%	Yoga group classes: 14.9 ± 7.99/24 classes Yoga home practice: 96.3 ± 38.2 min FODMAP: 2.62 ± 0.68/3 sessions Diet compliance: 70.7 ± 32.0 on the self-reported 100 visual analog scale 67.7 ± 2.3 on the nutritionists-reported 100 visual analog scale	Yoga: The two reported adverse events in the yoga group were not related to the intervention. FODMAP: Three patients reported adverse events. One serious event related to a major depressive episode, with two non-serious events (a mild self-reported depressive episode and unwanted loss of weight)

Table 1 (continued)

Study	Intervention	Comparison	Inclusion criteria	Assessments	Results (primary outcomes(s))	Results (secondary outcomes)	Attrition	Compliance	Adverse event outcomes
Shahabi et al. [37] (USA)	Average age = 34.7 ± 11.6 Iyengar yoga supervised group 60 min of 16 biweekly sessions, plus home practice (n = 17)	Average age = 39 ± 15.0 Walking (moderate intensity, supervised, 60 min of 16 biweekly sessions) (n = 10)	Male and female, 18–65, ROME III criteria, all IBS types	Baseline, 16 session (8 weeks), 6 months	Yoga showed a significant decrease in IBS severity measures, visceral sensitivity, and severity of somatic symptoms. Walking showed significant decreases in overall GI symptoms, negative affect, and state anxiety	Yoga showed significant decreases in IBS severity measures, visceral sensitivity (VSI), and severity of somatic symptoms (PHQ-15) Walking showed significant decreases in overall GI symptoms, negative affects, and state anxiety (STAI)	Yoga: 14.3% Walking: 8.6%	Yoga: 14.2 ± 2.0/16 classes Walking: 13.8 ± 3.1/16 classes	Not reported

IBS-D IBS-diarrhea, *GI* gastrointestinal, *IBS-SSS* IBS severity scoring system, *IBS-QOL* IBS quality of life, SF-36 35-item short form survey, *CPSS* cohen perceived stress scale, *PSQ* perceived stress questionnaire, *HADS* anxiety and depression scale, *BAQ* body awareness questionnaire, *BRS* Body responsiveness scale, *VSI* visceral sensitivity index, *PHQ-15* patient health questionnaire-15, *STAI* state-trait anxiety inventory, *IBS-GAI* IBS global assessment of improvement score, *TBDQ* Talley's bowel disease questionnaire

flexibility $p < 0.01$) with no significant between-group differences (anxiety $p = 0.65$, gastric motility $p = 0.149$, and physical flexibility $p = 0.372$). The autonomic symptom score (e.g., diarrhea, constipation, or abdominal pain, urinary disturbances, headaches) showed a marginal decrease ($p = 0.051$) and a significantly higher parasympathetic reactivity measured by the expiratory-to-inspiratory ratio in the yoga intervention compared to loperamide (yoga: 1.71 ± 0.22; loperamide: 1.44 ± 0.16; $p = 0.05$).

Kavuri et al. [34] investigated the benefits of a 12-week supervised yoga program consisting of posture, relaxation, breathing, and meditation (and participants were asked to reduce their prescription medications and supplements use for IBS, if any, to 3 days week) compared to a combination group (the same yoga program and conventional treatment including continued medication, if any) and an advice only wait-list control group (continuation of medications, if any, and advice to walk 60 min three times per week for 12 weeks). The conventional treatments and medications were not described. Seventy-eight males and females of all IBS subtypes were assessed at six and 12 weeks; however, no differences between IBS subtypes were examined in this study. Significant improvements in the yoga and combination groups compared to the wait-list group were found at six and 12 weeks for multiple outcomes. There was a significant difference between both yoga and control groups (mean difference $= 226.31 \pm 16.$; $p < 0.001$) and combination and control groups (mean difference $= 189.72 \pm 16.63$; $p < 0.001$) in IBS symptom scores (IBS Symptom Score Severity). There was a significant difference between yoga and control groups (mean difference $= 56.53 \pm 5.71$, $p < 0.001$) and between combination and control groups (mean difference $= 44.95 \pm 5.65$) in QOL (IBS-Quality of Life). In addition, anxiety, depression, GI-specific anxiety, autonomic symptom score, hip and trunk flexibility, and handgrip strength all significantly improved in the yoga and combination groups. Prescription and nonprescription medication, as well as herbal and dietary supplement use decreased significantly by week six and at week 12 for the yoga and combination group compared to the wait-list group; most of the participants in these groups either stopped or reduced medication and supplement use. There were no significant differences between yoga and combination groups in any of the examined outcomes.

Schumann et al. [35] examined the effects of a twice weekly supervised Hatha yoga, meditation, and Yoga Nidra program. Hatha yoga includes breath control, physical postures, and meditation, and Yoga Nidra is a whole body deep relaxation technique [36]. This group was compared to a group who received three sessions of nutritional counseling on the low-FODMAP diet. After 2 months, both interventions were equally beneficial at 12 and 24 weeks in reducing IBS symptoms (IBS Severity Scoring System). Compared to the low-FODMAP group, the yoga group experienced a statistically significant improvement in anxiety at 12 weeks and improved body awareness at week 24. Improvements in anxiety within participants in the yoga group continued at week 24. Participants included both males and females of all IBS subtypes, and explorative subgroup analysis revealed similar intervention benefit across all subtypes of IBS. Overall, yoga was found to be as effective in symptom reduction as the low-FODMAP diet and more effective at improving mental health scores and body awareness. In comparison with dietary interventions like the low-FODMAP diet shown to reduce physical symptoms such as pain and gas, yoga may reduce stress, leading to downregulation of sympathetic dominance, resulting in reduced symptoms of anxiety and depression [27].

In a study by Shahabi et al. [37], 16 sessions of supervised Iyengar yoga delivered over 12 weeks were compared to a biweekly supervised outdoor moderate-intensity walking program. Iyengar yoga is a systematized form of Hatha yoga utilizing postures where emphasis is placed on awareness and precision of body alignment during postures, often with the aid of props [37]. Twenty-seven males and females of all IBS subtypes (yoga: 17; walking: 10) completed the study. No differences between IBS subtypes were explored. Both interventions were found to be beneficial. Yoga demonstrated a significant decrease in IBS severity measures, visceral sensitivity index, and severity of somatic symptoms (Patient Health Questionnaire-15). Supervised walking showed significant decreases in overall GI symptoms, negative affect, and anxiety following the three-month intervention. However, after a six-month follow-up of 20 participants using a questionnaire, continued efficacy of walking was found compared to Iyengar yoga. Yoga participants expressed that it was difficult to continue to practice yoga and use props without supervision, and walking was more easily integrated into daily life. Although the practice of yoga appears beneficial for patients with IBS, unsupervised yoga not requiring props may be more feasible. When designing future yoga interventions, offering an acceptable yoga practice to IBS patients and measuring maintenance over time should be considered to examine long-term effects and benefits.

Studies comparing the effects of yoga and moderate-to-vigorous-intensity physical activity (MVPA) exercise in other populations report yoga may be as effective as or more effective than MVPA at improving a variety of health-related outcome measures in both healthy and diseased populations [38]. Comparable benefits between yoga and MVPA were seen with improvement in disease-specific symptoms (e.g., diabetes, multiple sclerosis, kidney disease), cholesterol and blood glucose levels, and indicators of oxidative stress, but yoga was more effective than MVPA in reducing symptoms of fatigue, anxiety and depression, and improving social

functioning, QOL, and sleep [38]. A meta-analysis of 22 RCTs comparing the effects of yoga to physically active and inactive controls among older adults [39] revealed significant effects favoring yoga for physical function outcomes (e.g., balance, lower body flexibility, lower limb strength) and health-related quality of life outcomes (e.g., depression, perceived mental health, sleep quality, and vitality) compared to inactive controls (e.g., wait-list controls, educational booklets) and lower limb strength, lower body flexibility, and depression compared to active controls (walking, aerobics) [39]. It should be noted that meta-analyses have identified a robust effect of exercise on depression, and depression and anxiety benefit estimates for exercise may be underestimated due to publication bias [40, 41].

Yoga appears comparable to, and in some studies more effective than, CBT and mindfulness-based cognitive therapy in reducing stress and improving QOL [42], but other literature suggests CBT is more robust at improving QOL and reducing depression symptoms specifically when compared to selective serotine reuptake inhibitors [43, 44]. Investigations into mindfulness-based stress reduction therapies among healthy adults revealed that yoga accounted for the largest effect on reduced psychological symptoms, stress, and improved well-being when compared to meditation alone [45]. Among individuals with IBS, mindfulness-based therapy inclusive of postures, diaphragmatic breathing, and meditation was more effective in reducing IBS symptom severity and improving QOL compared to CBT [46]. These findings suggest yoga may have beneficial effects in IBS patients, where postures, breathing relaxation techniques, and meditation are integrated into a single therapy.

Overall, yoga is a safe and effective therapy to improve outcomes of people with IBS. Beneficial effects of yoga were seen on both the physical (e.g., symptom severity) and mental health (e.g., anxiety) outcomes among patients with all IBS subtypes. Given the heterogeneity of study designs conducted to date, it is difficult to quantify the level of effectiveness. The heterogeneity of yogic practices adds further complexity to developing clear recommendations at the current time.

Strengths and Limitation of Yoga Literature in IBS

There are several strengths and weaknesses of the reviewed studies. Strengths include the use of homogeneous criteria to confirm diagnosis of IBS, diverse recruitment strategies resulting in the examination of varying degrees of symptom severity, use of active control groups, mostly supervised interventions, and an attempt to monitor compliance and report adverse event outcomes. Diverse recruitment criteria were applied to include both male and female participants in three out of four studies [34, 35, 37], and all IBS subtypes were included based on Rome criteria in all four studies. The four RCTs included a total of 174 adult participants recruited from GI clinics [33–35], psychiatry offices [34], primary care practices [34, 37], online [35, 37], and by local press [35, 37]. The heterogeneity of recruitment sites is important as patients recruited from psychiatry offices may have more severe comorbid psychiatric disease compared to patients recruited from GI clinics and general practitioner offices. However, patients recruited from GI clinics or primary care practices may have greater medical comorbidities that may increase perceived stress. All studies used an active control group, including a rigorous low-FODMAP control group [35]. Finally, the yoga intervention was developed and delivered by an experienced yoga instructor in three studies [34, 35, 37]. Adherence was reported in three studies (62–90%) [34, 35, 37], and two studies reported self-reported adverse event outcomes [34, 35].

Limitations of the published studies include variable sample sizes, intervention heterogeneity, the use of various comparison groups, as well as inconsistencies in reporting acceptability, compliance with therapies, and adverse outcomes (Table 1). All yoga interventions described earlier included both postures and breathing, but interventions varied in practice, delivery, and duration. Practices included traditional Hatha yoga and Yoga Nidra [35], Iyengar yoga [37], a Remedial Yoga Module [34], and twelve selected yoga postures [33]. Except Yoga Nidra, which is a deep relaxation technique, the other yoga practices have commonalities as they involve a set of similar postures but vary in the length of the hold for each posture, as well as the use of props like blocks or yoga straps. The comparison groups varied and included conventional treatment [33], supervised walking at moderate intensity [37], a low-FODMAP diet [35], and a combination group of yoga plus conventional treatment [34]. Three interventions were supervised by a certified yoga instructor and incorporated meditation [34, 35, 37]. The interventions also varied in length from two months [33], 12 weeks [34, 35], and 16 sessions delivered over the course of three months [37], making it challenging to define the ideal intervention length for this population. IBS patients from USA, India, and Germany were included in the reviewed trials. Since risk factors and prevalence of IBS differ across geographical regions [47], the findings from these studies may not be generalizable to other countries, and yoga acceptability and accessibility may have regional differences. Three studies are largely represented by women (84.5–93.3%) limiting the generalizability of findings to male patients with IBS.

Potential Mechanisms of Action

The interplay of the brain–gut axis in the pathophysiology of IBS has been well established [48]. The brain and the enteric nervous system communicate through both the autonomic

Table 2 Potential mechanisms of yoga for IBS

Therapeutic targets for IBS	Description of potential mechanism(s)
Psychological health, self-regulation, and the stress response	Increased parasympathetic nervous system activity, counteracting the stress-induced activity of the sympathetic nervous system and improved regulation of the HPA system [59] Increased gamma amino-butyric acid (GABA) levels in the thalamus correlated with improved mood [60, 61] Reduction in depressive and anxiety symptoms [36, 62, 63] Increased self-awareness and improved behavioral correction processes when regulating emotional responses to stress [64] Increased positive reappraisal reduces the negative impact of prolonged and repeated high stress-related neuroendocrine activity [65–67] Reduction in cortisol levels [68, 69] Structural brain changes in areas enhancing sensory awareness (sensory cortex and insula), attention (anterior and posterior cingulate), memory (hippocampus), and emotion regulation (orbitofrontal cortex) [70–72]
Immune function and inflammatory processes	Regulates autonomic function through increased stimulation of the vagus nerve to reduce pro-inflammatory cytokines (IL-6, IL-2, c-reactive protein); reduction in tumor necrosis factor-alpha (TNF-α) and Interferon-gamma (IFN-g) [73] Adverse early life events alter the gene expression of specific cell signaling proteins to cause colonic motor dysfunction in adulthood [74]. Changes in the global modification of histones (H4ac and H3K4me3) and silencing of several histone deacetylase genes (HDAC 2, 3, and 9) is seen in yoga compared to controls [73] Silencing of pro-inflammatory genes (RIOK2 and COX2), reversal of pro-inflammatory gene expression patterns that are related to cell cycle regulation and DNA damage changed expression, and an increase in antiviral gene expression (IRF-1) [75–77] Increased activity of anti-inflammatory glucocorticoid receptor (GR), which indicates a change in HPA axis in terms of responding better to cortisol and inducing a faster stress response [78]

nervous system and the hypothalamus–pituitary–adrenal (HPA) axis, and through this bidirectional signaling, the brain can affect intestinal epithelial permeability [49–51], motility and fluid secretion [52], immune function [53], and gut microbial composition [54], all of which have been found to be dysregulated in IBS. The HPA axis plays a major role in the biological response to stress, and dysregulation of the HPA axis is often observed in individuals with anxiety and depression [36]. An altered stress response, either psychological or environmental (e.g., life events) or physiological (e.g., infection, inflammation), may be involved in the impairment of this signaling [55], demonstrating a connection between GI function, stress, and psychological processes [56].

Several potential mechanisms for the effectiveness of yoga have been proposed, and we summarize these in Table 2. MBIs targeting anxiety-related affective and behavioral processes using relaxation techniques have been found to reduce stress. This decrease results in reduction in stress-induced modulation of nuclear factor kappa B activation leading to subsequent reduced mRNA expression of pro-inflammatory genes [57]. MBIs have also been shown to

modify genetic expression involved in inflammatory reactions and reduce cortisol levels induced by stress (50). These findings demonstrate MBIs can influence physical health and inflammation through modifying cognitive processes. Overall, MBIs are associated with better psychosocial (e.g., lower anxiety) and physiological adaptations (e.g., lower cortisol, greater Th1 cytokines) [58]. Yoga appears to be an effective therapy providing IBS symptom relief and improving cognitive state through improved regulation of the sympathetic nervous system and the HPA axis.

Recommendations

Despite methodological limitations, the studies reviewed support yoga as a beneficial therapy for IBS patients. The four studies examined included fewer than 180 patients with heterogeneity across studies in terms of design, intervention, and outcome measures. Adequately powered RCTs with carefully chosen control groups are required to increase validity of the findings. Studies should also evaluate potential adverse effects, adherence, direct and indirect costs (e.g., healthcare use, absenteeism) of both intermediate (e.g., 6 months), and long-term follow-up (e.g., 1 year). Since IBS is a chronic and recurrent disorder, longer follow-up times will identify long-term adverse outcomes and longevity of intervention benefits. Further research is needed to determine patient IBS attitudes and preferences toward yoga interventions and delivery strategies (in person vs. online) to more optimally understand how to sequence therapeutic interventions and whether this improves initiation and adherence to the intervention.

The results of our review suggest yoga have a positive effect on the physical and psychological outcomes of people with IBS. The heterogeneity and low quality of the current evidence base make it difficult to provide more specific recommendations for the treatment of IBS at this time, however, and additional work is required to determine whether there is an optimal practice, delivery, or duration of yoga that is likely to yield maximum benefit for people with IBS.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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