

1 **Effect of Yoga in the therapy of Irritable Bowel Syndrome: A Systematic Review**

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10 **Abbreviations:**

11 ANS - autonomic nervous system; BSI-18 - Brief Symptom Inventory 18; CI - confidence
12 interval; CSI - Child Somatization Inventory; ECG - Electrocardiography; EGG - surface
13 electrogastrography; FACIT - Functional Assessment of Chronic Illness Therapy Fatigue
14 Subscale; FDI - Functional Disability Index; GI - gastrointestinal; GIS - Global Improvement
15 Scale; IBS - Irritable bowel syndrome; HADS - Hospital Anxiety and Depression Scale; IBS-
16 D – diarrhea predominant IBS; IBS-GAI - IBS Global Assessment of Improvement; IBS-
17 QOL – Irritable Bowel Syndrome Quality of Life questionnaire; IBS-SSS - IBS Symptom
18 Severity Scale; MBSR - mindfulness-based stress reduction; NRS - Numeric Rating Scale;
19 PANAS-X - The positive and negative affect schedule; PHQ-15 - The patient health
20 questionnaire-15; PNS - parasympathetic nervous system; PSQI - The Pittsburgh Sleep
21 Quality Index; RCT(s) - Randomized controlled trial(s); SF-36 - Health-Related Quality of
22 Life Short Form 36; SMD - Standardized mean differences; STAI - state and trait anxiety
23 inventory; VSI - The visceral sensitivity index; WMF - Weekly Monitoring Form;

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25

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41

42 **Abstract**

43 **Background & Aims:** This review aims to systematically survey the effects of yoga on
44 symptoms of irritable bowel syndrome (IBS), pain, quality of life, mood, stress and safety in
45 IBS patients.

46

47 **Methods:** MEDLINE/Pubmed, Scopus, the Cochrane Library, CAM-QUEST, CAMbase, and
48 IndMED were screened through November 2015. Randomized controlled trials (RCTs)
49 comparing yoga to usual care, non-pharmacological or pharmacological interventions were
50 analyzed for patients with IBS. Primary outcomes included gastrointestinal symptoms, quality

51 of life and pain. Anxiety, mood and safety were defined as secondary outcomes. Risk of bias
52 was assessed according to the Cochrane Collaboration recommendations.

53

54 **Results:** Six RCTs with a total of 273 patients were included in the qualitative analysis. There
55 was evidence for a beneficial effect of a yogic intervention over conventional treatment in
56 IBS, with significantly decreased bowel symptoms, IBS severity and anxiety. Further, there
57 were significant improvements in quality of life, global improvement and physical
58 functioning after yoga compared to no treatment. Two RCTs reported safety data stating that
59 no adverse events occurred. Overall, risk of bias of the included studies was unclear.

60 **Conclusions:** The findings of this systematic review suggest that Yoga might be a feasible
61 and safe adjunctive treatment for people with IBS. Nevertheless no recommendation can be
62 made regarding yoga as a routine intervention for IBS patients due to major flaws in study
63 methods. More research is needed with respect to a high quality study design and consensus
64 in clinical outcome measurements in IBS.

65

66 **Keywords:** Irritable Bowel Syndrome, IBS, Yoga, Review

67

68

69 **Introduction**

70 Irritable bowel syndrome (IBS) is a condition characterized by the following symptoms:
71 abdominal pain, often in combination with constipation or diarrhea, bloating and changes in
72 stool appearance. Aggravation of symptoms is frequently reported after meals, which are not
73 limited to the lower abdominal tract but can also include nausea, belching and pyrosis ^{1, 2}.
74 Although pathophysiological diagnostics are lacking for most cases, patients suffer from
75 abdominal pain and comorbidities that have a strong impact on life quality ^{3, 4}.

76 It is the most common functional gastrointestinal (GI) disorder with worldwide prevalence
77 rates ranging from 9–23%, it accounts for up to 12% of total visits to primary care providers
78 and with up to 70% it is the most common disorder diagnosed by gastroenterologists ^{4,5}.

79 The current diagnosis of IBS is based on Rome-III criteria ^{1, 2}, which states the following
80 criteria, that have to be met: recurrent abdominal pain or discomfort associated with *two or*
81 *more* of the following:

- 82 a) Improvement of discomfort with defecation
- 83 b) Onset associated with a change in frequency of stool
- 84 c) Onset associated with a change in form (appearance) of stool
- 85 d) Change in passage (sensation of incomplete defecation or need of pushing)
- 86 e) Appearance of mucus in stool, often accompanied by bloating

87
88 Symptoms have to be present for the last 3 months on at least 3 days/month with a symptom
89 onset of at least 6 months prior to diagnosis. Furthermore, other diseases that might result in
90 such symptoms must be excluded: Chronic inflammatory diseases, neoplasia or infectious
91 diseases. Such organic diseases are often associated by signs of other diseases than IBS
92 include sudden weight loss, blood in stool and fever.

93
94 Yoga is a part of the ancient Indian philosophy which dates more than 5000 years back ⁶.
95 Yoga has evolved with a focus on physical practice with a strong connection to the traditional
96 indian medicine system, called Ayurveda (“the science of life“) ⁶. Yoga has been adapted as a
97 method in complementary medicine and is practiced especially in terms of prevention and
98 therapy of diseases ⁷. Yoga traditionally consists of body postures (sanskrit: Asanas),
99 breathing exercises (Pranayama) and meditation (Dyana). The goal of practicing yoga asanas

100 focuses on strengthening of muscle tissues and nervous system, while reaching a balance of
101 body and mind ⁸.

102 Different theories have been developed to explain the origin of irritable bowel syndrome such
103 as visceral hypersensitivity and psychosocial factors e.g. disturbed stress regulation ^{3, 9} and
104 autonomic nervous system (ANS) dysfunction appears to be involved in the pathophysiology
105 of IBS ¹⁰. Psychiatric comorbidities are common as well and need particular consideration ¹¹.
106 One explanation, as could be demonstrated by an increasing quantity of preclinical literature,
107 is the finding of bidirectional signaling between the brain and the gut which has led to the
108 suggestion that both play an equivalent role in the pathophysiology of psychiatric disorders or
109 in chronic abdominal pain syndromes, such as IBS ¹²⁻¹⁶. It is hypothesized that Yoga practice
110 corrects underactivity of the parasympathetic nervous system (PNS) induced by stress ¹⁷ and
111 it has been proven to be effective in the reduction of stress and psychological disorders in
112 different patient populations ¹⁸⁻²³. These factors play an important role in the onset and
113 persistence of IBS, suggesting that Yoga may be efficacious in improving IBS symptoms.
114 Therefore, the purpose of this review was to examine the efficacy and safety of Yoga as a
115 treatment for patients with IBS.

116

117 **Methods**

118 PRISMA guidelines for systematic reviews ²⁴ and the recommendations of the Cochrane
119 Collaboration ²⁵ were followed.

120

121 **Eligibility criteria**

122 *Types of studies*

123 Randomized controlled trials (RCTs) and randomized cross-over studies were eligible, only if
124 they were published as full paper.

125 ***Types of participants***

126 Adults and Adolescents with irritable bowel syndrome were eligible if they were diagnosed

127 by

128 1. Rome Criteria ^{1,2}.

129 2. Any other clinician-based diagnosis criterion

130

131 Studies involving participants with comorbid physical or mental disorders were eligible for

132 inclusion.

133

134 **Types of interventions**

135 ***Experimental***

136 Yoga interventions including at least 1 of the following: physical activity, breath control,

137 meditation, and/or lifestyle advice (based on yoga theory and/or traditional yoga practices)

138 were eligible. No restrictions were made regarding yoga tradition, length, frequency or

139 duration of the program. Studies on multimodal interventions, such as mindfulness-based

140 stress reduction and mindfulness-based cognitive therapy (that include yoga amongst others)

141 ²⁶ were excluded. Co-interventions were allowed if all groups received comparable co-

142 interventions.

143

144 ***Control***

145 1. Usual care or standard care.

146 2. Pharmacological interventions.

147 3. Exercise or other active non-pharmacological interventions.

148

149 **Types of outcome measures**

150 To be eligible, RCTs had to assess at least one primary outcome:

151 1. Improvement in the severity of symptoms of IBS, measured by patient-rated scales, such as
152 the Irritable Bowel Syndrome – Severity Scoring System (IBS-SSS) ²⁷, or any other validated
153 scale.

154 2. Pain or disability measured through means such as a Numeric Rating Scale (NRS).

155 3. Improvement in quality of life or well-being measured by any validated scale such as the
156 Health-Related Quality of Life—Short Form-36 (SF-36) ²⁸, the Irritable Bowel Syndrome
157 Quality of Life (IBS-QOL) questionnaire ²⁹ or Functional Disability Index (FDI) ³⁰.

158 Secondary outcomes included:

159 1. Stress, measured by any validated scale such as the Cohen Perceived Stress Scale (CPSS)
160 ³¹.

161 2. Anxiety, Depression or fatigue measured by any validated scale such as hospital anxiety
162 and depression scale (HADS) or Fatigue Impact Scale (FIS) ^{32, 33}.

163 3. Safety of the intervention assessed as number of patients with adverse events or side
164 effects.

165

166 **Search methods**

167 MEDLINE/Pubmed, Scopus, the Cochrane Library, CAM-QUEST, CAMbase, and IndMED
168 were searched from their inception through 2nd November 2015. The literature search was
169 constructed around search terms for “yoga”, “pranayama”, “asana” and search terms for
170 “irritable bowel syndrome”. For PubMed, the following search strategy was used:
171 (“Yoga”Mesh OR “Yoga”Title/Abstract OR “Yogic”Title/Abstract) OR
172 “Pranayam*”Title/Abstract) OR “Asana*”Title/Abstract) AND (“irritable bowel
173 syndrome”Mesh OR “irritable bowel”Title/Abstract OR “IBS”Title/Abstract). The search
174 strategy was adapted for each database as necessary.

175 Additionally, reference lists of identified original articles or reviews and the tables of contents
176 of the International Journal of Yoga Therapy, the Journal of Yoga & Physical Therapy, and
177 the International Scientific Yoga Journal SENSE were searched manually. Abstracts
178 identified during literature search were screened by 2 review authors independently.
179 Potentially eligible articles were read in full by 2 review authors to determine whether they
180 met eligibility criteria. Disagreements were discussed with a third review author until
181 consensus was reached. If necessary, additional information was obtained from the study
182 authors.

183

184 **Data extraction and management**

185 Data on patients (e.g. age, diagnosis), methods (e.g. randomization, allocation concealment),
186 interventions (e.g. yoga type, frequency, and duration), control interventions (e.g. type,
187 frequency, duration), co-interventions, outcomes (e.g. outcome measures, assessment time
188 points) and results were extracted independently by two authors using an a-priori developed
189 data extraction form. Discrepancies were discussed with a third review author until consensus
190 was reached. If necessary, the study authors were contacted for additional information.

191

192 **Risk of bias in individual studies**

193 Two authors independently assessed risk of bias using the risk of bias tool proposed by the
194 Cochrane Collaboration²⁵. This tool assesses risk of bias on the following domains: selection
195 bias, performance bias, attrition bias, reporting bias, detection bias and other bias. Risk of bias
196 was assessed for each criterion as 1) low risk of bias, 2) unclear, 3) high risk of bias.
197 Discrepancies were discussed with a third review author until consensus was reached.

198

199 **Results**

200 ***Literature search***

201 The literature search retrieved 93 records, 1 additional record was retrieved through other
202 sources. 63 non-duplicate records were screened and 57 records were excluded because they
203 did not fulfill RCT design and/or yoga was not an intervention. Six full-text articles (RCTs)
204 with a total of 273 patients were included in qualitative analysis³⁴⁻³⁹.

205

206 ***Study characteristics***

207 Characteristics of the sample, interventions, outcome assessment and results are shown in
208 Table 1.

209

210 ***Setting and participant characteristics***

211 Of the 6 RCTs that were included, 2 originated from India³⁷, 4 from North America (3 from
212 USA^{34, 35, 38} and 1 from Canada³⁶). Patients were recruited from gastroenterology clinics³⁴⁻³⁶,
213 psychiatry offices³⁵ and/or internet announcements, flyers and primary care physicians³⁴,
214^{36, 38}. Patients in 1 RCT were diagnosed with IBS according to Rome-I criteria³⁶, in 1 RCT
215 according to Rome-II criteria³⁹, and patients in 3 RCTs were diagnosed according to Rome-
216 III criteria^{34, 35, 38} while 1 of those RCT further included patients with a diagnosis of having
217 recurrent abdominal pain³⁴. The remaining RCT relied on clinical and laboratory diagnosis
218 only³⁷. Symptoms had to be present for more than 3 months in 1 RCT³⁹ and for more than 6
219 months in the others. Patients in all RCTs were allowed to continue symptomatic medical
220 treatment. Patients' mean age ranged from 14.2 years to 44.1 years with a median age of 32.5
221 years. Between 0.0% and 89.0% (median: 71.4%) of patients in each study were female.

222

223 ***Intervention characteristics***

224 Yoga was based on the yoga module developed by research associates of Vivekananda Yoga
225 Research Foundation in 1 RCT³⁵, on the principles of the Hatha Yoga Pradipika in 1 RCT³⁷
226 and 1 RCT did not follow a certain school, but instead selected the yoga exercises based on a
227 review of different yogic literature³⁹. In 1 RCT Hatha and Iyengar yoga tradition were
228 merged. The remaining 2 RCTs based their yoga intervention on Iyengar yoga^{34, 38}. All yoga
229 programs included yoga postures. Breath control was instructed in 3 RCTs^{35, 36, 39}, and
230 meditation was an additional part of 1 RCT³⁵. Program length and intensity varied (Table 1),
231 and asanas were taught by certified yoga teachers in 4 of the studies^{34-36, 38}, while the other 2
232 gave no further information about the instructors^{37, 39}. Three RCTs compared yoga to no
233 treatment³⁴⁻³⁶. 2 of those further divided the yoga intervention group as followed: Kavuri et
234 al. allowed patients in one part of the yoga intervention group to continue with their
235 medication as needed (combined group) and the other group was advised to restrict
236 medication to at most thrice a week (yoga group). Kuttner et al. divided the yoga intervention
237 group according to age specified as adolescents (14–17 years) and young adults (18–26
238 years). One study compared yoga to pharmacological intervention³⁹. One 3-arm RCT
239 compared yoga to pharmacological care and placebo³⁷ while one RCT examined yoga versus
240 a walking program³⁸. The exercise intervention was matched to the yoga intervention in
241 terms of frequency, length, and duration and was led by physical trainers.

242 Methods for assessing outcome measures symptoms of IBS are shown in Table 1. For
243 gastrointestinal symptoms a checklist by Blanchard and Scharff³⁶, Child Somatization
244 Inventory, Global Improvement Scale and Bowel Symptom Score developed by Talley³⁹,
245 NRS^{34, 38} Scoring system³⁷, IBS-SSS³⁵, and global assessment of improvement (IBS-GAI)³⁵
246 were used. Shahabi et al. further checked physical symptoms through the patient health
247 questionnaire PHQ-15³⁸. Quality of life was assessed in 2 studies using the health related
248 quality of life questionnaire SF-36³⁴ and the IBS-QOL-Questionnaire³⁵. Pain was measured

249 by 3 RCTs using NRS^{34, 36, 38}. Anxiety was assessed in 5 RCTs using the Revised Child
250 Manifest Anxiety Scale³⁶, State and Trait Anxiety Inventory STAI^{38, 39}, or Hospital Anxiety
251 and Depression Scale HADS³⁵. Depression was assessed through Children's Depression
252 Inventory Short Form³⁶, positive and negative affect schedule PANAS-X³⁸ or a subscale of
253 HADS³⁵. Evans et al. measured depression and stress with the BSI-18, and fatigue through
254 FACIT³⁴. While all RCTs reported short-term to medium-term effects (up to 6 months post-
255 intervention), no RCT reported long-term effects.

256

257 *Risk of bias in individual studies*

258 Risk of bias in individual studies is shown in figure 2. Three studies reported adequate
259 random sequence generation³⁴⁻³⁶, none of the studies however reported adequate allocation
260 concealment or blinding of participants and personnel. Blinding of outcome assessment was
261 sufficient in one study³⁵. Four RCTs were free of suspected selective reporting³⁵⁻³⁹, but one
262 RCT was of high risk³⁴. High risk had also to be considered concerning performance bias^{34,}
263³⁸, incomplete outcome data^{34, 38}, and for other bias^{35, 38} for two studies respectively. Three
264 other RCTs however received low risk rating regarding attrition bias^{36, 37, 39}.

265

266 **Outcomes**

267 *Yoga vs. no treatment*

268 Kavuri et al. reported significant improvements in IBS symptom severity and IBS-related
269 quality of life in Yoga and Combination groups when compared to Wait-list Control group.
270 Further, improvement in anxiety and depression scores, IBS Global Assessment of
271 Improvement and autonomic functions were observed which correlated with a reduction in the
272 amount of medicine and supplement use (psyllium, fiber drinks, herbal teas and probiotics) in
273 the Yoga and Combination groups.

274 According to Kuttner et al. adolescents who received the yoga intervention tended to report
275 lower levels of functional disability and anxiety than adolescents in the control group ³⁶.
276 There were no group differences in depression or overall gastrointestinal symptoms. Pain was
277 assessed but post-intervention results were not displayed due to group differences in baseline
278 levels between control and yoga. Evans et al. reported adolescents assigned to yoga to state
279 significantly improved physical functioning relative to controls, whereas young adults
280 assigned to yoga reported significantly improved IBS symptoms, global improvement,
281 disability, psychological distress, sleep quality, and fatigue ³⁴. For young adults, global
282 improvement, worst pain, constipation, and nausea were significantly improved post yoga, but
283 only global improvement, worst pain, and nausea maintained at the 2-month follow-up.
284 According to IMMPACT guidelines, approximately one-third of participants in the yoga
285 group reported clinically significant improvement in IBS symptoms. Evans et al. found no
286 significant group differences in pain on the NRS. They reported that 44% of adolescents
287 experienced a reduction of at least 1 point on the NRS, and 46% of young adults experienced
288 a reduction of at least 1.74 points on the NRS for abdominal pain, which is a minimally
289 clinically significant difference (MCSD), but no group differences were calculated for
290 MCSD. No evidence was found for short-term effects of yoga compared to no treatment on
291 anxiety. Evans et al. also found no significant evidence for short-term effects on fatigue ³⁴.

292

293 *Yoga vs. exercise*

294 Shahabi et al. compared a walking program to a yoga intervention ³⁸. There were no
295 significant group differences between yoga and walking groups. Exploratory analysis of
296 within group treatment effects showed significant differences in abdominal pain, overall GI
297 symptoms, visceral sensitivity and severity of somatic symptoms for yoga. Significant
298 differences in overall GI symptoms, negative affect and state anxiety were observed in the

299 walking group. When comparing yoga to exercise, there was a significant group by time
300 interaction for intermediate-term effects. Specifically, mean of overall GI symptoms for yoga
301 rose from post-treatment to 6-month follow-up, whereas for walking, mean of overall GI
302 symptoms continued to drop from post-treatment to 6 months.

303

304 *Yoga vs. medication*

305 Two RCTs compared Yoga to pharmacological intervention^{37,39}. Overall, Taneja et al. found
306 no significant difference between control group (loperamide 2-6 mg/day) and yoga group with
307 respect to bowel symptom scores, state anxiety scores and gastric motility. Similarly, no
308 group differences emerged for other measures of autonomic reactivity³⁹. In a 3-arm study
309 Madhu et al. also found no difference between groups comparing yoga versus medical
310 treatment including 2-3 tablespoons psyllium husk, 1 tablet propantheline (15 mg) thrice a
311 day and 1 tablet diazepam (5 mg) twice a day. After 3 months of treatment 3 of 5 patients on
312 medical therapy, 3 of 5 on yoga showed >50% improvement in their symptoms³⁷.

313

314 *Yoga vs. placebo*

315 Madhu et al. also compared yoga versus placebo treatment, but found no differences in
316 between groups, as 3 of 5 on yoga and 4 of 5 on placebo showed >50% improvement in their
317 symptoms³⁷.

318

319 **Safety.** Two studies reported adverse events^{34,35}. Evans et al. reported a participant slipping
320 while in headstand and hitting his knee, but the event was self-limited and did not stop the
321 participant from practicing yoga³⁴. Kavuri et al. recorded three patients in the yoga group
322 with temporarily aggravated lower back pain³⁵. A further incident of a cardiac arrest resulted

323 in death of one participant in the control group. Apparently other self-limited adverse events
324 were mentioned, however group allocation was not mentioned for these participants³⁵.

325

326

327 **Discussion**

328 *Summary of evidence and implications for clinical practice*

329 In this systematic review of six randomized trials on yoga for irritable bowel syndrome,
330 evidence for beneficial effects of yoga on gastrointestinal symptoms, quality of life and
331 anxiety was found when compared to no treatment. Individual studies reported considerable
332 effects on IBS related symptoms in favor of yoga compared to control group; and yoga also
333 seems to be equally effective as a walking program in improving patient-reported outcomes.
334 Nevertheless some limitations need to be taken into account. Applicability seems to be an
335 important factor concerning regular home practice. In the case of Iyengar yoga, the help of
336 props is often required and the emphasis lies on correct alignment which usually requires
337 supervision. Further less focus is put on relaxation during classes. In contrast to yoga, mean of
338 overall GI symptoms in the walking group continued to drop from post-treatment to 6 months,
339 which can be related to the fact that the percentage of participants who reported regular home
340 practice at 6 months was significantly greater for those in walking (75%) than in yoga (25%).
341 It should be considered that yoga has occasionally been associated with serious adverse
342 events in case studies⁴⁰. However, no serious adverse events were observed during yoga
343 practice in this review which is in line with previous cross-sectional studies^{20, 41} and
344 systematic reviews of yoga interventions in other patient populations that found no evidence
345 for serious yoga-associated adverse events^{18, 19, 21}. Thus, yoga seems to be a promising and
346 safe treatment for people with IBS supporting recent evidence in multiple studies, suggesting
347 that exercise has a positive effect on IBS associated symptoms^{42, 43}. Nevertheless, no

348 recommendations can be made to practice yoga for the relief of IBS symptoms based on this
349 review due to the wide methodological heterogeneity of the studies and mostly unclear risk of
350 bias of the included studies but its practice needs not to be discouraged in this patient
351 population, especially when they feel that it benefits their health, quality of life or IBS-related
352 comorbidities.

353

354 *Agreements with prior systematic reviews*

355 To best of our knowledge this is the first systematic review specifically investigating yoga
356 practice in IBS. One descriptive review on yoga for IBS was available which concluded that
357 the essential components of a yoga module for IBS should include postures, breathing, and
358 meditation and should be designed to be easily practiced by most patients, with least
359 complications⁴⁴. This review included 2 RCTs that were also included in our review^{36, 39} and
360 a trial which observed that any moderate physical activity three times a week ranging from 20
361 to 60 minutes, improved symptom severity of IBS when compared to non-active controls⁴³. A
362 long term follow-up also showed improvement in disease specific quality of life, fatigue,
363 depression and anxiety⁴². Another systematic review reviewing eight studies on the
364 effectiveness of yoga for the treatment of anxiety and anxiety disorders reported positive
365 results⁴⁵. Nevertheless, due to the many methodological inadequacies, diversity of conditions
366 treated and poor quality of most of the studies, no conclusion could be drawn for yoga to be
367 effective in treating anxiety or anxiety disorders in general⁴⁵. One multimodality approach
368 that also comprises of yoga elements, meditation techniques and breathing exercises is
369 mindfulness-based stress reduction (MBSR). A systematic review investigating whether
370 MBSR is effective in improving physical health outcomes for long-term physical conditions
371 included fifteen studies, finding some preliminary evidence that MBSR might be effective in
372 improving IBS²⁶. Similar, a systematic review on relaxation therapy for IBS patients showed

373 that IBS symptoms decreased significantly, while symptom severity and anxiety decreased
374 due to relaxation therapies without being statistically significant. However, these results need
375 to be interpreted with caution due to the small number of studies examined and associated
376 methodological problems ⁴¹.

377

378 *External and internal validity*

379 Mainly patients from Asia and people of mixed ethnicities from North America were
380 included. Given that there is no convincing evidence of a difference between western and
381 developing countries in the etiology of IBS ⁴⁶, these findings might not be limited to
382 geographical regions. Since female patients represented the majority of participants, the
383 results might not be fully applicable to male patients. It has to be added though, that eastern
384 and western countries show a female predominance or no gender difference in the prevalence
385 of IBS ⁴⁶. Two studies did not or only partially use Rome criteria as a standard for eligibility
386 ^{34,37}. This further limits the applicability of the results.

387 Overall, risk of bias of the included studies was unclear. Only one study reported adequate
388 blinding of outcome assessment ³⁵. High risk was found in one study for performance bias ³⁸
389 and for reporting bias ³⁴, in two studies for attrition bias ^{34,38} and other bias ^{35,38}, respectively.
390 It is noted that the blinding of participants and personnel form an inevitable issue in RCTs
391 investigating yoga interventions. Nevertheless, the observed studies lacked sufficient
392 description of methods such as adequate random sequence generation and allocation
393 concealment. Moreover selective reporting and high drop-out rates represented an issue.

394

395 *Strengths and weaknesses*

396 Strengths of this review include the comprehensive literature search and the assessment of
397 applicability of the results ⁴⁷. The primary limitation of this review is the deficiency of

398 eligible studies, resulting in a relatively limited overall sample size. The applicability of the
399 findings was limited. As only one study reported longer-term effects³⁸, no conclusions can be
400 drawn on the long-term effects. Publication bias could not be assessed due to the low number
401 of included studies. No unpublished studies or studies published in ‘grey literature’ were
402 included since the usefulness of including unpublished trials is still under debate as
403 unpublished studies tend to lack peer-review; also investigators are often unwilling to provide
404 unfavorable results²⁵.

405

406 *Modes of action*

407 Psychological factors seem to play an important role in the etiology of IBS, as a strong
408 association of psychiatric disorders in 94% of IBS patients can be found⁴⁸. Headache,
409 fibromyalgia, fatigue and depression were commonly found in individuals with IBS⁴⁹.
410 Evidence supports the role of stress in IBS patients, particularly in altering brain-gut
411 interactions⁵⁰. It was hypothesized that yoga addresses the brain-gut axis in the management
412 of IBS with fewer side effects than conventional treatment⁴⁴.

413

414 *Implications for further research*

415 Given that the main drawbacks of the included studies concern study methodology and
416 authors of prospect research should not only ensure rigorous methodology but also improve
417 the reporting of yoga trials and follow commonly accepted reporting guidelines (e.g.
418 CONSORT)^{51, 52}. The choice of outcome measures, future studies should be planned
419 according to methodological recommendations for high quality clinical trials for IBS based on
420 consensus. The Adequate Relief question should be a measure of choice when assessing
421 global symptomatology as an outcome in IBS studies⁵³. For a more detailed IBS symptom
422 assessment, the IBS Severity Scoring System is preferable and the IBS Quality of Life

423 measurement scale can be used to establish changes in health-related quality of life ⁵³.
424 Abdominal pain was believed to be the hallmark feature of IBS though newer research
425 suggests that bloating is the predominant complaint of patients ^{54, 55}. Among the pain
426 dimensions, intensity, frequency, constancy and predictability were strongly and
427 independently associated with illness severity while duration, speed of onset and relationship
428 to bowel movements had weaker associations. Thus IBS trials should measure pain
429 dimensions, including intensity, constancy, frequency and predictability to improve upon the
430 customary use of measuring pain as a unidimensional symptom in IBS. Further considerations
431 implied the use of the IBS global assessment of improvement scale (IBS-GAI) and
432 gastrointestinal symptom rating scale ⁵⁴.
433 Further, insufficient power of studies has to be regarded as a limiting factor, comprising of
434 small sample sizes, different patient populations and limited external validity. Most
435 importantly, safety of the intervention was insufficiently reported. Specifically, only two
436 studies explicitly assessed adverse events, although one of them described so-called side
437 effects, i.e. those events with a plausible causality to the intervention, and labelled them
438 adverse events. Future studies should ensure rigorous reporting of adverse events, and the
439 correct use of terminology. Since stress and IBS symptoms seem to be improved by
440 meditation, breathing exercises and yoga ⁵⁶⁻⁵⁸, a holistic approach including breathing
441 practices, relaxation modules and meditation should be considered in designing further studies
442 for patients suffering from an increased gastrointestinal response to stress. At this point, more
443 research is needed to draw definite conclusions. So far, the recent global guidelines of the
444 World Gastroenterology Organization on IBS consider sufficient physical activity and
445 relaxation techniques to be appropriate non-pharmacological approaches ⁵⁹.

446

447

448

449 **Figure Legends**

450 Figure 1: Flowchart of the results obtained from literature search

451 Figure 2: Risk of bias for each criterion for each included study (top) and risk of bias for each
452 criterion presented as percentages across all included studies (bottom)

453

454 **Table Legends**

455 Table 1: Characteristics of the included studies

456

457

458

459 **Literature**

460

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