Effects of yoga on eating disorders—A systematic review

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ABSTRACT

Background: The question of whether yoga practice ameliorates or even aggravates eating disorders is currently under debate. The aim of this review was to systematically assess and the effectiveness and safety of yoga in patients with eating disorders.
Methods: Medline/PubMed, PsycINFO, and the Psychological and Behavioral Science Collection were screened through July 2018 for randomized controlled trials, non-randomized controlled trials and longitudinal observational studies on yoga for patients with eating disorders and other individuals with disordered eating and/or body dissatisfaction. Risk of bias was assessed using the Cochrane risk of bias tool and the Newcastle-Ottawa Quality Assessment Scale.
Results: Eight randomized trials and four uncontrolled trials involving a total of 495 participants were included. Risk of bias was mixed. Comparing yoga to untreated control groups, effect sizes ranged from negligible effects of $d = 0.02$ to very large effects of $d = 2.15$. However, most effects were small to moderately sized and in most cases not significant. No safety-related data were reported.
Conclusions: There is limited evidence on the effectiveness and safety of yoga in patients with eating disorders. Yoga can be preliminarily considered as an additional treatment option in multimodal psychiatric treatment programs.

1. Introduction

According to recent epidemiological studies the prevalence of eating disorders seems to increase in almost all parts of industrial nations. According to large epidemiological studies the life time prevalence i.e. for anorexia nervosa range between 1.2 and 4.3%. In particular the percentage of eating disorders in young female adolescents rises [1] with a high risk of relapse and concurrent psychopathological problems. And although eating disorders are comparably rare amongst the general population, their burden for the public health sector cannot be negotiated. [2] Recent studies clearly demonstrate that the costs of treating patients with eating disorders like anorexia nervosa are quite substantia l3]. According to [3] mean costs for in-patient treatment and related total society costs were each about 50 TSD Canadian $ per admission. Several papers have suggested Mind-Body Approaches to Eating Disorders [4] in in- and outpatient treatment. Such interventions, i.e. interventions that focus on the interactions amongst the brain, the rest of the body, the mind, and behavior, [5] are frequently used as adjunct interventions for a range of psychiatric conditions [6]; and yoga is the most commonly used mind–body intervention. [7] Accordingly, a call has been made to rigorously evaluate the effectiveness of yoga in psychiatry [8–10] and prior research has shown that yoga can be a promising adjunct intervention for a variety of mental disorders such as depression [11–13] and anxiety [14]; while there is little evidence for effects in patients with psychosis. [11,15]

Yoga is rooted in Indian philosophy and has been a part of traditional Indian spiritual, self-care, and medical practice for millennia. [16,17] While the ultimate goal of yoga has originally been described as uniting mind, body, and spirit, it has become a popular means to promote physical and mental well-being, and is now mostly considered as a modality in complementary and integrative medicine [16,17] In this setting, yoga is most often associated with physical postures (asanas), breathing techniques (pranayama), and meditation (dyana) [17]; however yoga traditionally is a complex intervention that also comprises advice for an ethical and healthy lifestyle, such as consciously making healthy and ethical food choices. [16–18] In recent times, different yoga forms have emerged that put varying focus on physical and mental practices. [17]

The question of whether yoga ameliorates or even aggravates eating

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disorders is currently under debate. It has e.g. been shown in epidemiological studies that individuals who regularly practice yoga have a decreased risk for developing eating disorders.[19] The physical practice of yoga could have a therapeutic effect on patients with a distorted body image by addressing their body schema in a relaxing and empowering way. Indeed, yoga practice has been shown to have a positive influence on body image in the general population.[20] On the other hand, experts in the treatment of eating disorders have expressed worries that patients with eating disorders might turn to yoga to burn calories or to suppress hunger and that their illness might go unnoticed. This would be in line with other forms of exercise: compulsive exercise, this is exercising primarily to compensate for food intake, is an important risk factor for but also a symptom of eating disorders.[21] About 40% of adolescents with eating disorders show compulsive exercising.[22] Although seldomly used outside India, certain yoga techniques like voluntarily induced vomiting might mask symptoms of bulimia,[23] As a consequence yoga is sometimes considered to be in danger to rationalize self-harming of patients with eating disorders. On the other hand, epidemiological studies in contrast have shown that regular yoga use is associated with a decreased risk of developing eating disorders[24,25] and that yoga users are more satisfied with their body weight and shape than non-yoga users.[26]

Yoga might influence weight control behaviors and eating disorders by multiple mechanisms aiming at unifying mind, body, and spirit,[16] making use of increased body awareness and body reactivity.[20] In female yoga users, greater body awareness is associated with intuitive eating and a healthier relationship to food.[27] Yoga increased moment-to moment awareness, body satisfaction and self-acceptance in women with disordered eating,[28] which has been associated with fewer symptoms of eating disorders.[27] In particular, female yoga users have also been shown to be less self-objectified, i.e. pay fewer attention at how they may be viewed by others at the expense of their inner feelings.[20] This is of utmost importance, because self-objectivation has been associated with disordered eating.[29]

From a neurophysiological perspective, anorexia nervosa and bulimia nervosa are associated with disturbances in serotonin function which persist after recovery and perhaps even precedes the eating disorder.[30] Yoga has been shown to modulate plasma serotonin levels in healthy young individuals as well as in patients with depression.[31,32] Serotonin dysregulation in eating disorders is thought to induce dysphoric mood; and by reducing dietary intake, plasma tryptophan availability might be reduced, which modulates brain serotonin activity and thus increases mood.[30] Since modulating serotonin activity is also thought to be a key mechanism in yoga's antidepressant and anxiolytic effects,[11,33] this also fosters the hypothesis of positive effects of yoga in eating disorders.

Interoception is a strong factor in yoga, often involving a strong conscious monitoring of subtle bodily cues.[20,34] This is also described in yoga philosophy, where an altered connection to the body is thought to increase acceptance and meaning-making even in suffering.[34] This philosophical approach has also been used as a rationale for integrating yoga in the treatment of eating disorders.[34] Further rationales include the popularity of yoga – the presence of a captive audience to receive an intervention; that yoga is a suitable venue for messages aimed at promoting self-acceptance, body appreciation, connection to one's body, and responsiveness to one's body's needs; and that there is first evidence of effectiveness.[35]

Prior reviews have investigated the effects of yoga on eating disorders[24,36] only one of them was systematic[24]; and this review did not include any studies published after 2010 and did not report effect measures. Therefore, the currently available evidence for yoga as an adjunct treatment for eating disorders remains unclear.

Thus, the aim of this review was to systematically assess the effectiveness and safety of yoga in patients with eating disorders and other individuals with disordered eating and/or body dissatisfaction.

2. Methods

The *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) guidelines[37] and recommendations of the Cochrane Collaboration[38] were used to lend a framework for the reporting structure of this review. A priori registration of this review was not accomplished.

2.1. Eligibility criteria

2.1.1. Types of studies

Randomized controlled trials (RCTs), non-randomized controlled clinical trials (CCTs), and longitudinal observational studies (OS) were eligible. No language restrictions were applied. Studies were eligible only if they were published as full paper.

2.1.2. Types of participants

Studies on adults, children and adolescents with a diagnosed eating disorder, including but not limited to anorexia nervosa, bulimia, binge-eating disorder, were eligible. Studies involving participants with disordered eating and/or body dissatisfaction but without a formal diagnosis of an eating disorder were also eligible for inclusion as were studies involving participants with comorbid physical or mental disorders.

2.1.3. Types of interventions

Studies using yoga interventions including at least 1 of the following: physical activity, breath control, meditation, and/or lifestyle advice (based on yoga theory and/or traditional yoga practices) were eligible. No restrictions were made regarding yoga form, length, frequency or duration of the program. Studies on multimodal interventions were included only if the intervention was clearly based on yoga and yoga-specific techniques were the major part of the interventions. Co-interventions were allowed. Eligible control interventions included no treatment, usual care or active control interventions.

2.1.4. Types of outcome measures

To be eligible, studies had to assess at least 1 primary outcome:

1 Improvement in disorder-specific or general eating-related symptoms as assessed by validated patient-reported or clinician-assessed scales such as Eating Attitude Test (EAT-26), Eating Disorder Inventory (EDI), Eating Disorder Examination (EDE), Weight Concern Scale (WCS), Three Factor Eating Questionnaire (TFEQ), Binge Eating Scale (BES), Eating Disorder Diagnostic Scale (EDDS), or Food Preoccupation Questionnaire (FPQ).
2 Body Mass Index (BMI).
3 Anxiety, Mood or Depression assessed by patient reported validated scales such as the State Trait Anxiety Inventory (STAI), Becks Depression Inventory (BDI) or the Profile of Mood States (POMS)

Safety was assessed as the number of participants with adverse events was defined as secondary outcome.

2.2. Search methods

Medline/PubMed, PsycINFO, and the Psychological and Behavioral Science Collection were searched from their inception through March 31, 2015 and updated in July 2018. The literature search was constructed around search terms for "yoga" and search terms for "eating disorders". For PubMed, the following search strategy was used: *Yoga [All Fields] AND (Eating Disorders[All Fields] OR Anorexia[All Fields] OR Bulimia[All Fields])*. The search strategy was adapted for each database as necessary.

Additionally, reference lists of identified original articles or reviews and the tables of contents of yoga-specialty journals not or only
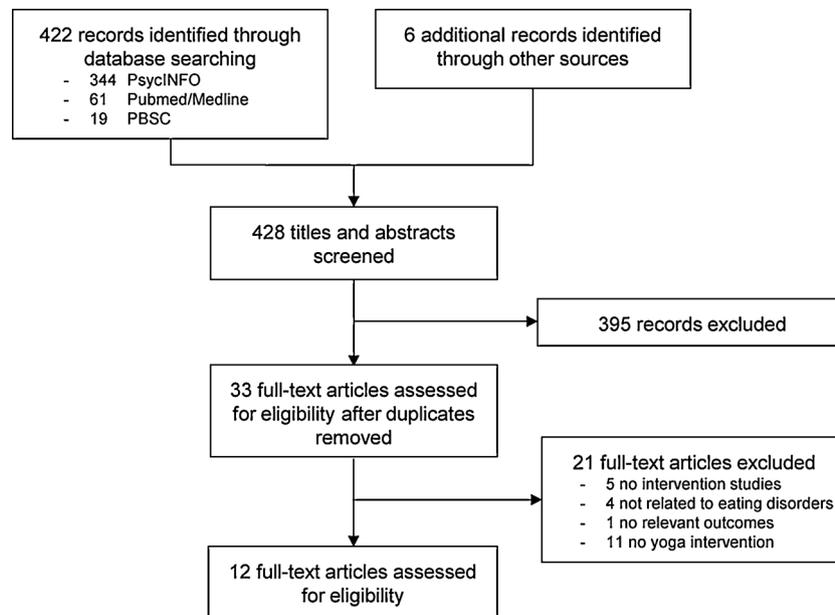
Fig. 1. Flow chart of the results of the literature search.

partially listed in electronic databases, i.e. the *International Journal of Yoga Therapy*, the *Journal of Yoga & Physical Therapy*, and the *International Scientific Yoga Journal SENSE*, were searched manually.

Abstracts identified during literature search were screened by 2 review authors independently. Potentially eligible articles were read in full by 2 review authors to determine whether they met the eligibility criteria. Disagreements were discussed with a third review author until consensus was reached. If necessary, additional information was obtained from the study authors.

2.3. Data extraction and management

Two reviewers independently extracted data on patients (eg, diagnosis, age, sex, and ethnicity), methods (e.g. randomization and allocation concealment), interventions (e.g. yoga type, frequency, and duration), control interventions (e.g. type, frequency, and duration), outcomes (e.g. outcome measures and assessment time points), and results using an a priori developed data extraction form. Discrepancies were discussed with a third reviewer until consensus was reached.

2.4. Assessment of risk of bias

Risk of bias in randomized controlled trials was assessed by 2 authors independently using the Cochrane risk of bias tool [38] by 7 criteria: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. For each criterion, risk of bias was assessed as 1. low, 2. unclear, or 3. high risk of bias.

According to the recommendations of the Cochrane Collaboration, [38] risk of bias in non-randomized studies was assessed by 2 authors independently using the Newcastle-Ottawa Quality Assessment Scale [39] by 4 criteria: selection of participants, comparability of groups, exposure, and outcome assessment. Using this instrument, up to 10 'stars' can be given to each individual study with more stars indicating lower risk of bias.

For all assessments, discrepancies were rechecked with a third reviewer and consensus achieved by discussion.

Assessment of publication bias (risk of bias across studies) was originally planned by means of visual inspection of funnel plots. [38,40] Due to the low number of eligible studies, this analysis had to be

omitted.

2.5. Statistical analysis

For each included study, effect sizes for within-group comparisons were extracted from the published articles. Were no effect sizes were provided, they were calculated using a standardized Excel spreadsheet. According to the recommendations of Cohen (1988), the following formulas for 1. effect size d and 2. standard error SE_d were used in within-group comparisons:

$$d = \frac{\overline{D}}{SD} \tag{1}$$

$$SEd = \sqrt{\frac{d^2}{2(n-1)} + \frac{2(1-r)}{n}} \tag{2}$$

where D denotes the difference between pre and post measure. If no correlation between assessment time points was reported, r was estimated as 0.7. [41,42]

For controlled clinical trials, additional effect sizes were extracted or calculated for between-group comparisons according to the recommendations given by Morris (2008) taking into account group differences in baseline values (Formula 3).

$$d_{ppc} = c_P \left[\frac{(M_{post,T} - M_{pre,T}) - (M_{post,C} - M_{pre,C})}{SD_P} \right] with\ c$$
$$= 1 - \frac{3}{4(n_T + n_C - 2) - 1} \tag{3}$$

SD_p in this formula denotes the pooled standard deviation, M represent the means of the treatment or control group and n denote the respective sample sizes. [43]

Where no standard deviations were available, they were calculated from standard errors, confidence intervals (CIs), F- or t-values, [38] or attempts were made to obtain the missing data from the trial authors by e-mail.

Cohen's categories were used to evaluate the magnitude of the overall effect size as follows: SMD of 0.2 to 0.5, small; SMD of 0.5 to 0.8, medium; and SMD greater than 0.8, large effect sizes. [44]

Table 1
Characteristics of the included randomized trials.

Reference	Study design	Study duration	Sample	Setting and ongoing treatments	Intervention groups — Yoga	Control	Outcome measures	Effect size d (SE)
Carei et al. 2010	RCT	8 weeks + 3 month Follow Up	54 patients with a diagnosis of anorexia nervosa, bulimia nervosa or eating disorder not otherwise specified; age range 11-21 years	Outpatient; standard medical care in both groups	Twice weekly 60-minute group yoga over 8 weeks; standard medical care	Standard medical care (wait-list)	Eating-related symptoms (EDE-Q-G), BMI, Depression (BDI), Anxiety (STAI-S, STAI-T)	0.23 (0.22) 0.02 (0.21) -0.11 (0.21) -0.30 (0.22) -0.25 (0.22)
Ganga & Chandra-sekaran 2015	RCT	6 weeks	30 female adolescent participants with anorexia nervosa	Not reported	Up to 60 minutes daily hatha yoga sadhana over a 6-week period	No intervention	Anxiety Self-concept	1.48 (0.42) 0.81 (0.38)
McIver et al. 2009	RCT	12 weeks + 3 month follow Up	90 patients with a diagnosis of binge eating disorder; BMI > 25; age range 25-63 years	Outpatient; community sample; no ongoing weight-loss programs	Weekly 60-minute group yoga sessions (5 minutes breathing techniques, 45 minutes hatha yoga, 10 minutes yoga nidra) over 12 weeks; 30 minutes daily home practice	No intervention (wait-list)	Eating-related symptoms (BES), Physical activity (IPAQ), BMI, Waist & Hip circumference	-2.15 (0.32) 1.20 (0.25) -0.15 (0.22) -0.18 (0.22) -0.30 (0.22)
Mitchell et all 2007	RCT	6 weeks	113 participants dissatisfied with their body; mean age 19.5	Outpatient; university students; ongoing treatments reported	Weekly 45-minute group yoga sessions over 6 weeks	No intervention	Eating-related symptoms (EDDS, BES, EDI-DT, EDI-BD, TFEQ), Body shape (BSQ-10) Body stereotype (IBSS), Anxiety (STAI-S, STAI-T) Alexithymia (TAS)	-0.27 (0.20) 0.03 (0.20) -0.17 (0.20) 0.07 (0.20) -0.12 (0.20) -0.05 (0.20) -0.14 (0.20) -0.20 (0.20) -0.34 (0.20) 0.08 (0.20)
Pacanowksi et al. 2016	RCT	5-day intervention period	38 participants of a residential eating disorder treatment program	Inpatient; residential eating disorder treatment in both groups	Daily 50-minute yoga classes before dinner (movement and breathing techniques) over a five-day period	No intervention	Eating-related symptoms (EAQ—AP, EAQ—NB, EAQ—SC, EAQ—AN, EDE-Q—R, EDE-Q—S, EDE-Q—W, EDE-Q—E, EDE-Q—G)	0.29 (0.33) 0.29 (0.33) 0.20 (0.33) 0.41 (0.33) 0.20 (0.33) 0.35 (0.33) 0.50 (0.33) 0.29 (0.33) 0.41 (0.33)
Hopkins et al. 2016	RCT	8 weeks	52 females at risk for obesity and related illnesses	Outpatient; community sample; no ongoing mental health treatment	Two 90-minute weekly group sessions a series of 26 Hatha yoga postures, two breathing exercises, and two resting relaxing postures in a room heated to 104 °F	No intervention (wait list)	Cortisol, Eating-related symptoms (EDDS, EEI, DRES) BMI	-0.40 (0.22) -0.75 (0.23) -0.58 (0.23) 0.54 (0.23) -0.42 (0.22)
Medina et al. 2015	RCT	8 weeks	See Hopkins et al. 2016	See Hopkins et al. 2016	See Hopkins et al. 2016	See Hopkins et al. 2016	Drive for thinness (DTS, DTS-Tolerance, DTS-Absorption), Eating-related symptoms (DEES)	0.82 (0.29) 0.89 (0.29) 0.97 (0.29) 0.92 (0.29)
Karlsen et al. 2018	RCT	11 weeks	30 females aged > 18 years with bulimia nervosa or eating disorders not otherwise specified	Outpatient; no ongoing treatments reported	Two 90-minute weekly group sessions of Hatha yoga including breathing exercises, physical exercises, relaxing, meditation and philosophy	No intervention (wait list)	Eating-related symptoms (EDE-Q—R, EDE-Q—S, EDE-Q—W, EDE-Q—E, EDE-Q—G, EDI-2)	0.45 (0.47) 0.79 (0.48) 0.94 (0.49) 0.63 (0.47) 0.76 (0.48) 0.15 (0.46)

Abbreviations: BDI Beck Depression Inventory; BES Binge Eating Scale; BMI Body Mass Index; BSQ Body Shape Questionnaire; CCT controlled clinical trial; DEES Dutch Emotional Eating Scale; DRES - Dutch Restrained Eating Scale; DTS - Distress Tolerance Scale; EAQ Eating Attitude Test; EAT Eating Attitude Questionnaire; EDE Eating disorder Examination; EDEQ Eating Disorder Examination Questionnaire; EDI Eating Disorder Inventory; EEI - Eating Expectancies Inventory; ; IBSS Ideal Body Stereotype Scale; IPAQ International Physical Activity Questionnaire; MSCS RCT randomized controlled trial; STAI State Trait Anxiety Inventory; TAS Toronto Alexithymia Scale; TFEQ Three Factor Eating Questionnaire.

Table 2
Characteristics of the included uncontrolled trials.

Reference	Study design	Study duration	Sample	Setting and ongoing treatments	Intervention groups Yoga	Outcome measures	Effect size pre-post d (SE)
Cook Cottone et al. 2008	OS	6-8 weeks	29 patients with a diagnosis of anorexia nervosa; age range 14-35 years	Outpatient; medical care and nutritional counseling	Weekly 90-120-minute sessions of yoga, journal activity, and relaxation exercises over 6-8 weeks	Eating-related symptoms (EDI-DT, EDI-BD, EDI-BU)	0.76 (0.19) 1.21 (0.24) 0.40 (0.17)
Dale et al. 2009	OS	6 days + 1 month follow up	8 participants with a history of eating disorders; age range 22-36 years	Outpatient; no other ongoing treatments	6-days eating disorders workshop (mental, physical and spiritual elements) developed by Barbara Ruzansky and Ana Forrest	Eating-related symptoms (EDI-DT, EDI-BD), Mood (POMS)	−0.58 (0.40) -0.13 (0.35) 0.54 (0.31)
Hall et al. 2016	OS	12 weeks	20 female participants with diagnosis of anorexia nervosa, bulimia nervosa, avoidant restrictive food intake disorder, or other specified feeding or eating disorder; age range 14-18 years	Outpatient; medical monitoring, nutritional counseling and social work intervention	Weekly 60-90-minute yoga classes (non-heated hatha-based classes) over a 12-week period	Eating-related symptoms (EDE-Q—S, EDE-Q—W, CSAN) Anxiety (STAI) Depression (BDI)	−0.74 (0.20) -0.45 (0.18) 0.65 (0.19) -0.45 (0.18) -0.97 (0.21)
Salem et al. 2011	OS	12 weeks	31 participants with a diagnosis of bulimia nervosa or anorexia nervosa; age range 16-19 years	Outpatient; no other ongoing treatments	Twice weekly 60 minute relaxation and yoga sessions over a 12 week period	Eating-related symptoms (Food Processor Software: calorie intake for Bulimic and Anorectic patients)	−2.5 (0.35) 0.04 (0.22)

Abbreviations: BDI – Beck Depression Inventory; Scale; CSAN - EDE – Eating disorder Examination; EDEQ – Eating Disorder Examination Questionnaire; EDI – Eating Disorder Inventory; OS – observational study; POMS – Profile of Mood States; STAI – State Trait Anxiety Inventory.

3. Results

3.1. Literature search

Thirty-three full-text articles were assessed for eligibility; and twenty-one were excluded because they were no intervention studies, [45–49] were not related to eating disorders, [50–53] did not assess relevant outcomes [54] or did not include a yoga intervention. [55–64] Twelve studies involving a total of 495 participants met the inclusion criteria and were included in the qualitative analysis (Fig. 1). All full-text articles except one French article were published in English.

3.2. Study characteristics

Characteristics of the sample, interventions, and outcome assessment are shown in Table 1 and 2. Eight of the included studies were randomized controlled trials, [65–67] and four were uncontrolled trials. [68,69] Of the twelve studies that were included, eight originated from the USA, [65,67–72] one from Norway, [73] one from India, [74] one from Tunisia, [75] and one from Australia. [66] The studies included a total of 495 participants; sample sizes ranged from 8 to 113 with a median sample size of 31. Participants in eight studies were diagnosed with eating disorders including binge eating disorder, [66] anorexia nervosa, [65,69] bulimia nervosa [65,69], eating disorders not otherwise specified, [65] or any eating disorder. [68] The remaining study involved participants with disordered eating and/or body dissatisfaction but without a formal diagnosis of an eating disorder. [67,72]

Yoga interventions were heterogeneous; three study applied daily yoga sessions [68,71,74] over 1–6 weeks; the remaining studies applied between one and two weekly or yoga session of 45–90 minutes over 6–12 weeks. Three trials supplemented yoga with psychological interventions such as journaling, [69] and relaxation. [69] All studies but one [71] used outpatient programs. Additional ongoing treatments for eating disorders were used in 2 uncontrolled [69,70] and 2 randomized trials. [65,71] In the latter, the control groups received the same additional treatments.

The controlled trials compared yoga to untreated control groups.

3.3. Risk of bias in individual studies

Risk of bias in randomized trials is shown in Table 3. While random sequence generation was adequate in two studies, [65,66] only one study had reported adequate allocation concealment [73]. Only two study had reported adequate blinding of outcome assessment and complete outcome data. [65,73] Reporting bias was low in four studies. Assessment of study quality in the included non-randomized studies is shown in Table 4. The studies reached 2–5 out of 10 possible stars.

3.4. Description of effect sizes

Overall, between-group effect sizes ranged from negligible effects of d = 0.02 to very large effects of d = 2.15 (Table 1–2). However, most effects were small to moderately sized and in most cases not significant.

Regarding eating-related symptoms, effect sizes for the EDE ranged from d = 0.23-0.76; for EDDS from d = 0.27-0.75. The effect sizes in the subscales of EDI were negligible in between-group comparisons, but moderate to large for within-group comparisons. Further instruments were used in single studies only and effect sizes are shown in Table 1–2.

Regarding body mass index, there were almost no between-group differences in patients with anorexia nervosa, bulimia nervosa or eating disorder NOS, [65] but small to moderate decreases in patients with binge eating or risk of obesity. [66,72] One single-group study [76] assessed calorie intake and reported very large effect sizes of d = 2.5 for patients with bulimia nervosa and virtually no change in patients with anorexia nervosa (d = 0.04).

Effects for anxiety ranged from d = 0.20–1.48 and were thus small

Table 3

Risk of bias assessment of the included randomized trials using the Cochrane risk of bias tool.

Bias							
Reference	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Carei et al. 2010	Low	Unclear	Unclear	Low	Low	Low	Unclear
Ganga and Chandrasekaran 2015	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Hopkins et al. 2016/ Medina et al. 2015	Low	Unclear	Unclear	Unclear	Low	High	Unclear
Karlsen et al. 2018	Unclear	Low	High	Low	High	Low	Low
McIver et al. 2009	Low	Unclear	High	High	High	Low	Unclear
Mitchell et all 2007	Unclear	Unclear	Unclear	Unclear	High	Low	Unclear
Pacanowski et al. 2017	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear

Table 4

: Assessment of study quality in the included non-randomized studies using the Newcastle-Ottawa Quality Assessment Scale.

Criterion				
Reference	Selection	Comparability	Exposure/ Outcome	Sum
Cook Cottone et al. 2008	**	/	*	3
Dale et al. 2009	***	/	**	5
Hall et al. 2016	**	/	**	4
Salem et al. 2011	**	/	/	2

to very large, effects for depression were negligible with d = 0.11 for between-group comparisons but large with d = 0.97 for between-group comparisons.

4. Discussion

4.1. Summary of evidence

In this systematic review of eight RCTs and four observational studies involving a total of 495 patients with eating disorders and other individuals with disordered eating and/or body dissatisfaction, evidence for small positive effects of yoga compared to usual care on symptoms of eating disorders were found. Only limited evidence for positive effects of yoga on drive for thinness and body satisfaction was found. Both measures improved across time during yoga practice but no between-group differences were found when comparing yoga to untreated control groups. Single trials found hints on further effects on psychological variables. However no trial assessed the safety of the interventions or potential adverse events. On the other hand, no symptom aggravation has been reported by any of the included trials.

In four trials, additional treatments beyond yoga were used. While in two trials it cannot be ruled out that effects occurred due to other forms of intervention that patients were receiving during the treatment, co-interventions were also offered to the control groups in other trials. Therefore, it is unlikely that results of randomized trials are biased due to additional treatments.

At present, only one systematic review on yoga for patients with eating disorders has been conducted so far. [24] This review included uncontrolled and controlled studies. In line with the present review found some positive evidence for efficacy but concluded that more research was needed before definite conclusions could be drawn. However, prior meta-analyses have reported effects of yoga either as an adjunct or stand-alone treatment for other psychiatric disorders, including depression [11,13,77] and anxiety [77,78]; while the evidence for more severe disorders like schizophrenia remains contradictory. [77,79] In a systematic review on complementary therapies for eating disorders, mixed evidence for positive effects of yoga were found. [80] However,

only two studies on yoga were included in this review. [65,66]

4.2. Strengths and weaknesses

To the best of our knowledge, this is the first systematic review available on yoga for eating disorders. Strengths of this review include its accordance with PRISMA guidelines and the differentiation of within-group and between-group effects, i.e. between unspecific and specific effects of yoga practice.

The primary limitation of this review is the paucity of eligible trials, especially of sufficient RCTs, the small overall sample size, and the heterogeneity of the include trials with respect to patients, outcomes and interventions. While a considerable number of studies and patients could be included in the within-group analyses, only one RCT and one non-randomized trial could be assessed for within-group differences. While both trials had a considerable large sample size of more than 100 participants, the insufficient reporting and/or low methodological quality limits the interpretability of the results. Another major drawback of the included studies is the lack of any safety-related data. It has been argued that patients with eating disorders might turn to yoga to burn calories or to suppress hunger and that the practice might thus even increase symptom burden. Even though there seems to be little evidence for an accumulation of adverse events associated with yoga practice, [81] it has been occasionally associated with serious adverse events in case reports. [82] Epidemiological studies reported a lifetime prevalence of yoga-associated adverse events ranging from 21.3% to 27.4%; with more severe adverse events being far less prevalent. [83–85] Only for patients with bipolar disorder, the risk of adverse events in psychiatric patients has been investigated in more depth and only few reported symptom aggravation due to yoga practice. [85] Whether these findings can also be applied to eating disorders remains to be investigated in future studies.

4.3. Implications for further research

At first, more trials on yoga for eating disorders and especially more large-scale RCTs are warranted to conclusively judge its potential in this patient population. Authors of prospect research should further improve the reporting of yoga trials and adhere to standard reporting guidelines (e.g. CONSORT). [86] Further trials should ensure rigorous methodology including a-priori sample size calculations to prevent negative results due to lack of power. They should further ensure adequate randomization, allocation concealment, intention-to-treat analysis, and blinding of at least outcome assessors. Rigorous inclusion criteria defining eligible eating disorders and the use of widely accepted outcome measures are warranted. A strong focus should be put on the safety of yoga in this patient population which can be regarded to be relatively vulnerable to symptom aggravation due to overly strong physical activity. Therefore, measuring compulsive exercising might be

worthwhile for future studies on yoga for eating disorders.

4.4. Implications for clinical practice

Based on the inconsistent results of this meta-analysis, no strong recommendation can be made for or against yoga for patients with eating disorders. Despite the methodological drawbacks and the heterogeneity of the included trials, yoga can however be preliminarily considered as an additional treatment option in multimodal psychiatric treatment programs. no evidence for a reduction in BMI was found, excessive yoga practice by patients with eating disorders should nevertheless be prevented and safety of the intervention should be closely monitored.

Authors' contributions

TO and HC contributed to study design, data collection, analysis and interpretation of data and writing up the paper. HV contributed to data collection, analysis and interpretation of data and writing up the paper. KB contributed to interpretation of data and writing up the paper. All authors read and approved the final manuscript.

Declaration of Competing Interest

All authors did not get did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors for the submitted work; There were no other relationships or interests that influenced the submitted work.

Acknowledgements

None.

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