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Yoga and eating disorder prevention and treatment: A comprehensive review and meta-analysis

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ABSTRACT

Yoga is frequently used in conjunction with standard treatment approaches for eating disorders. However, yoga's efficacy and effectiveness in preventing and treating eating disorders has remained unclear. The aim of this comprehensive review and meta-analysis is to review the extant literature and assess the effects of yoga in the prevention and intervention of eating disorder symptoms and correlates in both clinical and non-clinical populations. Studies assessing yoga and its effect on eating disorder symptoms and/or body image as related to disordered eating, were eligible for inclusion. The comprehensive review details correlational, non-controlled, non-randomized controlled, and yoga comparison studies. For the meta-analysis, only randomized controlled trials comparing a yoga-based intervention to a non-yoga control group were included. In total, 43 studies are included in this review, with 11 trials involving 754 participants included in the meta-analysis. Results of the comprehensive review and meta-analyses results indicated yoga interventions demonstrated a small, significant effect on global eating disorder psychopathology, a moderate-to-large effect on binge eating and bulimia, and a small effect on body image concerns, as compared to the control conditions. There was no statistically significant effect on dietary restraint in either direction. Additionally, results indicated a small-to-moderate effect on a composite measure of eating disorder-related constructs. These findings suggest that yoga-based interventions may be an effective approach supporting the prevention and treatment of eating disorders.

Clinical implications

- Yoga interventions reduce global eating disorder psychopathology, binge eating and bulimia, and eating disorder-related constructs.
- Yoga interventions have a positive effect on body image concerns.
- Yoga interventions have no significant effect on dietary restraint in either direction.
- Yoga-based interventions may be an effective approach supporting the prevention and treatment of eating disorders.

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Introduction

Anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED), the three primary eating disorders (EDs), are a set of complex disorders affecting how a person relates to food, eating, and the body (American Psychiatric Association, 2013; Cook-Cottone, 2020). In AN, individuals restrict food, have a distorted experience of their body and body image, demonstrate a drive for thinness, and may binge and purge (American Psychiatric Association, 2013). In BN, individuals struggle with emotional and physical dysregulation; body and body image concerns; and engage in a binge-purge cycle (American Psychiatric Association, 2013). In BED, individuals engage in frequent binges, experience emotional and physical dysregulation, and do not compensate with purging (American Psychiatric Association, 2013). For those with EDs, the body and eating become the central point of cognitive and emotional focus (Cook-Cottone, 2020). The body is the perceived source of symptoms (e.g., body dissatisfaction, felt sense of emotions) as well as the place where many of the symptoms take a toll (e.g., bone density issues, malnutrition, electrolyte imbalance, and other consequences of extreme weight loss or gain; American Psychiatric Association, 2013).

Outcomes related to treatment for EDs have shown only moderate effects with cognitive behavioral therapy, bonafide psychotherapy, and family-based interventions showing the most promise (Cook-Cottone, 2020; Grenon et al., 2019; Van den Berg et al., 2019). While comprehensive treatment programs across methodologies address cognitive and emotional symptoms, rarely do these manualized programs integrate somatic or body work. The same could be said for prevention. Ariel-Donges et al. (2019) report that, for many years, the gold standard for addressing body dissatisfaction has been cognitive dissonance and media literacy interventions, both of which are cognitive approaches. Those at risk for and struggling with EDs have little opportunity to learn and practice positive embodiment, such as learning how to be and work with their bodies in healthy ways and experiencing the body as a source for grounding, connection, breathwork, emotional experience, relaxation, and intuition (Cook-Cottone, 2020; Neumark-Sztainer et al., 2020; Perey & Cook-Cottone, 2020; Piran & Neumark-Sztainer, 2020). Perhaps in response to this gap in intervention, many treatment centers regularly include embodied practices, such as yoga, in their therapeutic offerings.

Yoga, a mind-body practice, is frequently used in conjunction with standard treatment approaches for EDs, with many treatment centers incorporating yoga classes into their schedules, and practitioners referring patients to yoga. Yoga is theorized to help support and maintain protective factors associated with wellbeing, and reduce risk for disordered eating through active practice being with and working with physical sensations, emotions, and cognitions

(Cook-Cottone, 2020). However, despite the acceptance and utilization of yoga among practitioners and the growing support for a positive embodiment model for understanding the mechanism of change, yoga's efficacy and effectiveness in preventing and treating EDs is unclear (Cook-Cottone, 2020; Klein & Cook-Cottone, 2013). In order to address this need in a comprehensive manner, this review and meta-analysis was written as one component of a special issue on yoga, embodiment, and eating disorders which includes two articles on the theoretical connection among yoga, embodiment, and disordered eating (see Perey & Cook-Cottone, 2020; Piran & Neumark-Sztainer, 2020), an article detailing a conceptual model describing mechanisms for how yoga practice may support positive embodiment (Cox & Tylka, 2020), an article on social justice and inclusion issues as related to these three constructs (Webb et al., 2020), as well as an article detailing potential future directions in research (Cox, Cook-Cottone et al., 2020). The specific aim of this review and meta-analysis, within the context of the larger special issue, is to assess the effects of yoga on ED symptoms and correlates in both clinical and non-clinical populations via a review and analysis of the extant literature.

Eating disorders, mechanisms of change, and yoga

When EDs are viewed from the perspective of being with and working with the experiences of the body, there is a clear intersection among biopsychosocial mechanisms associated with ED risk, the onset and maintenance of EDs, factors associated with wellbeing and recovery, and the mechanisms and benefits of yoga (Cook-Cottone, 2015, 2020). As the body of work exploring yoga as a prevention and treatment intervention for disordered eating grows, so does the theoretical framework for understanding its effectiveness. Yoga and ED researchers have identified several factors that appear to be related to risk and pathology that are also known to be positively affected by the practice of yoga. These include: stress reactivity (Hopkins et al., 2016), negative affect (e.g., depression and anxiety; Ariel-Donges et al., 2019; Carei et al., 2010; Halliwell et al., 2018; Pacanowski et al., 2020), emotion regulation difficulties (Brennan et al., 2020; Hopkins et al., 2016), self-objectification (Cox et al., 2016; Daubenmier, 2005; Fredrickson & Roberts, 1997; Mahlo & Tiggemann, 2016), negative body image (Ariel-Donges et al., 2019; Halliwell et al., 2019), body dissatisfaction (Halliwell et al., 2018; Pacanowski et al., 2020), body surveillance (Halliwell et al., 2019, 2018), self-criticism (Brennan et al., 2020) and loneliness and isolation (Pacanowski et al., 2020).

Going beyond the amelioration of risk and dysregulation, yogic approaches to disordered eating are also aligned with positive psychological approaches in which flourishing and positive embodiment are emphasized (Cook-Cottone, 2015, 2020). Positive embodiment is defined as a way of being in which awareness and experience is conceptualized as residing in and manifesting

from the body (Cook-Cottone, 2020). In addition to shifting how individuals think about their body, theories of embodiment hold that interventions must also change how individuals inhabit and experience their bodies (Cook-Cottone, 2020; Halliwell et al., 2019, 2018; Menzel & Levine, 2011; Piran, 2016). Existing interventions addressing body image components of disordered eating have incorporated behavioral elements allowing for active practice of new ways of being; however, most are primarily cognitive and based on models of attitude change (Halliwell et al., 2019). Notably, positive embodiment practices such as yoga offer something beyond the reprieve from symptoms (Cook-Cottone, 2020). They offer skills for, and direction toward, a life that an individual wants to be present in, a life in which the body is a resource and connection with the self is the center of an unfolding experience of being each and every day (Cook-Cottone, 2020).

Yoga has been identified as a specific and accessible approach to positive embodiment (Cook-Cottone, 2015, 2020; Halliwell et al., 2019). Further, yoga is readily available and cost effective (Ariel-Donges et al., 2019). Yoga cultivates a direct experience of the body (Karlsen et al., 2018). Yoga incorporates concentration and meditation practices, physical awareness and movement, as well as breath awareness (McIver et al., 2009). Yoga is believed to be a practice in body awareness which involves attentive focus on, and awareness of, internal body sensations, which has been found to be low among persons with EDs (Karlsen et al., 2018). Yoga and ED researchers have identified several constructs that are aligned with a positive embodiment approach to prevention and recovery. These include: mindfulness (Brennan et al., 2020; Douglass, 2009), self-compassion (Brennan et al., 2020), body appreciation (Halliwell et al., 2018), positive body image (Halliwell et al., 2019; Tylka & Wood-Barcalow, 2015), body connectedness (Halliwell et al., 2019), functionality appreciation (Halliwell et al., 2018), positive affect (Pacanowski et al., 2020), and cultivating of a sense of community (Pacanowski et al., 2020).

To date there have been three comprehensive reviews, but no meta-analyses, conducted on the research related to yoga and EDs (Domingues & Carmo, 2019; Klein & Cook-Cottone, 2013; Ostermann, Vogel, Boehm et al., 2019). In 2013, Klein and Cook-Cottone reviewed the extant research which included 14 articles (40% cross sectional studies and 60% longitudinal designs) that explored the effectiveness of yoga interventions for preventing and treating EDs. Overall, findings indicated that yoga practitioners were reported to be at a decreased risk for EDs, and ED risk and symptoms were either reduced or unchanged after yoga interventions.

In 2019, Domingues and Carmo reviewed 12 cross-sectional studies and concluded that the results across studies were inconsistent. Yoga practice was reported to be associated with healthier eating behaviors, lower disordered eating symptoms, higher positive body image, and stronger body satisfaction. They also suggested that a high dosage of yoga may be

associated with a higher prevalence of ED behaviors. The specific studies that reported this were unique and relative outliers in terms of the specific relevance to the larger question of yoga risk and ED recovery. For example, one of the studies combined yoga and Pilates (a physical fitness system that integrates the use of apparatus to complete strength and flexibility exercises) as a single construct, finding increased risk of binge eating and unhealthy and extreme weight control behaviors to occur only in male survey respondents (Neumark-Sztainer et al., 2011). The second study found higher rates of orthorexia (a condition involving obsessive behavior organized around the pursuit of a healthy diet) among instructors of body/mind classes (Herranz Valera et al., 2014). Note, orthorexia is not a clinical ED.

Last, Ostermann, Vogel, Boehm et al. (2019) conducted a systematic review on the effects of yoga on EDs, reviewing eight randomized controlled trials and four non-randomized controlled trials on yoga for patients with EDs and other individuals with disordered eating and/or body dissatisfaction. The authors reported that comparison of yoga to untreated control groups yielded effect sizes that were small to moderately sized and, in most cases, not significant. This report concluded that there was limited evidence on the safety and effectiveness of yoga among patients with EDs. This review included citations through July 2018. A significant limitation of the review was that it analyzed all eating-related symptoms as one construct, rather than by specific symptoms relevant to the prevention and treatment of EDs. Further, the statistical analysis was limited to the calculation of an effect size for each outcome measure within each study. Without statistically combining data across studies, the ability to meaningfully synthesize the data is limited.

To meet the need for an updated review and meta-analysis of RCTs, this study was conducted to integrate recently published studies as well as to systematically analyze constructs relevant and specific to the prevention and treatment of disordered eating. Note, 9 of the 43 articles (21%) included in this review and meta-analysis were published in 2019 and 2020. This report is detailed in two sections. The first section is a comprehensive literature review. The second section includes a series of meta-analyses of the qualifying RCTs comparing yoga to non-yoga (control) groups for ED prevention and intervention. The meta-analyses address four domains of outcomes including: global ED psychopathology; binge eating and bulimia; dietary restraint and eating concerns; and body image concerns. A fifth meta-analysis measures an overall, or summary, effect.

Comprehensive review of the literature (2005 to 2020)

This section reviews correlational, non-controlled, non-randomized controlled, and qualitative studies. Two RCTs were included in the section under non-controlled trials as they explored various conditions under which yoga was provided, rather than comparing a yoga intervention to a non-yoga control group. Papers eligible for this review were found using the search strategy and meeting the eligibility criteria detailed in the methods section below.

Study characteristics

All studies included in the systematic review were published between 2005, when research on eating disorders and yoga began, and 2020. Of the 43 included articles, 10 of them were correlational studies (Bak-Sosnowska & Urban, 2017; Daubenmier, 2005; Delaney & Anthis, 2010; Dittmann & Freedman, 2009; Flaherty, 2014; Mahlo & Tiggemann, 2016; Martin et al., 2013; Neumark-Sztainer, MacLehose, et al., 2018; Prichard & Tiggemann, 2008; Zajac & Schier, 2011), 11 were non-controlled trials (Cook-Cottone et al., 2008, 2010; Dale et al., 2009; Diers et al., 2020; Cox et al., 2016, 2019; Hall et al., 2016; Impett et al., 2006; Kramer & Cuccolo, 2019; Rani & Rao, 2005; Scime et al., 2006), 5 were non-randomized controlled trials (Cook-Cottone et al., 2017; Cox et al., 2017; Gammage et al., 2016; Norman et al., 2014; Scime & Cook-Cottone, 2008), 2 were RCTs comparing yoga conditions without a no-yoga control group (Cox, Ullrich-French, et al., 2020; Frayeh & Lewis, 2018), 6 were qualitative studies (Diers et al., 2020; Dittmann & Freedman, 2009; McIver et al., 2009; Neumark-Sztainer, Watts et al., 2018; Ostermann, Vogel, Starke et al., 2019; Pizzanello, 2016), and 11 were RCTs. Note, the Dittmann and Freedman (2009) article included two studies and was therefore assigned to both the correlational and qualitative categories. The Diers et al. (2020) study utilized a mixed-methods design and was assigned to both the non-controlled trials and qualitative categories.

Correlational studies

The 10 correlational studies varied substantially: 8 compared yoga practitioners to those who engaged in fitness exercise, and/or those who did no yoga or exercise; 1 surveyed yoga practitioners; and 1 compared different types of yoga. See Table 1 for study design, participants, and yoga-related outcomes. Overall, these studies suggest that those who practice yoga have more body awareness (Daubenmier, 2005; Dittmann & Freedman, 2009), body responsiveness (Daubenmier, 2005; Dittmann & Freedman, 2009), and body satisfaction (Daubenmier, 2005; Dittmann & Freedman, 2009; Flaherty, 2014; Neumark-Sztainer, MacLehose et al., 2018); score higher on body image and esteem measures (Bak-Sosnowska & Urban, 2017; Mahlo & Tiggemann, 2016);

Table 1. Characteristics of correlational studies included in the review.

Study	Design Notes	Participants	Yoga-Related Outcome Notes
		Yoga vs. Exercise, No-Yoga, or No-Exercise	
Bak-Sosnowska & Urban, 2017	Surveyed women participating in group yoga classes and other types of group fitness classes, and compared body image between the two groups	Group yoga class participants (n = 56) between the ages of 24 and 60 years (M = 35.10, SD = 7.94) Other group fitness class participants (n = 56) between the ages of 18 and 59 years (M = 32.51, SD = 9.55)	High levels of weekly physical activity were found in both groups. Yoga practitioners had higher body esteem across all subscales (i.e., sexual attractiveness, weight concern, physical condition) and less body dissatisfaction than other group fitness class participants.
Daubenmier, 2005	Surveyed a community sample of women, comparing yoga practitioners, aerobics class participants, and a baseline comparison group that did not participate in either yoga or aerobics classes	Community women (n = 139) between the ages of 18 and 87 years (M = 37.16, SD = 14.29)	Yoga practitioners showed higher body awareness, body responsiveness, and body satisfaction, as well as lower self-objectification than both the aerobics and baseline comparison groups. The yoga group reported lower ED symptomology than the aerobics group and similar levels of ED symptomology as the baseline comparison group. More hours spent doing yoga each week was associated with less self-objectification, and more yoga expertise was associated with greater body satisfaction. Amount of experience was not associated with ED symptomology in the yoga group, however, in the aerobics group, time spent doing aerobics each week was positively associated with ED symptomology. Body responsiveness and body awareness explained group differences in self-objectification, body satisfaction and ED symptomology.
Flaherty, 2014	Surveyed men recruited from yoga studios and fitness centers, and examined body image satisfaction among yoga beginners, experienced yoga practitioners, and non-yoga practicing aerobic and weight training exercisers	Yoga beginners (n = 26, M age = 40.3 yrs, SD = 11.6) Experienced yoga practitioners (n = 22, M age = 46.4 yrs, SD = 11.6) Non-yoga practicing aerobic and weight training exercisers (n = 34, M age = 41.2 yrs, SD = 11.9)	Body image satisfaction was significantly higher among yoga groups than among exercisers. There was no significant difference in body image satisfaction between beginner and experienced yoga practitioners.

(*Continued*)

Table 1. (Continued).

Study	Design Notes	Participants	Yoga-Related Outcome Notes
Mahlo & Tiggemann, 2016	Surveyed female Iyengar yoga practitioners, Bikram yoga practitioners, and university students that did not practice yoga	Iyengar practitioners (n = 124) between the ages of 22 and 75 years (M = 51.16, SD = 12.34) Bikram practitioners (n = 69) between the ages of 18 and 66 years (M = 36.35, SD = 11.53) University students (n = 127) between the ages of 17 and 57 years (M = 21.37, SD = 7.27)	Yoga practitioners scored higher on positive body image and embodiment, and lower on self-objectification, than non-yoga participants. The relationship between yoga participation and positive body image was serially mediated by embodiment and reduced self-objectification. Bikram practitioners endorsed appearance-related reasons for participating in yoga more than Iyengar practitioners. There were no significant differences between Iyengar and Bikram yoga practitioners on body image variables.
Martin et al., 2013	Surveyed female exercisers from fitness centers, yoga centers, and the community	Females (n = 159) between the ages of 18 and 80 years (M = 41.81, SD = 16.43)	Yoga participation was positively associated with mindful eating, trait mindfulness, and body awareness, and negatively associated with disordered eating. The relationship between yoga practice and disordered eating was mediated by body awareness. Cardio-based exercise participation was positively associated with disordered eating and negatively associated with trait mindfulness.
Neumark-Sztainer, MacLehose, et al., 2018	Sampled participants in Project EAT, a 15-year longitudinal study, using two waves (EAT-III and EAT-IV) collected five years apart	General population, young adults (n = 1664, M age = 31.1 yrs, SD = 1.6) 16.2% (n = 268) of the sample reported practicing yoga 30 minutes or more each week	At EAT-IV data collection, yoga practitioners had higher concurrent body satisfaction than those not practicing yoga (after controlling for EAT-III body satisfaction and body mass index). Among yoga practitioners, more time practicing yoga each week was associated with increased body satisfaction. Among those with prior low levels of body satisfaction (i.e., 1st quartile at EAT-III), EAT-IV body satisfaction was higher among yoga practitioners than other young adults.

(*Continued*)

Table 1. (Continued).

Study	Design Notes	Participants	Yoga-Related Outcome Notes
Prichard & Tiggemann, 2008	Surveyed fitness class participants exploring exercise type, reasons for exercise, self-objectification, body esteem, and ED behavior	Female fitness class participants (n = 571) between the ages of 18 and 71 years (M = 35.99, SD = 11.93)	Participation in yoga-based exercise classes was negatively associated with self-objectification and appearance-related reasons for exercise, and positively associated with health and fitness reasons for exercise. No relationship was found between yoga participation and disordered eating. Participation in cardio-based workouts (e.g., on cardiovascular machines) was positively associated with self-objectification, disordered eating, and appearance-related reasons for exercise, and negatively associated with body esteem. Time spent exercising within the fitness center environment was more strongly related to body image and eating disturbance, than time spent exercising outside of that environment. Appearance-related reasons for exercise mediated the relationships between exercise types and self-objectification, disordered eating, and body esteem.
Zajac & Schier, 2011	Surveyed body image dysphoria and motivation to exercise in Polish and Canadian women practicing yoga or aerobics	Canadian aerobics participants (n = 38, M age = 26.82 yrs, SD = 12.86) Canadian yoga practitioners (n = 30, M age = 24.37 yrs, SD = 10.26) Polish aerobics participants (n = 40, M age = 25.55 yrs, SD = 5.32) Polish yoga practitioners (n = 30, M age = 35.73 yrs, SD = 9.79)	Polish yoga practitioners scored significantly lower than the three other groups on measures of negative body related emotions, suggesting some interplay between specific cultural and motivational factors. Yoga practitioners (of both nationalities) scored significantly higher on positive health and stress management reasons for exercise, and significantly lower on weight management reasons for exercise, than aerobics participants.

(*Continued*)

Table 1. (Continued).

Study	Design Notes	Participants	Yoga-Related Outcome Notes
		Yoga Practitioners	
Delaney & Anthis, 2010	Surveyed women who practice yoga, exploring the relationship between type of yoga and different aspects of body image. Classes were considered high, medium, or low mind-body, determined by how well they emphasized the "mind" aspects of yoga (e.g., meditation, breathing, mindfulness, and chanting) as much as the "body" aspects of yoga (e.g., postures and fitness)	Adult female yoga practitioners (n = 92) between the ages of 23 and 81 years (M = 45.31, SD = 11.95)	Participants that primarily attended high or medium mind-body yoga classes showed greater internalization of yoga principles than low mind-body yoga class participants. Medium mind-body yoga participants had significantly greater body awareness and body satisfaction than low mind-body yoga participants; high mind-body participants scored similarly to the medium mind-body participants, however, the scores between the high and low mind-body groups were not significantly different. Greater internalization of yoga principles was associated with higher body satisfaction, as well as a greater belief that the participant's weight and appearance is within her control. More yoga experience was associated with lower body surveillance. Longer duration of yoga class attendance and greater self-rated yoga expertise were both associated with higher body awareness. Greater self-rated yoga expertise was also associated with fewer body shape concerns. None of the yoga measures were associated with ED attitudes and behaviors.
Dittmann & Freedman, 2009	Surveyed women who practice yoga, exploring relationships among body satisfaction, body awareness, body responsiveness, intuitive eating, spirituality, and reasons for practicing yoga	Adult female yoga practitioners (n = 157) between the ages of 22 and 72 years (M = 47.4, SD = 11.19)	Yoga participants scored high on measures of body awareness, body responsiveness, intuitive eating, body satisfaction, and spiritual readiness. Higher body responsiveness was associated with higher body awareness and intuitive eating, and higher spiritual readiness was correlated with higher scores on body awareness, body responsiveness, and body satisfaction. When exploring reasons for practice (psychospiritual vs. physical), participants did not vary in regard to body awareness, body responsiveness, or body satisfaction. Psychospiritual reasons for practicing yoga was associated with increased home practice of yoga.

and show more embodiment (Mahlo & Tiggemann, 2016) and intuitive eating (Dittmann & Freedman, 2009). Further, they have less self-objectification (Daubenmier, 2005; Mahlo & Tiggemann, 2016; Prichard & Tiggemann, 2008), lower negative body-related emotions (Zajac & Schier, 2011), less exercising for weight management and appearance reasons (Prichard & Tiggemann, 2008; Zajac & Schier, 2011), and fewer ED symptoms (Daubenmier, 2005; Martin et al., 2013). Notably, internalization of yoga principles, regular yoga practice, positive body image, cultural nuances, and reasons for exercise may all play a role in these relationships, mediating or moderating yoga effects (e.g., Zajac & Schier, 2011). These studies are the building blocks for more causal research, demonstrating associations and relationships among variables. Risk of bias across all studies reported is high as samples were secured via non-probabilistic sampling, leaving risk for sampling bias high (Elfil et al., 2017). Additionally, there are no comparative control groups. Further, with the exception of Neumark-Sztainer, MacLehose et al. (2018), directionality remains unclear.

Non-controlled and non-randomized studies

In total there were 10 non-controlled trials and 5 non-randomized controlled trials. Twelve of the studies were preventative in nature and three studies explored the role of yoga in the treatment of EDs (see Table 2).

Prevention research

Overall, yoga for youth and adults may have a protective effect in terms of increasing protective factors, as well as decreasing ED risk factors, correlates, and symptoms. Five of these studies were part of a 10-year initiative assessing *Girls Growing Wellness and Balance: Yoga and Life Skills to Empower*, a yoga-based ED prevention program integrating psychoeducational, emotional regulation, and dissonance content for 5th grade, middle school girls (Cook-Cottone et al., 2013). These studies found reductions in drive for thinness (Cook-Cottone et al., 2010, 2017; Norman et al., 2014; Scime et al., 2006), body dissatisfaction (Cook-Cottone et al., 2010, 2017; Norman et al., 2014; Scime & Cook-Cottone, 2008; Scime et al., 2006), and bulimia symptoms (Cook-Cottone et al., 2010); and increased social self-concept (Cook-Cottone et al., 2010; Scime & Cook-Cottone, 2008) and self-care (Cook-Cottone et al., 2017). Note, because this series of studies combined yoga with psychoeducational content, it is difficult to ascertain if the yoga, the psychoeducational content, or the combination was what caused the positive effects (e.g., Cook-Cottone et al., 2013).

Several of the prevention studies investigated yoga classes (Cox et al., 2016; Gammage et al., 2016), yoga courses (Cox et al., 2016; Kramer & Cuccolo, 2019), yoga immersions (Impett et al., 2006), yoga trainings (Rani & Rao, 2005), or yoga physical education curriculum (Cox et al., 2017).

Table 2. Characteristics of non-controlled trials; non-randomized, controlled trials; and RCTs comparing yoga conditions included in the review.

Study	Design Notes	Participants	Yoga-Related Outcome Notes
		Prevention Trials	
Cook-Cottone et al., 2010	Non-controlled trial of a 10-week yoga-based eating disorder prevention program, Girls Growing in Wellness and Balance, using a matched sample of participants identifying as either white or non-white minority, analyzed using repeated measures MANOVA	5th grade white (n = 25) and non-white minority (n = 25) female Girls Group participants (M age = 10.2 yrs, SD = 0.53)	Both white and non-white minority Girls Group members showed significant decreases in drive for thinness, body dissatisfaction, and bulimia symptoms, and increases in competence, physical self-concept, social self-concept from pre-test to post-test. These improvements were similar for white and non-white minority girls. There was no change in perceived stress for either group.
Cook-Cottone et al., 2017	Non-randomized, controlled trial of a 14-week version of the yoga-based eating disorder prevention program, Girls Growing in Wellness and Balance, that examined its effect on ED risk factors and self-care, analyzed using repeated measures ANOVAs	5th grade females in Girls Group (n = 92, M age = 10.13 yrs, SD = 0.5) and waitlist control group (n = 40, M age = 10.8 yrs, SD = 0.27)	Girls Group participants showed significantly larger decreases in drive for thinness and body dissatisfaction and increases in self-care from pre-test to post-test, as compared to controls. There was no significant difference between Girls Group and control group on change in bulimia symptoms from pre-test to post-test. Participants' bulimia symptoms at pre-test were low.
Cox et al., 2016	Non-controlled, prospective study that assessed the degree to which participants' state mindfulness during yoga explained changes in self-objectification and related outcomes across an 8-week period, analyzed using repeated measures MANOVAs and regression analyses	University students enrolled in yoga classes for academic physical activity credit (n = 148, 80% female, 88% between the ages of 18 and 23 years)	Participants reported significant decreases in self-objectification and increases in physical self-concept, health/fitness reasons for exercise, and state mindfulness from pre-test to post-test. There was no change in body shame, mood/enjoyment reasons for exercise, or appearance reasons for exercise. Mindfulness during exercise was linked to increases in health/fitness and mood/enjoyment reasons to exercise and decreases in self-objectification over time.
Cox et al., 2017	Non-randomized, controlled trial examining the effects of a 12-week yoga-based physical education curriculum to promote positive body image, analyzed using repeated measures MANCOVA and multi-level modeling	High school students in a yoga-based PE class (n = 20, 90% female, M age = 16.45 yrs) and a traditional PE class (n = 23, 57% female, M age = 14.52 yrs)	There was a significant and moderate decrease in trait body surveillance and minimal, insignificant increase in physical self-worth for the yoga class but not the traditional PE class. There was no effect on body appreciation. For students in both yoga-based and traditional PE classes, more mindfulness of the body was associated with less body surveillance.

(*Continued*)

Table 2. (Continued).

Study	Design Notes	Participants	Yoga-Related Outcome Notes
Cox et al., 2019	Non-controlled, prospective study of college women taking a yoga course, analyzed using latent variable structural equation modeling and latent growth curve analyses	College women taking a yoga course (n = 323, M age = 20.31 yrs, SD = 2.12)	A change in self-compassion over time predicted positive changes in body surveillance and body appreciation. Change in body appreciation predicted intrinsic motivation for physical exercise.
Gammage et al., 2016	Prettest-posttest repeated measures design that compared a Hatha-style yoga class with a resistance exercise class in a counterbalanced order, analyzed using MANOVA	University women who exercised 2 times per week or less (n = 46, M age = 18.98 yrs, SD = 1.48)	Body satisfaction was significantly increased after the yoga class. After both classes there was a significant decrease in social physique anxiety, with the magnitude larger after the yoga class compared to the resistance class.
Impett et al., 2006	Non-controlled study of a 2-month Anusara yoga immersion program that examined the associations between yoga and well-being, embodiment, and self-objectification, analyzed using paired-sample t-tests and hierarchical linear modeling	Female (n = 17) and male (n = 2) yoga immersion participants between the ages of 23 and 57 years (M = 34.4, SD = 8.6)	Women in the study reported significantly less self-objectification post-test. No significant changes were found in participants' positive affect, negative affect, satisfaction with life, self-acceptance, body awareness, or body responsiveness from pre-immersion to post-immersion. However, practicing more yoga (than one's average) during a given week was associated with increased body awareness, positive affect, and life satisfaction, and decreased negative affect that week.
Kramer & Cuccolo, 2019	Non-controlled study of college students taking an 8-week yoga course, assessing changes in ED symptomology, body image, and related factors over time, analyzed using repeated measures ANOVAs	College students (n = 99; 77.8% female; female M age = 20.0 yrs, SD = 1.46; male M age = 20.78 yrs, SD = 1.67)	Following the course, students reported significantly lower body dissatisfaction and ED pathology, and increased body appreciation, self-compassion, and yoga self-efficacy. No changes in mindfulness were found. Men showed greater reductions in concern with being overweight and greater improvements in body image perception than women.
Norman et al., 2014	Non-randomized, controlled study that explored the role of interpersonal style on the outcomes of a 12-week version of the yoga-based eating disorder prevention program, Girls Growing in Wellness and Balance, analyzed using MANOVA and ANOVAs	5th grade females in Girls Group (n = 82) or waitlist control (n = 37), between the ages of 9 and 12 years (M = 10.6)	Drive for thinness and body dissatisfaction were significantly reduced in the yoga intervention group, compared to controls. No significant differences were found for bulimia symptoms. Symptoms of bulimia were related to a lower personal affiliation among those in the yoga intervention group.
Rani & Rao, 2005	Non-controlled trial investigating the impact of a 2-week yoga training course on body image and mood, analyzed using t-tests	Male (n = 23) and female (n = 17) young adults between the ages of 20 and 29 years	No significant improvement in body image was found. Depression scores were significantly reduced from pre-test to post-test, and body image was negatively correlated with depression.

(*Continued*)

Table 2. (Continued).

Study	Design Notes	Participants	Yoga-Related Outcome Notes
Scime & Cook-Cottone, 2008	Non-randomized, controlled study of a 10-week yoga-based eating disorder prevention program, Girls Growing in Wellness and Balance, analyzed using repeated measures MANOVAs and ANOVAs	5th grade females in Girls Group yoga group ($n = 75$) or waitlist control ($n = 69$)	Significant decreases in body dissatisfaction and bulimia attitudes/behaviors and increases in social self-concept were found for the yoga group. No effects were found in drive for thinness, current methods of ED behaviors, future intention to engage in ED behavior, competence, physical self-concept, or perceived stress.
Scime et al., 2006	Non-controlled, pilot study of a 10-week yoga-based eating disorder prevention program, Girls Growing in Wellness and Balance, analyzed using paired samples t-tests	5th grade females ($n = 45$) between the ages of 9 and 11 years	Significant decreases in drive for thinness, body dissatisfaction, and media influence were found from pre-test to post-test.
		Treatment Trials	
Cook-Cottone et al., 2008	Non-controlled trial of a manualized, yoga-based group treatment program for females with EDs, analyzed using paired samples t-tests	Adolescent and adult females ($n = 29$) between the ages of 14 and 35 years ($M = 20$), diagnosed with AN or BN	Significant decreases in drive for thinness and body dissatisfaction were found from pre-test to post-test. There was no difference in bulimia symptoms.
Dale et al., 2009	Non-controlled pilot study of a 6-day yoga workshop for women with a history of EDs, analyzed using repeated measures ANOVAs and paired samples t-tests	Adult females ($n = 5$) between the ages of 22 and 36 years ($M = 30$)	Significant decreases in interoceptive deficits, emotion dysregulation, and affective problems were found from baseline to post-test, and maintained at one-month follow-up. There was no significant change in drive for thinness, bulimia, body dissatisfaction, self-esteem, personal alienation, interpersonal insecurity, interpersonal alienation, perfectionism, asceticism, maturity fear, eating disorder risk, ineffectiveness, interpersonal problems, over control, and general psychological adjustment.

(*Continued*)

Table 2. (Continued).

Study	Design Notes	Participants	Yoga-Related Outcome Notes
Diers et al., 2020	Non-controlled pilot study of a novel 8-week, group-based, therapeutic yoga and body image program for individuals in outpatient treatment for an ED, analyzed using paired samples t-tests	Adults (n = 67) between the ages of 18 and 66 years (M = 38.1, SD = 11.1) receiving outpatient treatment for an ED	Significant improvement in body image concerns were found from pre-test to post-test. For example, decreases were reported in: avoidance of social situations and romantic relationships, dating, or physical intimacy because of feelings about one's body; mood and self-esteem being connected to one's body; percentage of the day spent thinking about one's body; and shame or embarrassment about one's body. Increases were reported in: ability to think about or experience one's body without getting emotionally reactive; feeling confident about one's body shape and appearance; feeling [physically] connected to one's body; and being kind to one's body by one's thoughts and behaviors.
Hall et al., 2016	Non-controlled study of a yoga pilot program for individuals in outpatient treatment for an ED, analyzed using generalized estimating equations	Females (n = 20) between the ages of 11 and 18 years (M = 15.9, SD = 1.8) in outpatient treatment for AN, BN, ARFID, or OSFED	Significant decreases in depression, measured clinical states of anorexia nervosa, state anxiety, weight concern, and shape concern were found over time. There was no change in restraint or eating concerns.
		RCTs Comparing Yoga Conditions	
Cox, Ullrich-French, et al., 2020	RCT examining the effect of teaching a single, 45-minute yoga class, comparing three different conditions of yoga instruction delivery: mindfulness-based, appearance-based, and neutral, analyzed using ANOVAs	Females (n = 62) between the ages of 18 and 54 years (M = 23.89, SD = 6.86)	The mindfulness condition showed a greater increase in affect from before to after the yoga class, compared to the appearance condition. The appearance condition reported lower remembered and forecasted pleasure compared to the mindfulness and neutral conditions. Body surveillance was lower in the mindfulness and neutral conditions compared to the appearance condition. There were no significant differences in state mindfulness of the body and state body appreciation across conditions.
Frayeh & Lewis, 2018	RCT examining body image and appearance comparisons, comparing the effect of a single, 60-minute yoga class, delivered in a mirrored vs. non-mirrored room, analyzed using independent samples t-tests, repeated measures MANCOVA and ANCOVAs, and regression analyses	Female university students (n = 97) between the ages of 18 and 25 years (M = 20.71)	State body satisfaction and state social physique anxiety improved from pre-test to post-test for both conditions. The non-mirrored condition reported significantly fewer appearance comparisons during yoga, and experienced a larger decrease in state social physique anxiety, than the mirrored condition. Within the mirrored condition, those who engaged in more appearance comparisons reported higher state social physique anxiety than those who engaged in fewer comparisons. No between-group differences were found on state body satisfaction and self-objectification.

These studies found yoga to be associated with decreased: body surveillance (Cox et al., 2017, 2019), body dissatisfaction (Kramer & Cuccolo, 2019), depression (Rani & Rao, 2005), negative affect (Impett et al., 2006), self-objectification (Cox et al., 2016; Impett et al., 2006), social physique anxiety (Gammage et al., 2016), and ED pathology (Kramer & Cuccolo, 2019). Among these studies, yoga was reported to increase: mindfulness (Cox et al., 2016), body awareness (Impett et al., 2006), body appreciation (Cox et al., 2019; Kramer & Cuccolo, 2019), body satisfaction (Gammage et al., 2016), positive body image (Cox et al., 2017; Gammage et al., 2016), exercising for health and fitness reasons (Cox et al., 2016), physical self-concept (Cox et al., 2016), life satisfaction (Impett et al., 2006), self-compassion (Cox et al., 2019; Kramer & Cuccolo, 2019), and yoga self-efficacy (Kramer & Cuccolo, 2019).

Among the non-controlled and non-randomized controlled studies, risk of bias is higher in those studies with smaller sample sizes (e.g., Cox et al., 2017; Gammage et al., 2016; Impett et al., 2006; Rani & Rao, 2005) and those without controls (Cook-Cottone et al., 2010; Cox et al., 2016, 2019; Kramer & Cuccolo, 2019; Scime et al., 2006). Further, although causality can be inferred in some cases, risk for bias remains a concern for non-controlled and non-randomized, controlled studies. Without randomized group allocation to a yoga or no-yoga condition, participants either self-select into a group or are placed into a group based on convenience or scheduling demands clouding efficacy inferences.

Treatment research

There are three non-controlled trials exploring the effect of yoga in adjunct to treatment (Cook-Cottone et al., 2008; Hall et al., 2016) or among those with a history of disordered eating (Dale et al., 2009). Outcomes suggest improvement in some ED symptoms and correlates in some cases and no effect in others. Overall, these studies found yoga to be associated with decreases in drive for thinness (Cook-Cottone et al., 2008), body dissatisfaction (Cook-Cottone et al., 2008), weight concern (Dale et al., 2009), shape concern (Dale et al., 2009), AN symptoms (Hall et al., 2016), interoceptive deficits (Dale et al., 2009), emotion dysregulation (Dale et al., 2009), affective problems (Dale et al., 2009), depression (Hall et al., 2016), and anxiety (Hall et al., 2016). No differences were found in these studies for bulimia symptoms (Cook-Cottone et al., 2008; Dale et al., 2009). Dale et al. (2009) found no difference in multiple outcomes, including body dissatisfaction, drive for thinness, self-esteem, perfectionism, eating disorder risk, and general psychological adjustment. Hall et al. (2016) found no change in restraint and eating concern. For all three studies, the risk of bias is high given the small sample sizes and absence of control groups. Further, Cook-Cottone et al. (2008) combined yoga and psychotherapeutic group content, making the contribution of yoga to outcomes unclear.

RCTs comparing yoga conditions

There are two RCTs that could not be included in the meta-analyses as they compared different yoga conditions and did not include a no-yoga group (see Table 2). However, these researchers are the first to take the needed, important next steps of asking questions about the best way to teach a yoga class in order to ameliorate risk for triggering or maintaining ED thoughts and behaviors (see Cook-Cottone & Douglass, 2017 for guidelines). In 2018, Frayeh and Lewis found that individuals in a mirrored yoga condition reported a significantly higher level of state social physique anxiety and more appearance comparisons when compared to the non-mirrored yoga condition. Further, the higher the state social comparisons a person reported, the higher their physique anxiety. In 2020, Cox et al. found significantly higher body surveillance and lower forecasted pleasure in the appearance-based yoga class when compared to mindfulness-based and neutral yoga instruction classes. These well-designed studies suggested that how yoga is delivered has implications for the role yoga can play in ED prevention.

Qualitative studies

Qualitative findings were generally positive across a breadth of important constructs, with two cautions related to body image and yoga being used in service of EDs. The six qualitative studies identified for this review explored the experiences of women engaged in a yoga treatment program for binge eating via data from personal journals (N = 20; McIver et al., 2009), the insights of women recovered from AN who used yoga as part of the recovery process using interviews (N = 16; Pizzanello, 2016), the impact of yoga on young adults' body image using interviews (N = 34; Neumark-Sztainer, Watts et al., 2018), answers to open-ended questions following a pilot yoga and body image intervention (N = 67; Diers et al., 2020), experience of female yoga practitioners via interviews (N = 18; Dittmann & Freedman, 2009), and the experience of a patient with AN using an interview (N = 1; Ostermann, Vogel, Starke et al., 2019). Qualitative study participants reported that their yoga practice was related to reduced ED pathology and behaviors, such as reduced quantity of food eaten as related to binge eating and decreased eating speed (McIver et al., 2009). Further, participants reported a more positive connection with food (McIver et al., 2009). Positive effects on body image were fostered through developing gratitude for one's body (Neumark-Sztainer, Watts et al., 2018), self-confidence (Diers et al., 2020; Neumark-Sztainer, Watts et al., 2018), a sense of accomplishment related to yoga practice, and the benefit of witnessing different types of bodies practicing yoga (Neumark-Sztainer, Watts et al., 2018).

In three studies, there were reports of a potentially negative influence of yoga. For example, when participants made upward comparisons with others (i.e., comparative critique) or engaged in negative self-talk (i.e., inner critique)

yoga was perceived to have a negative impact on body image (Diers et al., 2020; Neumark-Sztainer, Watts et al., 2018). Among those who were recovered from AN, some participants cautioned that yoga could be used as a tool for the ED, in the form of over-exercise, or as a pathway to perfectionism, stringent self-discipline, and self-abuse (Pizzanello, 2016). Some participants reported feeling that yoga exposed emotional challenges, as they felt vulnerable or confronted feelings that they were uncomfortable with (Diers et al., 2020).

Qualitative participants also described yoga being associated with increased embodiment and connection (Diers et al., 2020; Dittmann & Freedman, 2009; McIver et al., 2009; Ostermann, Vogel, Starke et al., 2019; Pizzanello, 2016). Participants across studies reported feeling more aware of, connected to, and positive about their physical and emotional well-being and accepting of their bodies (Diers et al., 2020; Dittmann & Freedman, 2009; McIver et al., 2009). One woman with AN reported perceiving and feeling herself again and learning to utilize her body to cope with her traumatic experiences (Ostermann, Vogel, Starke et al., 2019). The practice of yoga was reported to help women shift from judging the body's appearance to appreciating its functionality; recognize the body's ability to ground and stabilize mood; and view embodiment as a pathway for introspection or spiritual growth (Dittmann & Freedman, 2009).

Some participants reported yoga helped them move toward a more authentic experience of self (Pizzanello, 2016), with less discrepancy between the real and ideal self (Dittmann & Freedman, 2009). In three studies, participants reported feeling empowered and in awe of what the body can do related to their yoga practice (Dittmann & Freedman, 2009; Neumark-Sztainer, Watts et al., 2018; Pizzanello, 2016). Other findings included: self-empowerment (McIver et al., 2009; Pizzanello, 2016), decreased perfectionism (Dittmann & Freedman, 2009), and increased present moment awareness (Dittmann & Freedman, 2009; McIver et al., 2009).

Limitations and conclusions of the comprehensive review

Despite the trend toward positive outcomes in ED risk factors, correlates, and behaviors across correlational; non-controlled; non-randomized, controlled; RCTs comparing yoga conditions; and qualitative studies, the question of efficacy of yoga for the prevention and treatment of EDs remains unanswered due to non-probabilistic sampling, study design (no controls or lack of randomization of assignment), and small samples sizes. The limitations of these studies highlight the importance of RCTs exploring the efficacy of yoga for ED prevention and treatment. The next section of this report aggregates and analyzes the RCTs and makes recommendations for future research and practice.

Method

Protocol

PRISMA guidelines were followed to complete this review. Each study is cited, summarized, and evaluated. A study protocol was not completed for this review. To conserve space, we did not include web addresses for funding sources for included studies. All other guidelines were followed and integrated into this review and meta-analysis.

Eligibility criteria

Studies were eligible for inclusion in the review and meta-analysis if they met the following criteria: (a) published in a peer-reviewed journal; (b) yoga was a primary component of intervention or target of inquiry; and (c) investigated ED symptoms and behaviors, or body image as related to disordered eating (e.g., related to risk or maintenance of EDs as indicated in text or by other measures used), as a primary outcome. Articles were excluded if EDs or disordered eating were not the target of study (e.g., body image in the context of cancer or pregnancy), the study explored mindfulness-based practices not explicitly identified as yoga, or the primary aim of the study was weight loss. Studies were also excluded if they were conference abstracts or dissertations/theses, or were not published in English. Clinical guidelines, opinion papers, and reflection papers were excluded.

Search strategy

Studies were identified through electronic database searches of Academic Search Complete, Alt HealthWatch, CINAHL Plus, Health Source: Nursing/Academic Edition, MEDLINE, PsycARTICLES, Psychology and Behavioral Sciences Collection, and PsycINFO. The following search terms were used with Boolean search logic: [(yoga) AND (ED OR disordered eating OR eating pathology OR anorexia OR bulimia OR dietary restraint OR binge eating OR purge OR body image OR body dissatisfaction OR body esteem OR drive for thinness OR body image disturbance OR body preoccupation OR eating attitudes OR food preoccupation)]. Searches were limited to articles written in English. The search was last conducted on January 6, 2020. Additionally, the table of contents of the *International Journal of Yoga Therapy* (through volume 29, issue 1), *International Scientific Yoga Journal SENSE* (through volume 6, number 6), and *Journal of Yoga and Physical Therapy* (through volume 9, issue 3) were searched manually. Separate searches of author names were also conducted. Finally, reference lists of previous reviews were also checked.

Study selection and data collection

The selection process for studies is displayed in Figure 1. After duplicates were removed, both authors independently screened the titles and abstracts of the

identified papers for eligibility. Full-text papers were then reviewed. Disagreements were resolved through discussion between authors. All 11 RCTS included in the meta-analysis were published between 2007 and 2020 (Ariel-Donges et al., 2019; Brennan et al., 2020; Carei et al., 2010; Halliwell et al., 2019, 2018; Hopkins et al., 2016; Karlsen et al., 2018; McIver et al., 2009; Mitchell et al., 2007; Pacanowski et al., 2020, 2017). One author (AB) performed data extraction on participants (e.g., age, gender), style of yoga, yoga dosage (e.g., session duration and frequency), control type, measures, measurement time points, and outcome. Extracted data was double-checked for accuracy by author CCC.

Methods for assessing risk to internal validity

Risk of bias of individual studies was rated independently by each author using the Cochrane Collaboration's tool, which assesses risk of bias on the following 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.

Calculation of effect sizes

All analyses were performed using Comprehensive Meta-Analysis (CMA; version 3) software. CMA calculated the standardized mean difference (SMD) for individual studies, which was then converted to Hedge's *g* to correct for small sample sizes (Borenstein et al., 2009). Mean scores for some scales were multiplied by −1 to correct for differences in the direction of the scales. When a study included multiple measures of the same outcome, a mean effect size was computed so that only one effect size for each study was included in the meta-analysis. When a study included a waitlist control and an active comparison group, only the data from the participants in the waitlist control group were used in order to minimize study heterogeneity. A negative *g* indicates that those in the yoga condition had lower levels of ED behaviors and body image concerns at post-test relative to the control condition. The weight of each study was calculated using the inverse of the variance, as recommended by Borenstein et al. (2009). We conducted analyses using random effects models due to the assumed heterogeneity between studies (Borenstein et al., 2009).

Heterogeneity and subgroup analyses

Q-statistic and I^2 were used to assess heterogeneity of effect sizes between studies. The *Q*-statistic is used to evaluate the statistical significance of the heterogeneity of effect sizes, while the I^2 statistic measures the proportion of observed variance that is due to true heterogeneity rather than chance (Borenstein et al., 2009). The I^2 statistic ranges from 0–100%, with values of 25%, 50%, and 75% suggesting low, moderate, and high levels of heterogeneity, respectively (Higgins et al., 2003). Outcomes that had significant effect size heterogeneity across studies were further explored using subgroup analyses to

identify possible sources of the heterogeneity. All subgroup analyses were conducted using random effects models with the estimate of τ^2 pooled across subgroups. This approach is recommended when there are few studies within each subgroup (Borenstein et al., 2009).

Outcome variables

Between-group analyses were performed on the following outcomes:

(1) Global eating disorder psychopathology. This outcome consisted of self-report and clinical interview measures that assessed ED symptoms and behaviors.
(2) Dietary restraint and eating concerns. This outcome consisted of self-report and clinical interview measures of the cognitive and behavioral aspects of restricting food, concern about eating particular foods, drive to be thinner, and fear of gaining weight. This relates cognitive fears with the dietary restraint that is unique to ED behaviors.
(3) Binge eating and bulimia. This outcome consisted of self-report and clinical interview measures of the frequency of binge eating episodes, number of binge eating episodes, and number of days of binge eating in previous 30 days.
(4) Body image concerns. This outcome consisted of self-report and clinical interview measures that assessed body dissatisfaction, weight and shape concerns, thin-ideal internalization, and extent of investment in one's appearance.
(5) Overall summary effect. This outcome consisted of a composite measure of all ED-related constructs, including those that did not fit into one of the aforementioned categories (i.e., body surveillance).

Meta-analysis results

Characteristics of included studies

Figure 1 presents a flowchart of the literature search. Database searches yielded a total of 284 articles, and an additional 10 articles were identified through manual searches of journals, manual searches of authors, and reviewing reference lists. After duplicates were removed, the titles and abstracts of 155 articles were screened for eligibility. Of these, 77 full texts were assessed. There was a total of 11 RCTs that met criteria for inclusion in the meta-analysis.

Among the RCTs, sample sizes ranged from 30 to 344 with a median sample size of 52. The majority of RCTs (k = 9) sampled adults only, while 1 study sampled children/adolescents only, and 1 study sampled adolescents and young adults. Five studies utilized a clinical sample. Six of the RCTs were conducted in the United States. The remaining RCTs were conducted in the

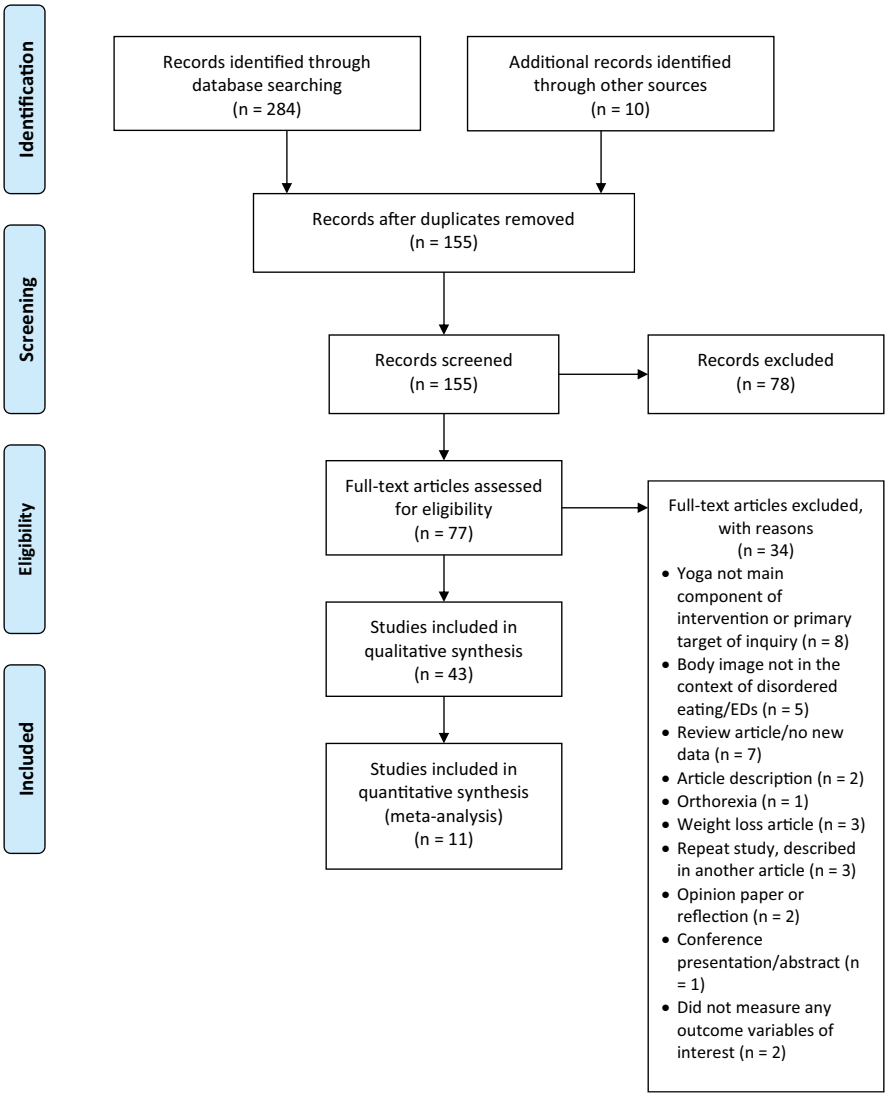


Figure 1. Flowchart of the study selection process.

United Kingdom (Halliwell et al., 2019, 2018), Australia (McIver et al., 2009), Norway (Karlsen et al., 2018), and Canada (Brennan et al., 2020).

Intervention duration ranged from five consecutive days (Pacanowski et al., 2017) to 12 weeks (Ariel-Donges et al., 2019; McIver et al., 2009), with an average duration of 7.6 weeks. Each yoga session ranged from 40 minutes (Halliwell et al., 2018) to 90 minutes (Hopkins et al., 2016; Karlsen et al., 2018) in length, with an average of about one hour. In the majority of the studies, yoga sessions were once ($k = 5$) or twice ($k = 4$) per week. Styles of yoga used in the in interventions varied widely and included Bikram, Hatha, Iyengar, and Viniyoga.

Finally, the risk of bias ratings for each study varied. Allocation concealment, blinding, and selective outcome reporting were judged by the authors to be unclear in the majority of the studies ($k = 10$). Risk of bias ratings for each study are shown in Table 4.

Synthesis of results

Effect sizes for the five RCT outcomes (global ED psychopathology, dietary restraint and eating concerns, binge eating and bulimia, body image concerns, and overall effects) are displayed in Figure 2.

Global eating disorder pathology

Six of the RCTS included a measure of global ED psychopathology. The effect size for global ED psychopathology was $g = -0.237$, 95% CI [−0.466, −0.008], $p = .043$, indicating a small but statistically significant effect in favor of the yoga condition. Effect sizes did not significantly differ between studies, $Q(5) = 3.231$, $p = .664$.

Dietary restraint and eating concerns

Six of the RCTs included a measure of dietary restraint and eating concerns. The effect size for dietary restraint and eating concerns was non-significant, $g = -0.132$, 95% CI [−0.373, 0.109], $p = .284$.

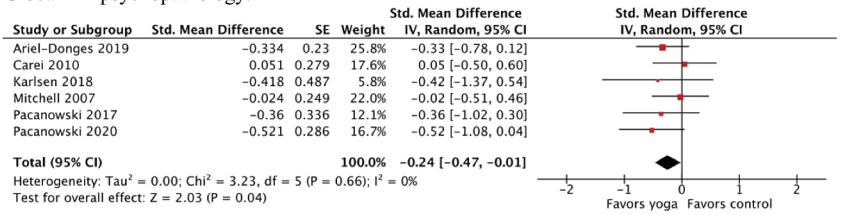
Binge eating and bulimia

Five of the RCTs included a measure of binge eating and bulimia. The summary effect for binge eating and bulimia was moderate-to-large, $g = -0.609$, 95% CI [−1.214, −0.004], $p = .049$, with significant heterogeneity of effect sizes between studies, $Q(4) = 22.965$, $I^2 = 82.582$. We performed a subgroup analysis that compared studies with clinical samples to studies with non-clinical samples. The point estimate for clinical samples was $g = -1.280$, $se = 0.285$, $z = -4.485$, $p < .001$, indicating that there was a large, statistically significant effect of yoga on binge eating and bulimia symptoms in clinical samples. The point estimate for non-clinical samples was $g = -0.148$, $se = 0.221$, $z = -0.671$, $p = .502$, indicating that there was no significant effect of yoga interventions on binge eating and bulimia symptoms in non-clinical samples. The difference between groups was significant, $Q(1) = 9.824$, $p = .002$, indicating that the effect of yoga on binge eating and bulimia was significantly different between clinical and non-clinical samples.

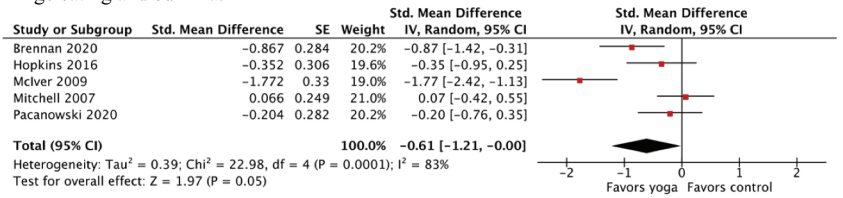
Body image concerns

Seven of the RCTs included a measure of body image concerns. On average, yoga participants reported significantly lower levels of body image concerns compared to controls. The summary effect size was small, $g = -0.311$, 95% CI

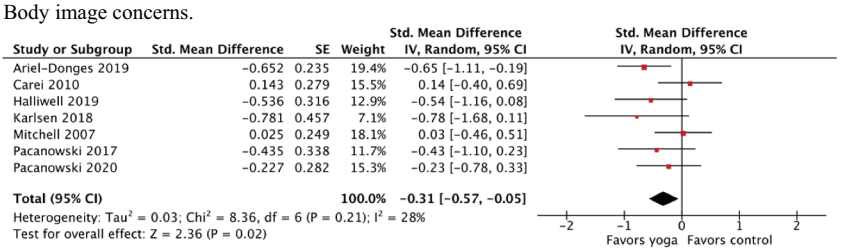
Global ED psychopathology.



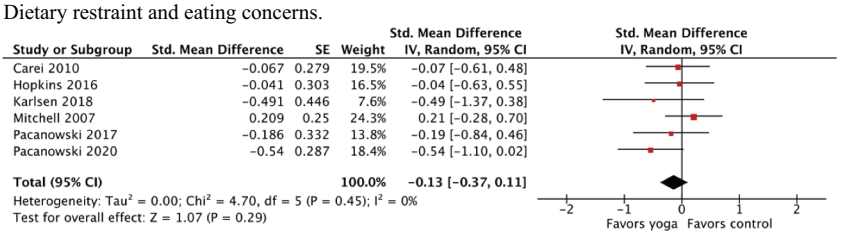
Binge eating and bulimia.



Body image concerns.



Dietary restraint and eating concerns.



Overall effects.

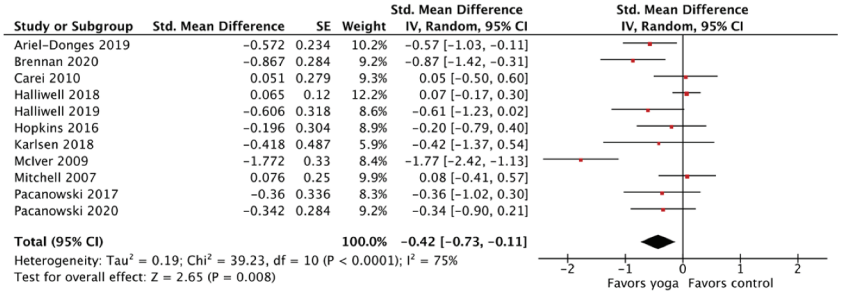


Figure 2. Meta-analysis results.

[−0.568, −0.053], p = .018. Effect sizes did not significantly differ between studies, $Q(6)$ = 8.355, p = .213, I^2 = 28.185.

Overall effect

All 11 RCTs were included in a meta-analysis examining the overall effect on ED-related measures. The summary effect size was small-to-moderate, g = − 0.422, 95% CI [−0.734, −0.110], p = .008. There was significant heterogeneity between studies $Q(10)$ = 39.209, I^2 = 74.496. Results of the subgroup analysis indicated that the point estimate for clinical samples was g = − 0.676, se = 0.231, z = − 2.927, p = .003. The point estimate for non-clinical samples was g = − 0.240, se = 0.190, z = − 1.265, p = .206. The difference between groups was not statistically significant, $Q(1)$ = 2.121, p = .145. However, this does not necessarily indicate that the true effect sizes were the same. It is possible that the effect is either small or that there was not enough statistical power to detect an effect, particularly given the limited number of studies included in each subgroup (Borenstein et al., 2009).

Discussion

Overall, the comprehensive review and meta-analysis of the 43 qualifying articles found yoga to be generally effective for the prevention and treatment of EDs. Specifically, the comprehensive review of studies showed a trend in the reduction of ED risk, correlates and symptoms in prevention and treatment conditions among the 10 correlational, 11 non-controlled, 5 non-randomized controlled, 2 RCTS comparing yoga conditions, and 6 qualitative studies. The first on this topic, the meta-analysis of 11 RCTs comparing yoga to control conditions in the prevention and treatment of EDs found a significant reduction in global ED psychopathology, binge eating and bulimia symptoms, and body image concerns. There was no effect on dietary restraint and eating concerns.

The comprehensive review demonstrated the growing breadth of research in this area, beginning with the first studies published on yoga and EDs (2005). Correlational studies found a trend toward yoga practice being associated with increased body awareness, body responsiveness, body satisfaction, body image and esteem, embodiment, and intuitive eating, and less self-objectification, negative body-related emotions, and exercising for weight and appearance reasons, as well as fewer ED symptoms. Further, these studies showed that internalization of yoga principles, regular yoga practice, positive body image, cultural nuances, and reasons for exercise may play a role in these relationships. Non-controlled and controlled studies addressed yoga as prevention for and support in the treatment of EDs. Prevention studies suggested that yoga for youth and adults may have some protective effect in terms of increasing protective factors, as well as decreasing ED risk factors, correlates, and

symptoms. The three noncontrolled treatment studies had mixed findings, with improvement in some ED symptoms and correlates, but no effect on others. The two RCTs with different yoga conditions showed that the conditions in a yoga class matter, and that some conditions (e.g., mirrors, appearance-related instruction) can place yoga practitioners at increased risk or attenuate positive outcomes. Qualitative studies support positive findings and echoed the potential risk of yoga in some conditions and contexts, reporting that comparative critiques, negative self-talk and use of yoga as a pathway to perfectionism, stringent self-discipline, and accomplishment may increase risk.

Meta-analytic findings

First, findings indicate that yoga is beneficial as related to the reduction in global ED psychopathology (small and significant effect). This is consistent with positive findings explicated in reviews by Klein and Cook-Cottone (2013) and Domingues and Carmo (2019), and inconsistent with Ostermann, Vogel, Boehm et al.'s (2019) finding that yoga has no effect on eating related symptoms. It is likely that the superior methodology (i.e., meta-analysis) and addition of recent, well-designed studies contributed to our positive findings. Further, the meta-analytic portion of our study focused exclusively on ED symptoms and behaviors. To increase translational utility, separate analyses were conducted for each distinct ED symptom and behavior rather than a sole focus on general outcomes.

Next, as related to specific ED symptoms, our study found that yoga was significantly beneficial in the reduction of binge eating and bulimia symptoms (medium effect) and body image concerns (small effect). Our results on the binge eating and bulimia outcome are consistent with the findings of Klein and Cook-Cottone (2013); binge eating and bulimia symptoms were not specifically reported on by Domingues and Carmo (2019) or Ostermann, Vogel, Boehm et al. (2019). The body image concerns results are consistent with findings reported by Klein and Cook-Cottone (2013) as well as Domingues and Carmo (2019), who reported that yoga was correlated with higher body image and stronger body satisfaction. Interestingly, participation in yoga did not have an effect on dietary restraint and eating concerns. It may be that yoga is able to support interoceptive/body awareness, body image, body connection, affect regulation (reduce negative affect, increase positive affect), body image other factors more specifically supportive of reductions in binge eating and purging behaviors (Dale et al., 2009; Diers et al., 2020; Hall et al., 2016; Klein & Cook-Cottone, 2013). It is important to note that food restriction is one of the primary symptoms of anorexia nervosa, the most difficult to treat ED, with food avoidance and restriction requiring very specific treatment techniques, including food exposure and activities like family meals (Cardi et al., 2019).

These behaviors appear to be more resistant to treatment in general and may take longer to address. The relative short durations of yoga trials may not be sufficient to show effect on restraint. Last, as mentioned in qualitative findings yoga can be utilized, by some and in specific circumstances, in a way that aligns with traits associated with restraint such as perfectionism, stringent self-discipline, and self-abuse (e.g., Pizzanello, 2016). Notably and importantly, these findings suggest that yoga does not appear to cause an increase in dietary restraint and eating concerns.

Limitations and future directions

This meta-analysis had several limitations. First, despite the growing body of literature on yoga and eating disorders, there were still a relatively small number of RCTs we were able to include in the meta-analysis. Second, due to the limited number of studies, we were unable to run subgroup analyses for a variety of important study characteristics, including dosage (Cook-Cottone, 2013), style of yoga, and use of active vs. waitlist control groups. Third, we were unable to conduct a meta-analysis using positive embodiment and related positive constructs as an outcome because these variables were included in only two studies. A random-effects meta-analysis with only two studies is likely to produce an inaccurate summary effect and misleading confidence interval (Borenstein et al., 2009). Finally, each meta-analysis examined the effects of the yoga interventions only at post-test; due to high variability in follow-up measurement dates, we were unable to examine the long-term effects of the interventions.

Future directions should include continued encouragement of use of best practices for RCT research (e.g., manualization, treatment integrity assessments, active control groups). Within the current body of research, there is insufficient attention paid to the factors listed in the Cochrane risk of bias tool including adequate sequence generation (related to randomization procedures), allocation concealment, blinding (participants and study personnel), selective outcome reporting, and other sources of bias (see Table 4). Further, future designs should target specific mechanisms of change (e.g., the content of instructor guidance; style of yoga; sequences and specific practices designed to manage body image, mood, stress, or trauma symptoms) and include detailed reports of protocols so that they can be replicated and extended. More detailed guidance in these areas follows.

Specific to the delivery of yoga, the authors should report the style of yoga, describe in detail the dose and delivery of yoga, manualize the components of the yoga intervention, explicate the specific class sequences for replicability and treatment integrity measures, consider the size of classes (e.g., Brennan et al., 2020 kept all class sizes under 12 to ensure individual attention), and

describe how instructors will deal with modifications (Ariel-Donges et al., 2019; Sherman, 2012). The specific yoga protocol should be published as a manual and treatment integrity measures should be utilized. There are a variety of methods for conducting treatment integrity checks. For example, Ariel-Donges et al. (2019) audio recorded all sessions to allow replication by other researchers. Further, a trained research coordinator evaluated 12.5% of the yoga classes offered, using a treatment fidelity checklist based on Sherman's (2012) guidelines to assess consistency across instructors and adherence to protocols.

Exposure to yoga prior to the intervention (naivety to yoga) as well as home/studio practice during the study are critical variables to assess. Among published studies there is substantial variability in regard to yoga experience with limited or no yoga experience part of inclusion criteria for some studies (e.g., Brennan et al., 2020; Karlsen et al., 2018; Pacanowski et al., 2020), regular yoga practice part of exclusion criteria for other studies (Hopkins et al., 2016; McIver, O'Halloran, et al., 2009) and many studies do not address the issue at all. Some studies explicitly encouraged at home practice (e.g., Karlsen et al., 2018; McIver, McGartland, et al., 2009) with many studies not addressing home practice with intervention or control participants. Given the popularity of yoga, assessing this in both the treatment and control group is necessary. Further, requesting that the control group not engage in mind/body and yoga-based activities during the study may be necessary.

Yoga instructors are key to the delivery of yoga. Each author should explain their selection criteria and process for choosing instructors. Instructors should be certified and trained and their certification and training specifically detailed (Ariel-Donges et al., 2019). To avoid biases introduced by within-class interactions, follow the exemplar detailed by Ariel-Donges et al. (2019). These researchers balanced the exposure to individual instructors by requiring the participants to attend classes taught by at least two of the three instructors. Using one instructor is not a sufficient way to address this issue. For example, Carei et al. (2010) used the same instructor for all individual sessions, making it impossible to parse out interventionist and intervention effects.

Overall, the studies included in this meta-analysis used waitlist controls or treatment/school as usual (e.g., Ariel-Donges et al., 2019; Brennan et al., 2020; Carei et al., 2010; Halliwell et al., 2018). Mitchell et al. (2007) and Halliwell et al. (2019) used active controls. Mitchell et al. (2007) found that a dissonance induction intervention worked more effectively than yoga when offered over 6 weeks at a low dose of 45 minutes per week, with no differences found between the yoga and assessment-only control groups. Karlsen et al. (2018) used an active control (i.e., two 90-minute educational meetings) to account for the group effect. Halliwell et al. (2019) used pamphlets on yoga, finding positive effects for the yoga vs. control group. Future studies should consider using dissonance-

based and exercise-only control groups for prevention yoga interventions, and exercise-only control groups for treatment-based yoga interventions.

More research on the possible contraindications, safety, and conditions under which yoga may be detrimental should be conducted (see Cook-Cottone & Douglass, 2017 for guidelines). Certain conditions may be less helpful, harmful, or more helpful than others (e.g., mirrors; Frayeh & Lewis, 2018; mindfulness vs weight and shape focused instruction; Cox, Ullrich-French, et al., 2020). Qualitatively, some participants cautioned that yoga could be used as tool for the ED as a form of over-exercise or a pathway to perfectionism, stringent self-discipline, and self-abuse (Pizzanello, 2016). How might a yoga intervention counter such phenomena and what approach is most effective?

A specific concern for those with AN is that participation in yoga may be associated with weight loss. In three studies that assessed BMI at pre and posttest, there were mixed findings. Carei et al. (2010) reported no change in BMI among participants that included those diagnosed with AN as well as those with other clinical EDs. McIver et al. (2009) found that those who participated in yoga did have a significant decrease in BMI. However, the participants were adult females diagnosed with BED; it is understandable that a reduction in bingeing would correspond with a reduction in BMI. Hopkins et al. (2016) also measured BMI at pre—and post-test in their study with a community sample of participants. Although there was evidence of a decrease in BMI in the yoga group, it was not statistically significant. Despite evidence suggesting that yoga is likely safe in the prevention and treatment of EDs, more research is needed to better understand the nuances, contexts, and unique risks that yoga participation may pose for some.

Although there are trends emerging in the data, the current body of research is not comprehensive enough to offer specific prescriptions for age, gender, or risk/psychopathology level. In terms of age, correlational, non-controlled, and non-randomized controlled, studies have focused primarily college students and adults with the exception of the series of studies completed by Cook-Cottone's team focusing on 5th grade females (i.e., Cook-Cottone et al., 2010, 2017; Norman et al., 2014; Scime et al., 2006; Scime & Cook-Cottone, 2008) and the study completed by Cox studying adolescents (Cox et al., 2017) suggesting yoga has protective benefits related to ED risk and symptoms (see Tables 1 and 2). Most of the more rigorous studies have been conducted on college age or older participants with only two RCTs assessing outcomes among youth (Carei et al., 2010; Halliwell et al., 2018; Table 3). Overall studies have included mostly females. About a third of correlational studies included males (Table 1) and among the non-controlled, non-randomized controlled studies 33% included males (Table 2). Nearly all the RCTs have been conducted with girls and women with only two RCTs also including boys and young men (Carei et al., 2010; Halliwell et al., 2018; Table 3). Therefore, despite

the growing body of evidence, we cannot readily generalize these findings to males or those under college age.

Potential differential efficacy for clinical and non-clinical populations should be further explored. More research is needed to fully understand the best approaches and research protocols for impact among those at risk and those who are already struggling. All of the correlational studies were conducted among non-clinical populations (see Table 1). Twenty percent of the non-controlled and non-randomized controlled studies were conducted among clinical populations (Table 2). The RCT studies were split about equally between clinical and non-clinical populations (Table 3). Currently, most of the intervention studies focus on reducing psychopathology and ED correlates, whereas prevention studies integrate more positive psychology and embodiment variables.

Finally, in terms of exploring mechanisms of change, specific mechanisms associated with the delivery of the yoga class need to be specifically explored such as the nature and extent of mindfulness teachings (Ariel-Donges et al., 2019; Brennan et al., 2020) and the effect of specific poses, breathing exercises, and relaxation techniques (Ariel-Donges et al., 2019). Further, there is currently insufficient data to know if yoga should be offered individually or within the group context and for whom one or the other might be best (Norman et al., 2014). Moreover, studies should continue to look at outcomes related to ED risk, etiology, and maintenance as well as integrate positive psychology constructs and assessments that can effectively explore positive embodiment.

Practice implications and conclusions

Yoga is an affordable and relatively accessible practice for those both in and out of treatment (Ariel-Donges et al., 2019). Overall, these findings suggest that there appears to be a benefit in participation in yoga sessions for those at-risk for and struggling with disordered eating. Findings suggest that yoga may be helpful in reducing global ED psychopathology, binge eating and bulimia symptoms, and body image concerns. Further, there appears to be no effect on dietary restraint and eating concern, neither increasing nor decreasing restriction behaviors. Last, with no studies reporting safety issues, there is no indication that yoga is not safe for those with EDs. However, specific research asking safety-related questions is needed. Additionally, Halliwell et al. (2019) warn that there has been an increase in yoga classes being offered that focus on appearance ideals (e.g., Beach Body Yoga) with less focus on important mindfulness constructs such as mindfulness, body appreciation, self-compassion, and acceptance. They assert that these developments in the yoga industry make it difficult to simply recommend yoga as a pathway to wellbeing. Therefore, offering referrals to vetted classes, styles, and instructors may be important. Given the right referral,

Table 3. Characteristics of randomized controlled trials included in the review.

Study	Participants	Type of yoga	Dosage	Control type(s)	Outcomes meta-analyzed	Country
Ariel-Donges et al., 2019	75 college females, ages 18 to 30, with body image dissatisfaction and normal eating behaviors	Vinyasa, Ashtanga	60 mins, 2x/week for 12 weeks	Waitlist control	Global ED (EAT-26) Body image concern (MBSRQ-AS)	United States
Brennan et al., 2020	53 adult females, community sample, met diagnostic criteria for BN or BED	Kripalu	90 minutes, 1x/week for 8 weeks	Waitlist control	Binge eating/bulimia (two EDE-Q items on binge eating)	Canada
Carei et al., 2010	53 adolescents, ages 11 to 21, in outpatient treatment for AN, BN, or EDNOS	Private Viniyoga	60 minutes, 2x/week for 8 weeks	Received standard medical care	Global ED (EDE) Restraint/eating concerns (EDE-R, EDE-EC) Body image concern (EDE-WC, EDE-SC)	United States
Halliwell et al., 2018	344 British children, ages 9 to 11, recruited from four schools	Hatha	40 minutes, 1x/week for 4 weeks	Assessment-only control, attended PE as usual	OBCS-Y-BS [a]	United Kingdom
Halliwell et al., 2019	44 undergraduate females, mean age 20.21	Anusara, Iyengar, Vinyasa	60 minutes, 1x/week for 4 weeks	Reviewed and rated 2 articles about yoga	Body image concern (MBSRQ-BASS) OBCS-BS [a]	United Kingdom
Hopkins et al., 2016	52 females, ages 25 to 45, with elevated levels of perceived stress, dietary restraint, and emotional eating	Bikram	90 minutes, 2x/week for 8 weeks	Waitlist control	Binge eating/bulimia (EDDS item 8) Restraint/eating concerns (DRES)	United States

(*Continued*)

Table 3. (Continued).

Study	Participants	Type of yoga	Dosage	Control type(s)	Outcomes meta-analyzed	Country
Karlsen et al., 2018	30 adult females, mean age 32.4, with BN or EDNOS	Hatha	90 minutes, 2x/week for 11 weeks	Received two 90 minute group meetings. Topics included nutrition, physical activity, and eating disorders	Global ED (EDE, EDI-2) Restraint/eating concerns (EDE-R, EDE-EC) Body image concern (EDE-WC, EDE-SC)	Norway
McIver, O'Halloran, et al., 2009	50 females, ages 25 to 63, met diagnostic criteria for BED, BMI > 25	Hatha yoga, yoga nidra	60 minutes, 1x/week for 12 weeks	Waitlist control	Binge eating/bulimia (BES)	Australia
Mitchell et al., 2007	93 female undergraduate psychology students, mean age 19.56	Integral	45 minutes, 1x/week for 6 weeks	Dissonance-based intervention group; assessment-only control	Global ED (EDDS) Binge eating/bulimia (BES) Restraint/eating concerns (EDI-DT,TFEQ-R) Body image concern (BSQ-R-10, EDI-BD, IBSS-R)	United States
Pacanowski et al., 2017	38 patients at a residential eating disorder treatment facility, mean age 26.8	Modified Viniyoga	50 minutes/day for 5 consecutive days	Treatment as usual	Global ED (EDE-Q) Restraint/eating concerns (EDE-Q-R, EDE-Q-EC) Body image concern (EDE-Q-WC, EDE-Q-SC)	United States
Pacanowski et al., 2020	51 female undergraduate students, ages 18 to 26, mean age 19.6	Modified Viniyoga	50 minutes, 3x/week for 10 weeks	Assessment-only control	Global ED (EAT-26) Binge eating/bulimia (BES, EAT-26-B) Restraint/eating concerns (EAT-26-OC, EAT-26-D, MBSRQ-OWP) Body image concern (MBSRQ)	United States

Note. BES, Binge Eating Scale; BSQ-R-10, Body Shape Questionnaire-Revised-10; DRES, Dutch Restrained Eating Scale; EAT-26, Eating Attitudes Test-26:—B, Bulimia and Food Preoccupation subscale,—D, Dieting subscale,—OC, Oral Control subscale; EDI, Eating Disorder Inventory:—BD, Body Dissatisfaction subscale,—DT, Drive for Thinness subscale; EDDS, Eating Disorder Diagnostic Scale; EDE/EDE-Q, Eating Disorder Examination/Eating Disorder Examination-Questionnaire:—R, Restraint subscale,—EC, Eating Concern subscale,—WC, Weight Concern subscale,—SC, Shape Concern subscale; IBSS-R, Ideal Body Stereotype Scale-Revised; MBSRQ, Multidimensional Body-Self Relations Questionnaire:—AS, Appearance Scales,—BASS, Body Areas Satisfaction Scale,—OWP, Overweight Preoccupation subscale; OBCS-BS, Objectified Body Consciousness Scale—Body Surveillance subscale; OBCS-Y-BS, Objectified Body Consciousness Scale-Youth Body Surveillance subscale; TFEQ Restraint, Three-Factor Eating Questionnaire Restraint subscale.

[a]This measure was included only in the meta-analysis for overall effects.

yoga may be a place of reprieve from risk and struggle, as described by this participant with a clinical ED after participating in yoga classes as part of the intervention, "*This is the only hour in my week when I don't think about my weight*." (Carei et al., 2010, p. 350).

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