



Mindfulness meditation as an intervention for binge eating, emotional eating, and weight loss: A systematic review



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ARTICLE INFO

Article history:

Received 22 July 2013

Received in revised form 23 November 2013

Accepted 22 January 2014

Available online 1 February 2014

Keywords:

Mindfulness

MBSR

Eating

Weight

Obesity

ABSTRACT

Mindfulness-based approaches are growing in popularity as interventions for disordered eating and weight loss. Initial research suggests that mindfulness meditation may be an effective intervention for binge eating; however, no systematic review has examined interventions where mindfulness meditation was the primary intervention and no review has examined its effect on subclinical disordered eating or weight. Using the PRISMA method for systematic reviews, we reviewed 14 studies that investigated mindfulness meditation as the primary intervention and assessed binge eating, emotional eating, and/or weight change. Results suggest that **mindfulness meditation effectively decreases binge eating and emotional eating in populations engaging in this behavior**; evidence for its **effect on weight is mixed**. Additional research is warranted to determine comparative effectiveness and long-term effects of mindfulness training.

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1. Introduction

Mindfulness-based interventions are intensive skills-based programs aimed at reducing distress and improving well-being through the cultivation and practice of mindfulness (Kabat-Zinn, 1990). Mindfulness is often defined as a state of nonjudgmental attention to the

immediate experience and an acceptance of moment-to-moment experience (Bishop et al., 2004). Awareness and acceptance of transitory moments allow one to replace automatic thoughts and automatic reactivity to events with conscious and healthier responses (Sears & Kraus, 2009).

Mindfulness-based interventions are being increasingly used to address eating-related issues ranging from anorexia nervosa (Heffner, Sperry, Eifert, & Detweiler, 2002) to weight management (Dalen et al., 2010). The conceptual rationale for using mindfulness in the treatment

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of eating disorders has been reviewed by other authors and includes the importance of cultivating awareness of internal experiences (e.g., emotions, physical sensations), facilitating self-acceptance, cognitive flexibility, compassion, and forgiveness, and generally improving one's ability to cope adaptively with emotions (Baer, Fischer, & Huss, 2005; Kristeller, Baer, & Quillian-Wolever, 2006; Kristeller & Wolever, 2011; Wolever & Best, 2009). As the body's biological stress response has been associated with increased feelings of hunger, preference for high fat and high sugar foods, and abdominal fat deposition (Dallman, 2010), mindfulness meditation has also been proposed as a potentially useful intervention for individuals attempting to lose weight.

Prior reviews have focused on the use of mindfulness treatments for individuals with eating disorders, including anorexia nervosa, bulimia nervosa, and binge eating disorder (BED; Baer et al., 2005; Wanden-Berghe, Sanz-Valero, & Wanden-Berghe, 2011). Results suggest that interventions with a mindfulness training component hold promise as a treatment for eating disorders; however, these studies were limited by small sample sizes and await replication to determine the comparative and long-term effectiveness of the interventions. To our knowledge, no review has examined the effects of mindfulness interventions on individuals who struggle with their eating and/or weight, but do not meet criteria for an eating disorder diagnosis (e.g., overweight or obese individuals with no emotional and/or binge eating; or individuals who struggle with emotional eating but do not meet full criteria for an eating disorder). Given that mindfulness-based interventions are increasingly being proposed as potentially effective treatments for overeating and obesity (Daubenmier et al., 2011; Ludwig & Kabat-Zinn, 2008), and a growing number of studies have examined weight as an outcome measure in mindfulness intervention studies (Alberts, Mulken, Smeets, & Thewissen, 2010; Kearney, McDermott, Malte, Martinez, & Simpson, 2012; Timmerman & Brown, 2012), it is important to evaluate how mindfulness meditation may impact weight or eating behavior in individuals with subclinical eating pathology.

The dose of mindfulness training is an important parameter to consider when examining the impact of mindfulness interventions. While some programs heavily emphasize mindfulness training (e.g., Mindfulness-Based Stress Reduction; MBSR; Kabat-Zinn, 1990), others include it as one of many treatment components (e.g., Dialectical Behavior Therapy, DBT; Linehan, 1993). For example, in DBT for BED, mindfulness is taught for four sessions and the remaining 16 sessions focus on teaching other skills such as emotion regulation and distress tolerance (Telch, Agras, & Linehan, 2001), whereas interventions such as Mindfulness-Based Eating Awareness Training (MB-EAT; Kristeller & Hallett, 1999), Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1990), and Mindfulness-Based Cognitive Therapy (MBCT; Teasdale et al., 2000) focus on mindfulness training in each session. Past reviews have included a range of mindfulness-based interventions including Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999) and DBT (Linehan, 1993). Thus, prior reviews provide information on how interventions that include some mindfulness training impact patients with clinical eating disorders, but the extent to which the mindfulness training itself (versus other treatment components) accounted for the observed treatment effects is less clear.

Given these points, and the fact that since the last review (Wanden-Berghe et al., 2011) several larger studies have been published examining the impact of primarily mindfulness-based interventions on eating behavior (e.g., Alberts, Thewissen, & Raes, 2012; Kristeller et al., *in press*), an updated review evaluating the impact of primarily mindfulness interventions on eating-related behaviors and clinical outcomes such as weight is warranted. The aim of this review paper is to systematically review the impact of mindfulness meditation on overeating behaviors (i.e., binge eating, emotional eating) and weight change. To achieve this goal, we examined studies of interventions for which mindfulness was the primary treatment modality and where binge eating, emotional eating, or weight was a measured outcome.

2. Method

2.1. Literature search

We conducted our review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA; Moher, Liberati, Tetzlaff, & Altman, 2009) and registered our review online under the international prospective register of systematic reviews.¹ Literature searches were conducted from the earliest date available through May 2013 in the following online bibliographical databases: PsycINFO, PubMed, MEDLINE, and Google Scholar. Terms related to mindfulness were entered in conjunction with terms related to eating behavior or weight using Boolean operators (e.g., “mindfulness” and “eating”). Terms for mindfulness included mindfulness, meditation, and mindful. Terms for eating behavior included eating, obesity, and weight. Searches were limited to articles written in English. Additionally, we reviewed reference sections of all the articles included in the review to identify additional articles that met the criteria for this review. The flow of the review process is shown in Fig. 1.

2.2. Study selection

Inclusion criteria were: a) original articles published in peer-reviewed journals, b) intervention studies with at least pre-post data, c) studies in which the intervention included mindfulness training in some portion of each session (e.g., MBSR and MBCT were included given that these treatments include mindfulness training in each session, DBT and ACT were excluded given that mindfulness is used in only a subset of sessions in these treatments), and d) studies with at least one of the following outcome measures: binge eating, emotional eating, or weight. Exclusion criteria were a) populations including individuals with anorexia nervosa or bulimia nervosa, b) populations with participants currently undergoing chemotherapy (due to its possible effect on weight and eating behaviors), and c) case studies or studies with a sample size of less than five. We did not exclude studies according to patient age, gender, weight range, or diagnosis other than described above. The decision to include or exclude studies was initially made on the basis of the article title, then its abstract, and finally the full-text article.

2.3. Data extraction

The first two authors of this review (SK and BK) independently evaluated each of the selected studies and extracted the following data from each of the original articles: authors and year of publication, design, sample size (i.e., sample size for the mindfulness intervention condition and total sample size), population, intervention length, the primary outcome(s)/variable(s), the intervention aimed to reduce (e.g., weight, binge eating, cravings, stress), the secondary outcomes relevant to our review (e.g., emotional eating, binge eating and/or weight), and the main findings. In the articles where emotional or binge eating was assessed, the measure used and the within- and between-groups Cohen's *d* effect sizes were extracted or estimated based on available data. In the articles where weight change was assessed, BMI or weight change at post-intervention and follow-up (if applicable) was extracted, and Cohen's *d* was extracted or calculated for the post-intervention change when the variability statistic was provided. We also gathered information about the components of the intervention specific to weight management including any nutrition education, energy balance information, or exercise or dietary self-monitoring or goal setting that was included. Both authors independently entered data into a table and compared information to check for accuracy. If extracted data were discrepant, the first author returned to the original article to clarify the correct information.

¹ Registration number: CRD42013004293; www.crd.york.ac.uk/prospero/.

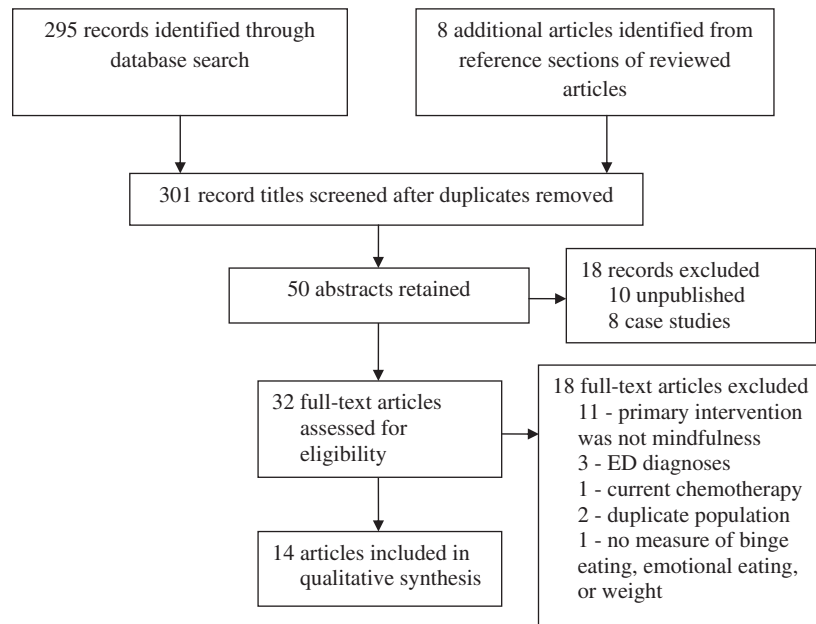


Fig. 1. Flowchart for article selection.

2.4. Risk of bias assessment

Based on recommendation by the PRISMA statement (Moher et al., 2009), we conducted an assessment of “study-level” bias by examining the attendance and compliance rates for each intervention condition, retention rates at post-intervention and follow-up assessments, and whether weight was self-reported or measured. We conducted an assessment of “outcome-level” bias by examining the primary outcome(s) of each study (e.g., if the study was a secondary analysis as part of a larger study, we examined the original study main outcomes) to examine whether these studies were reporting results from primary or secondary analyses. Publication reporting biases (e.g., selective reporting of studies with findings that are consistent with hypotheses) and the empirically demonstrated “outcome reporting bias” within individual studies (Chan, Hrobjartsson, Haahr, Gotzsche, & Altman, 2004) were also taken into consideration when interpreting results (see limitations section of Discussion).

3. Results

Fifty article abstracts were identified as potentially relevant, and after the full-text articles were reviewed, 14 studies met all eligibility criteria and were included in the current review (see Fig. 1 for details). Eighteen articles were excluded because they had a sample size of less than five or were not published in peer-reviewed journals (e.g., dissertations), and 18 additional articles were excluded due to one of the following reasons: mindfulness was not the primary intervention ($n = 11$; e.g., ACT; Forman, Butryn, Hoffman, & Herbert, 2009), the study used the same sample as a study already included in the review ($n = 2$; e.g., Smith, Shelley, Leahigh, & Vanleit, 2006), there was no measure of weight, binge eating, or emotional eating ($n = 1$; Carmody & Baer, 2008), or the sample included individuals with anorexia or bulimia nervosa ($n = 3$; e.g., Hepworth, 2011) or participants currently undergoing chemotherapy ($n = 1$; Hebert et al., 2001). The 14 included studies were all published within the last 24 years in 13 different journals. The majority of studies were conducted in the United States, with two conducted in the Netherlands (Alberts et al., 2010, 2012), and one in Canada (Courbasson, Nishikawa, & Shapira, 2011).

3.1. Study characteristics

Table 1 provides information on each study’s design, sample size, population, intervention length, primary outcome(s), secondary outcomes relevant to our review (e.g., emotional eating, binge eating and/or weight), and its main findings. Intervention length ranged from 6 to 16 consecutive weeks; and one study had an additional 3 monthly review sessions after 9 consecutive weeks of intervention (Kristeller et al., *in press*). For the majority of the studies, binge eating, emotional eating, or psychological distress were the primary outcome measures. Only Dalen et al. (2010), Miller et al. (2012), and Timmerman and Brown (2012), targeted weight loss as a specific goal of the intervention. Although all focused on mindfulness training throughout each session, the degree of focus on mindful eating and appetite awareness ranged from none to considerable. Importantly, three studies targeted overall stress reduction (Kearney et al., 2012; Smith et al., 2008) or better glycemic control (Rosenzweig et al., 2007) and did not have a specific eating focus but were included in the review because they assessed binge eating, emotional eating, and/or weight pre- and post-intervention. All other interventions included some degree of focus on mindful eating practice and discussion at each group meeting.

Women comprised the larger percentage of participants in all but one study (Kearney et al., 2012; 87.5% male veterans), although nine studies did include men (percentages ranging from 10% to 37%). Target populations for the studies varied and included adults with type II diabetes (Miller et al., 2012; Rosenzweig et al., 2007), community members interested in stress reduction (Smith et al., 2008), individuals who were overweight or obese (with and without binge eating behavior), individuals who had undergone bariatric surgery (Leahy et al., 2008), and veterans recruited for “managing stress” who did not necessarily have any eating or weight concerns (Kearney et al., 2012).

Participant age ranged from 18 to 75; mean age for the majority of studies fell between 40 and 60 years. Given that weight was not always a primary outcome, only a portion of studies (9 of 14) reported participant’s weight or body mass index (BMI). Of those, the majority of studies included participants with a mean BMI between 30 and 45 kg/m². Exceptions include Kristeller and Hallett (1999), who examined a sample of obese binge eaters with a wide range of BMIs (28–52 kg/m²),

Table 1
All studies included in the review.

Study	Design	Mindful <i>n</i> /total <i>N</i>	Population	Intervention length (weeks)	Primary outcome(s) <i>Secondary outcome(s)</i>	Main findings
Alberts et al. (2010)	MI + diet vs diet	10/19	Overweight adults with food cravings	10	Cravings <i>Weight</i>	Cravings and emotional eating decreased more in MI group; weight decreased in both groups
Alberts et al. (2012)	MI vs CTL	12/26	Women with “problematic eating”	8	Emotional and external eating, cravings, body image disturbance <i>Weight</i>	Emotional and external eating, cravings, and body image disturbance decreased in MI compared to controls, weight change ns
Baer et al. (2005)	MI	10	Women who binge eat	10	Binge eating	Reduced binge eating
Courbasson et al. (2011)	MI	29	Adults with BED and substance use disorder	16	Binge eating	Reduced binge eating
Dalen et al. (2010)	MI	10	Obese adults	6	Weight, emotional and binge eating	Reduced weight, emotional and binge eating, depression, and C-reactive protein
Daubenmier et al. (2011)	MI vs CTL	18/38	Overweight women “stress eaters”	9	Emotional eating <i>Weight</i>	Emotional eating and anxiety reduced in MI compared to controls, weight change ns
Kearney et al. (2012)	MI	38	Veterans	8	Stress and gastrointestinal (GI) symptoms <i>Emotional eating, weight</i>	MI reduced stress and GI specific anxiety, emotional eating and weight change ns
Kristeller and Hallett (1999)	MI	18	Overweight women who binge eat	6	Binge eating <i>Weight</i>	Reduced binge eating, weight change ns
Kristeller et al. (in press)	MI vs CBT vs CTL	40/108	Obese adults, 66% BED	9 weekly, 3 monthly	Binge eating <i>Weight</i>	Reduced binge eating in MI compared to controls, similar to CBT, weight change ns
Leahey et al. (2008)	MI	7	Post-bariatric surgery adults who binge eat	10	Binge eating	Reduced binge eating, depressive symptoms, and increased motivation
Miller et al. (2012)	MI vs CBT	27	Adults with DM-2	8 weekly, 2 bi-weekly	Weight, glycemic control	Weight decreased in both groups, but weight loss was greater for CBT group, both groups had improved glycemic control (HbA1c)
Rosenzweig et al. (2007)	MI	11	Adults with DM-2	8	Glycemic control, blood pressure, stress <i>Weight</i>	HbA1c, mean arterial pressure, and stress improved, weight change ns
Smith et al. (2008)	MI vs CBT	36/50	Adults paying for “stress reduction”	8	Range of health related outcomes <i>Binge eating</i>	Both groups improved on all health outcomes, MI improved more on mindfulness, energy, pain, and trend for binge eating
Timmerman and Brown (2012)	MI vs CTL	19/35	Women who eat out 3×/week	6	Weight, diet, emotional eating	Weight decreased and diet improved in MI group vs controls, emotional eating ns

Note. MI = mindfulness intervention group; diet = dietary education and 1 h of physical exercise per week; CTL = control group; CBT = cognitive-behavioral intervention group; mindful *n* = participants who completed the post-intervention assessment in the mindfulness condition; total *N* = participants who completed the post-intervention assessment across all study conditions; BED = binge eating disorder; ns = non-significant; HbA1c = hemoglobin A1c.

and Leahey et al. (2008), who examined post-operative bariatric surgery patients with BMIs ranging from 35 to 52 kg/m².

3.2. Effect of mindfulness interventions on binge eating and emotional eating

Table 2 provides an overview of the studies that examined binge eating or emotional eating. Binge eating was measured in seven studies using either the Binge Eating Scale (BES; Gormally, Black, Daston, & Rardin, 1982) or the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994). All seven studies that examined binge eating found a significant reduction in binge eating with medium to large effect sizes (Cohen's *d* ranged from 0.43 to 2.08). When between-groups effects were available (four studies), mindfulness-based interventions reduced binge eating significantly more than an assessment-only control condition in two analyses ($d = -0.53$ in Alberts et al., 2012 and $d = -1.10$ in Kristeller et al., in press) and at

a trend level in the another ($d = -0.57$ in Daubenmier et al., 2011). Kristeller et al. (in press) found no significant differences in binge eating when a mindfulness intervention was compared to a cognitive-behavioral intervention (CBT). Smith et al. (2008) found that the mindfulness intervention reduced binge eating slightly more (and at a trend level) compared to CBT. Notably, Smith et al. (2008) allowed participants to self select their condition and the CBT group was significantly smaller than the mindfulness condition.

Emotional eating was measured in five studies by the Dutch Eating Behavior Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986), the Emotional Eating Scale (Arnou, Kenardy, & Agras, 1995) or the Three-Factor Eating Questionnaire (Karlsson, Persson, Sjöström, & Sullivan, 2000). Effect sizes ranged from -0.01 to -0.94 and two of five analyses showed statistically significant improvement in emotional eating. Notably, in two of the three studies where no significant effect on emotional eating was observed (Kearney et al., 2012; Timmerman & Brown, 2012), participants were not recruited for

Table 2

Effect sizes for within group and between group changes in measures of binge eating and emotional eating.

Study	Measure	Within-groups effect (<i>d</i>)	Between-groups effect (<i>d</i>)
Alberts et al. (2012)	Emotional eating (DEBQ)	−0.54*	−0.53*
Baer et al. (2005)	Binge eating (BES)	−0.88 ^a	n/a
Courbasson et al. (2011)	Binge eating (EDE-Q)	−0.86*	n/a
Dalen et al. (2010)	Binge eating (BES)	−1.30**	n/a
Daubenmier et al. (2011)	Emotional eating (DEBQ)	−0.94*	−0.57†
Kearney et al. (2012)	Emotional eating (TFEQ)	−0.07	n/a
Kristeller and Hallett (1999)	Binge eating (BES)	−2.08**	n/a
Kristeller et al. (in press)	Binge eating (BES)	−1.73**	−1.10 (vs CTL) ns (vs CBT)
Leahy et al. (2008)	Emotional eating (EES)	−0.90	n/a
	Binge eating (EDE-Q)	−1.47 ^a	
Smith et al. (2008)	Binge eating (BES)	−0.43	0.31†
Timmerman and Brown (2012)	Emotional eating (EES)	−0.01	0.00

Note. DEBQ = Dutch Eating Behavior Questionnaire; BES = Binge Eating Scale; EDE-Q = Eating Disorder Examination Questionnaire; TFEQ = Three-Factor Eating Questionnaire – 18 item version; EES = Emotional Eating Scale; CTL = control group; CBT = cognitive-behavioral intervention group.

^a p-Value not provided in article.

† p < .10.

* p < .05.

** p < .01.

emotional eating concerns and reported very low levels of emotional eating at baseline.

3.3. Effect of mindfulness interventions on weight

Six of ten studies provided some type of nutrition or energy balance education and/or an exercise-related component (see Table 3). One study included behavioral goal setting and problem-solving to change eating behavior (Timmerman & Brown, 2012), typical cornerstones of behavioral weight management programs. Overall, with the exception

of the study by Miller et al. (2012; Cohen's *d* = −3.29), the observed effects on weight at post-intervention were small and mainly non-significant (Cohen's *d* ranged from −0.17 to +0.04). Those studies that found a significant decrease in weight were those that focused on weight loss as a primary outcome (Dalen et al., 2010; Miller et al., 2012; Timmerman & Brown, 2012). Two studies reported a small weight gain from baseline following participation in a standard MBSR program, one of which was statistically significant at 24 weeks (+1.2 kg; Kearney et al., 2012). Although not part of our outcomes for this systematic review, one study found a significant reduction in

Table 3

Changes in BMI/weight in the mindfulness intervention groups.

Study	Weight loss-specific components ^a	BMI/wt change (<i>SD</i>) at post-intervention ^b	BMI/wt change at follow-up (weeks since baseline)	Effect size at post-intervention (Cohen's <i>d</i>)
Alberts et al. (2010)	Info on “healthy food choices;” performed 1 h of exercise after each session	−1.9 kg (±1.7)	n/a	−0.12**
Alberts et al. (2012)	None	−0.4 kg/m ²	n/a	−0.06†
Dalen et al. (2010)	“General” info on nutrition, exercise, calories, nutrition; encouraged an increase in physical activity of 5–10% each week	Not given	−4.0 kg** (12 weeks)	
Daubenmier et al. (2011)	2-hour nutrition and exercise information session aimed at “moderate weight loss”	−0.06 kg (±3.1)	n/a	−0.02
Kearney et al. (2012)	None	+0.8 kg	+1.2 kg* (24 weeks)	+0.04
Kristeller and Hallett (1999)	None	No change	No change	Not given
Kristeller et al. (2013)	Weight management info briefly introduced in session 4 in the context of physical hunger and calorie balance, and reinforced in session 9, but was not a primary focus of the intervention	−0.1 kg/m ²	+0.4 kg/m ² (28 weeks)	−0.01
Miller et al. (2012)	“Basic” info on energy and nutrition intake; participants were encouraged to engage in physical activity and mindful movement; however, no specific diet or activity goals were provided	−1.8 kg (±0.5)**	−1.5 kg (±0.5)** (24 weeks)	−3.29**
Rosenzweig et al. (2007)	None	+0.9 kg	+1.8 kg (12 weeks)	+0.04
Timmerman and Brown (2012)	General info on weight management; problem-solving and behavioral goal setting in each session	−1.7 kg*	n/a	−0.09*

Note. BMI = body mass index; wt = weight.

^a Includes nutrition education, energy balance information, exercise or dietary goal setting or monitoring.

^b Standard deviations for weight and BMI change given when provided in the article.

† p < .10.

* p < .05.

** p < .01.

abdominal fat, despite lack of significant effects on weight change (Daubenmier et al., 2011). Additionally, the same study was the only study in the review to present results based on initial BMI category, and found that while there were no significant changes in weight between conditions in the overall sample, obese participants assigned to the mindfulness intervention maintained their weight, while obese participants assigned to the wait-list control group gained 1.7 kg over four months (Daubenmier et al., 2011).

3.4. Risk of bias assessment

Average time spent practicing mindfulness exercises was available for six of the studies and ranged from approximately 8 min (Alberts et al., 2010) to 30 min per day (Alberts et al., 2012) with the four studies averaging between 14 and 22 min per day (Daubenmier et al., 2011; Kristeller & Hallett, 1999; Kristeller et al., in press; Rosenzweig et al., 2007). Three other studies did not specifically report compliance data but were able to document that measures of mindfulness and/or acceptance did significantly increase from pre- to post-intervention (Baer et al., 2005; Kearney et al., 2012; Smith et al., 2008), and the remaining five studies did not provide this information.

Attendance was reported in five studies (Dalen et al., 2010; Daubenmier et al., 2011; Kearney et al., 2012; Leahey et al., 2008; Miller et al., 2012) and ranged from 70% (Miller et al., 2012) to 100% (Dalen et al., 2010) for participants included in analyses. Courbasson et al. (2011) excluded participants from analyses if they missed four consecutive sessions out of the sixteen. Only one study (Timmerman & Brown, 2012) did not provide any data related to attendance or compliance.

Retention at post-intervention assessments was reported for all studies, and ranged from 60% (Baer et al., 2005) to 100% (Alberts et al., 2010, 2012; Leahey et al., 2008), with most studies falling between 75 and 90% (Courbasson et al., 2011; Dalen et al., 2010; Kearney et al., 2012; Kristeller & Hallett, 1999; Miller et al., 2012; Rosenzweig et al., 2007; Smith et al., 2008; Timmerman & Brown, 2012). There were no significant differences in attrition across study conditions (when applicable) with the exception of the larger trial by Kristeller et al. (in press) where a significantly higher retention was observed in the mindfulness condition versus the CBT and control conditions at one of the two study sites, but not in the overall sample. In all studies that measured weight as an outcome, weight was measured during an in-person assessment.

For the “outcome-level” bias assessment, we examined the primary outcome(s) of each study to determine whether these studies were reporting results from primary or secondary analyses. The majority of studies examined weight and/or eating behavior as the primary focus and outcome with the exception of one study that examined eating behavior as a secondary analysis of a larger study that examined the impact of MBSR on gastrointestinal and post-traumatic stress symptoms (Kearney et al., 2012).

4. Discussion

Mindfulness meditation as an intervention for eating- or weight-related behavior change is a topic of increasing research and clinical interest. Our review supports the accumulating evidence that mindfulness training may be an important contributor to positive changes in disordered eating. Evidence suggests that primarily **mindfulness-based interventions are effective treatments for binge and emotional eating and a standard Mindfulness-Based Stress Reduction program alone does not appear to invoke weight change.**

Mindfulness-based interventions were found to **significantly reduce binge eating from pre- to post-intervention with medium to large effect sizes.** Very few studies examined a comparison condition (e.g., CBT) and of the two that did, mindfulness meditation had either similar effects (Kristeller et al., in press) or slightly greater effects (Smith

et al., 2008) on binge eating. The effect sizes in this review are **comparable to those found for alternative treatments for binge eating, including dialectical behavioral therapy (Telch et al., 2001) and interpersonal therapy, and higher than those found for behavioral weight loss (Wilson, Wilfley, Agras, & Bryson, 2010).** Although future research is needed to examine outcomes beyond four months post-treatment and comparative effectiveness of mindfulness interventions versus other empirically supported treatments, **mindfulness meditation training is an acceptable and effective treatment for binge eating behavior.** Previous reviews have suggested that interventions with some mindfulness training are effective in reducing symptoms of eating disorders (Baer et al., 2005; Wanden-Berghe et al., 2011), and this review suggests that interventions that are primarily mindfulness-based also yield consistent, positive effects on binge eating.

Approximately half of the studies that examined binge eating included populations that meet criteria for BED. Mindfulness was effective in reducing binge eating episodes and behaviors across a range of populations, including a bariatric surgery sample, participants diagnosed with comorbid BED and substance abuse, and a nonclinical community sample using several different variations of mindfulness interventions that included didactics on nutrition or utilized traditional mindfulness training programs (e.g., MBSR). Given that binge eating decreased despite such variability in the target population and intervention, mindfulness may be a powerful tool in treating this behavior regardless of sample characteristics or comorbidities.

Mindfulness-based interventions also appear to be **effective in reducing emotional eating,** at least among individuals who report elevated levels of this behavior. Of the five studies that examined emotional eating, two found significant improvements with moderate and large effect sizes in the mindfulness condition. Notably, Leahey et al. (2008) demonstrated a large but nonsignificant effect size with seven participants ($d = 0.90$). In studies that failed to find a significant reduction in emotional eating, participants were not recruited to address emotional eating and reported low baseline levels of emotional eating (Kearney et al., 2012; Timmerman & Brown, 2012), suggesting that this was not a behavior of concern for the participants or a focus of the intervention. Taken together, in addition to reducing binge eating, it appears that mindfulness meditation reduces emotional eating for those who are engaging in this behavior.

The available evidence on mindfulness and weight loss suggests that **mindfulness training alone, without supplemental behavioral weight management strategies or guidance, may not produce significant or consistent weight loss.** However, because only three studies targeted weight loss as a specific goal of the intervention, additional research is needed to fully determine the impact of mindfulness meditation on weight change, particularly in combination with weight-loss strategies. Therefore, results of the available data suggest that while some individuals lose weight with interventions that are primarily mindfulness-based and where weight loss is a goal (Dalen et al., 2010; Miller et al., 2012), weight loss generally is not observed with mindfulness interventions that focused on other outcomes such as binge eating (Kristeller et al., in press) or general stress management (Kearney et al., 2012).

Out of the ten studies that measured weight as an outcome, six provided didactics on energy balance, nutrition, or exercise, and only one included standard behavioral weight loss techniques such as problem solving and encouraging behavioral goal-setting (Timmerman & Brown, 2012). Among the interventions where weight loss was observed, weight loss served as a primary outcome of the intervention and treatment included either nutrition education alone (Dalen et al., 2010; Miller et al., 2012) or in conjunction with behavioral strategies (Timmerman & Brown, 2012). This **focus on behavioral strategies may have accounted for the effect on weight, given the known importance of these variables in weight control (Wing & Hill, 2001).** However, weight loss was observed even when behavioral strategies were not utilized in a small study of overweight

adults (Dalen et al., 2010). Thus, **weight loss was observed when it was a primary outcome, but there is no evidence that weight loss occurs in response to mindfulness training in the absence of a specific focus on weight.** Notably, a recent randomized controlled trial that combined acceptance-based strategies (i.e., with some training in mindful eating and a focus on accepting thoughts and feelings while pursuing behaviors consistent with one's values) with more traditional behavioral weight loss strategies had a positive impact on weight loss above and beyond standard behavioral weight loss treatment (Forman et al., 2013), suggesting that perhaps **a combination of behavioral strategies with some mindfulness training may yield more positive effects for weight loss.** Taken together, there is preliminary evidence that mindfulness training holds promise for improving weight control efforts, but more research is needed to clarify several factors including the appropriate dosage of mindfulness training versus other treatment components.

Furthermore, although several studies failed to find significant weight loss in the short-term, it remains unknown whether mindfulness meditation impacts long-term weight change. Mindfulness is one mechanism utilized for developing intrinsic or autonomous motivation (Deci & Ryan, 2008), and given that this type of motivation is most strongly associated with long-term behavior change (Teixeira et al., 2010), it is **possible that positive effects of mindfulness on weight would be more delayed.** No study examined weight more than four months post-intervention. Thus, longer term follow-up is needed to determine the effects of mindfulness meditation on weight change over time.

The current review has several limitations. This area of research is still relatively new and is thus limited by a lack of active comparison conditions and small sample sizes. In addition, studies were heterogeneous in terms of target population, intervention components, and primary outcomes. Our risk of bias assessment revealed that there was substantial variability in the attendance and compliance data that was reported, and while approximately half of studies provided information on average daily practice of mindfulness meditation, other studies did not provide this information. Thus, more complete compliance data and comparison control conditions are needed to determine the true impact of mindfulness practice on changes in eating and weight.

Retention rates ranged from 60% to 100%, and thus we are missing some information on how the intervention affected participants lost to follow-up. Retention rates were similar across groups, however, lending more support to the preliminary hypotheses drawn regarding effects for participants that completed the intervention. Finally, as is common with review papers, we are limited to studies that were published in peer-reviewed journals, and cannot disregard the known bias towards publishing significant effects (Chan et al., 2004) and the possibility that mindfulness interventions that were not effective in reducing eating and weight outcomes were left unpublished. Thus, we cannot rule out the possibility that this review overstates the impact of mindfulness on eating behavior and weight. Taken together, the results of this review are preliminary and should only be generalized to different populations with caution. More research with larger samples, compliance data, and comparison conditions is needed to replicate and extend findings and draw firmer conclusions.

Despite the aforementioned limitations, the current review adds to the accumulating evidence that interventions that include mindfulness meditation training hold promise in improving maladaptive eating behaviors. The available evidence suggests that **a standard mindfulness-based training program does not produce consistent weight loss.** This was the first review to examine the impact of primarily mindfulness based interventions on eating behavior and weight in a non-eating disordered population. Our review suggests **that mindfulness meditation is effective in reducing binge eating behavior across a variety of populations, and may also reduce emotional eating.** Thus, mindfulness meditation as an intervention for problematic eating warrants further clinical and empirical attention.

Role of funding sources

The current manuscript had no external funding source.

Contributors

All authors attended multiple collaborative meetings to determine the review protocol (inclusion/exclusion) and discuss the structure of the results and discussion. Authors Katterman and Kleinman conducted the review process, reviewed all articles, and wrote all sections of the manuscript. All authors provided feedback and suggestions on multiple drafts of the manuscript and have all approved the final manuscript.

Conflict of interest

All authors declare no conflicts of interest.

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