THE IMPACT OF MINDFULNESS-BASED INTERVENTIONS ON STRESS EATING, EMOTIONAL EATING, AND BINGE EATING: A LITERATURE REVIEW

By
Kira Minot

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Food Science and Nutrition Department
California Polytechnic State University
San Luis Obispo, CA

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Abstract

This literature review examines the impact of various mindfulness-based interventions (MBIs) on the obesity-related eating behaviors of stress eating, emotional eating, and binge eating. With the inconsistency of the weight loss industry to provide long-term weight loss results, the United States is in need of alternative methods of weight loss and weight maintenance to combat the current overweight and obesity epidemic. MBIs are thought to be beneficial when targeted at behaviors of weight gain because mindfulness promotes an individual's awareness of present physical and emotional sensations within the body, including hunger and satiety cues. Self-acceptance and stress reduction are also targeted outcomes of mindfulness and are linked to the benefits of MBIs on obesity-related eating behaviors. Results show that MBIs may be beneficial to improving the targeted eating behaviors which have been linked to weight gain. However, when weight change is the goal, MBIs have been shown to be most effective when used in conjunction with other weight loss methods such as dietary and physical activity and education modifications. To date, studies are few and contain a variety of definitions for both eating behaviors and MBIs. Future research with a narrowed scope of view and greater variation within the study populations will be beneficial. Although more research is needed, current evidence exists to support the use of MBIs to reduce the frequency and severity of stress eating, emotional eating, and binge eating.

Introduction

The objective of this literature review is to explain results from multiple studies related to the effects of mindfulness-based interventions (MBIs) on obesity-related eating behaviors. Overweight and obesity have become increasingly pressing health issues in the United States. Of the 324,701,650 people living in the United States, more than two-thirds of the adult population, or 68.8%, are considered overweight or obese (United States Census Bureau, 2016; National Institute of Health [NIH], 2016b). This is a large health problem because obesity is linked to chronic disease and mortality. Although Americans spend upwards of $60 billion annually on weight loss, an estimated 80% of individuals who lose weight will return to, or exceed, their original weight within three to five years (Williams, 2013; O'Reilly, Cook, Spruijt-Metz & Black, 2014). The United States is in need of weight loss methods that are more than temporary.

Mindfulness-based interventions are skill-based programs aimed at increasing an individual's quality of life through cultivation of mindfulness practices. Mindfulness is defined as a mental state achieved by focusing awareness on the present moment, acknowledging thoughts and bodily sensations in a nonjudgmental way, and accepting the experiences in each transitory moment (Katterman, Kleinman, Hood, Nackers, & Cosica, 2014). Mindfulness-based interventions are being increasingly researched because they empower individuals to recognize initial thoughts and reactivity to events, and allow time for conscious contemplation of a more healthful response (Katterman et al., 2014). Mindfulness based interventions target health issues such as obesity-related eating behaviors by increasing awareness of bodily sensations such as hunger and satiety signals, as well as emotional cues. Eating behaviors that disregard internal and

external cues have been related to ingestion of more calories than the body deems necessary at that moment (Wansink, 2006).

Stress eating, emotional eating, and binge eating have been linked to weight gain and weight regain, and are the obesity-related eating behaviors of focus in this review (O'Reilly et al., 2014). Stress eating occurs as a physical response to psychological feelings of demand or threat. Stress eating is characterized by a hyper-secretion of cortisol from the adrenal cortex which has been connected to increased feelings of hunger and abdominal fat (Daubenmier et al., 2011). Emotional eating relates to the consumption of food in response to emotional signals as opposed to hunger cues. Binge eating is described as the consumption of large amounts of food in conjunction with loss of control over eating (O'Reilly et al., 2014). With obesity on the rise, exploration of alternative methods to weight loss are becoming more prevalent within the scientific research community, whose findings are the focus of this review.

Obesity-Related Eating Behaviors

For the purposes of this paper, obesity-related eating behaviors are defined as behaviors in which there is evidence of a correlation with weight gain or obesity (O'Reilly et al., 2014). Studies included in this review will involve those whose focus is associated with obesity-related eating behaviors of stress eating, emotional eating, and binge eating.

Stress Eating

Stress eating, as defined above, is common amongst Americans today. The American Psychological Association (APA) (2016) reports that 38% of adults say they have overeaten, or eaten unhealthy foods in the past month due to stress. Forty-nine percent of those adults say this habit occurs weekly or more often (APA, 2016). Stress eating also affects the way individuals

view themselves psychologically. Forty-nine percent of people who overeat or eat unhealthy foods report feeling disappointed in themselves, and 46% report feeling bad about their bodies (APA, 2016). The physical and emotional effects of stress eating make it easy for individuals to gain weight and difficult for them to decipher physiological cues of hunger and satiety. This relationship between stress and eating can be measured in a laboratory setting.

Stress relates to behaviors induced when an individual's sympathetic nervous system is triggered and a fight-or-flight response results. This response can be documented using a biomarker such as cortisol, which is released from the hypothalamic-pituitary-adrenal (HPA) axis when the body is under stress (Daubenmier et al., 2011). Cortisol is related to weight gain because it causes glucose to be released from the cells and used as energy for large muscle groups during the fight-or-flight response. Cortisol also inhibits insulin production in attempt to keep glucose in the blood stream for immediate use, as opposed to being stored in cells. As a result, cells become starved for glucose and send hunger signals to the brain causing an individual to feel hungry (Aronson, 2009). This can lead to overeating and the creation of excess glucose which will be stored as fat, potentially contributing to weight gain (Aronson, 2009). While increased abdominal fat can be traced back to stress factors such as increased levels of cortisol, stress *eating* can also be a result of the prevalence of this hormone.

Cortisol has been shown to affect the type and amount of food consumed. Increased psychological stress has been linked to consumption of high fat and sweet foods, leading to overall weight gain (Daubenmier et al., 2011). Stress-induced cortisol reactivity has also been linked to a greater consumption of calories in high cortisol reactor groups as opposed to low cortisol reactor groups, as shown in Figure 1 (Epel, Lapidus, McEwen, & Browned, 2001).

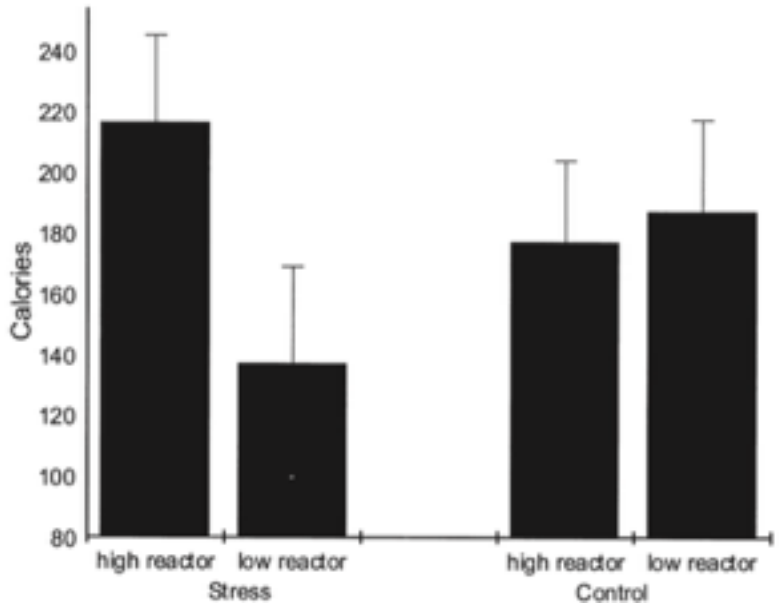

FIGURE 1. Raw mean calories consumed by reactivity group on stress and control days. From Epel et al. (2001).

It is common for people to adjust their eating habits in response to internal and external stressors. While approximately 20% of individuals will not change their dietary habits under stress, many do. About 40% of people will increase their caloric intake and 40% will decrease their intake (Sojcher, Fogerite, & Perlman, 2012). It is theorized that stress can elicit an imbalance between hedonic feeding, the tendency for humans to trigger a pleasure response, and inhibitory control, the ability to inhibit food intake in response to food scarcity or social pressures (Sojcher et al., 2012). This imbalance can result in a habitual increase in caloric intake and decreased cognitive control (Sojcher et al., 2012).

Stress eating is a quantifiable behavior that can be measured in a few different ways. Over the past two decades, salivary cortisol has been the most commonly used biological measure of stress (Centre for Studies on Human Stress, 2007). Salivary cortisol samples are reflective of serum cortisol levels which relate to levels of stress (Epel et al., 2001). The Profile

of Mood States (POMS) can measure mood reactivity including depression/ dejection, anger/ hostility, and tension/anxiety, all of which are body stressors (Epel et al., 2001). These behaviors can give insight into a person's stress level based on the degree of their negative mood. Dietary restraint can be measured using the Eating Attitude Test (EAT) (Epel et al., 2001). Dietary restraint is relevant to stress-induced eating in relation to an individual's caloric intake. Body image concern has been related to stress and can be measured using the Body Shape Questionnaire (BSQ), a 16-item survey measuring concern about body image and shape in individuals with disordered eating patters (Alberts et al., 2012). It is important to quantify stress factors and the effect of stress on an individual's physiological and psychological state when determining if a correlation is present between stress and eating behaviors.

Emotional Eating

Emotional eating is defined as the consumption of food when listening to mental signals of emotional distress as opposed to physiological hunger cues (Kearney, Milton, Malte, McDermott, Martinez, & Simpson, 2012). There are no current prevalence statistics for emotional eating; however, studies have shown emotional eating occurs more often in obese individuals compared to normal-weight individuals (Patel & Schlundt, 2001). Emotional eaters tend to target high-fat, high-calorie foods that are more energy dense, and less nutrient dense (Kearney et al., 2012). Emotional eating can be stress induced, or lead to stress after the ingestion of food. An individual's dietary choices affect the way they think and feel about themselves physically and emotionally (APA, 2016). This creates the potential for emotional eaters to engage in a dangerous cycle of stress, emotional eating, then greater stress, leading to a higher probability of weight gain (Kearney et al., 2012).

Emotional eating can be measured using multiple methods. The Three-Factor Eating Questionnaire (TFEQ), developed by Stunkard and Messick, is a self-assessment consisting of fifty-one items specific to eating behaviors (Stunkard & Messick, 1985). The three factors relate to: “Cognitive Restraint”, “Disinhibition”, and “Hunger”. The TFEQ was modified to highlight specific eating behaviors in a revised, eighteen-item version called, TFEQ-R18. The three factors included in the revised questionnaire include: “Cognitive Restraint”, “Uncontrolled Eating”, and “Emotional Eating” (Angle, Engblom, Eriksson, Kautiainen, Saha & Lindfors, et al., 2009). Higher scores within the emotional eating section of the TFEQ-R18 have been correlated to a higher body mass index (BMI) in adolescent females (Angle et al., 2009). The TFEQ-R18 has demonstrated good reliability in obese and non-obese populations (Angle et al., 2009; Domoff, Meers, Koball & Musher-Eizenman, 2014).

A second method to measure emotional eating is the Dutch Eating Behavior Questionnaire (DEB-Q). This questionnaire consists of three sub scales measuring emotional eating, restrained eating, and external eating (Domoff et al., 2014). The questionnaire is a self-reported scale asking individuals to give information regarding the frequency of emotional eating, and eating in response to feeling a specified emotion. Mixed results have been found related to the concurrent validity of this self-reporting measure of emotional eating behaviors compared to actual food intake (Domoff et al., 2014). While stress can influence emotional eating behaviors, stress has also been shown to affect individuals with binge eating disorder (BED).

Binge Eating

Binge eating disorder was newly characterized by the American Psychiatric Association (APA), in the 2013 Fifth Edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5). The DSM-5 describes characteristics of BED including: eating more rapidly than normal, eating until uncomfortably full, eating large amounts of food when hunger is not present, eating alone because of embarrassment related to the size of the meal, feeling disgusted, depressed, or guilty after overeating, and the absence of purging (Marx, 2013). Binge eating disorder is the most common eating disorder in the United States affecting 2% of men, 3.5% of women, and up to 1.6% of adolescents (Marx, 2013). The APA reports that two-thirds, or 66.7% of individuals with BED are obese (Marx, 2013). Binge eating disorder is also shown to affect black and white populations equally (Marx, 2013).

Binge eating leads to obesity via continuous overconsumption of food in a short period of time. It has been theorized that individuals who partake in binge eating and emotional eating may do so as a maladaptive coping mechanism to negative self-assessments and psychological distress (O'Reilly et al., 2014). Stress, again, plays a cyclic role in this obesity-related eating behavior. Individuals suffering from BED have been shown to have higher morning basal cortisol levels than those without BED. (Gluck, Geliebter, & Lorence, 2004). This shows that stress plays a major role in the disorder, as well as the affiliation of BED with weight gain and obesity. In one case-control study comparing caloric intake of obese individuals with BED, and obese individuals without BED, the group with BED consumed an average of 971.5 more calories (total kcals=3,395) on "binge days" opposed to the non-BED group (total kcals=2,424)

(Raymond, Neumeyer, Warren, Lee, & Peterson, 2003). Binge eating disorder is related to weight gain and obesity and can be measured and diagnosed using different methods.

Binge eating disorder can be diagnosed using the 1993 version of the Questionnaire on Eating and Weight Patterns (QEWP). This questionnaire can be self-reported, or given by telephone, and focuses primarily on assessing diagnostic criteria of BED. The QEWP has been shown to work best when used for the screening of BED, with interviews used to confirm the disorder (Yanovski, Marcus, Wadden, & Walsh, 2015). Binge eating severity can also be assessed using the Binge Eating Scale (BES), a valid and reliable self-reported measure of assessment (Mclver, Halloran, & McGartland, 2009) . Total BES scores above 27 indicate a serious binge eating problem, while scores between 18-26 indicate a moderate binge eating problem, and scores below 17 indicate the absence of a binge eating problem (Mclver et al., 2009). There are also clinical ways to assess and diagnose BED including physical exams and interviews with questions related to BED characteristics described in the DSM-5 (Gluck et al., 2004).

Stress eating, emotional eating, and BED are multifactorial obesity-related eating behaviors. Stress alone plays a part within all of these eating behaviors by enhancing cortisol levels and insulin resistance leading to increased hunger cues, mobilization of fat to the abdomen, and increased consumption of high-fat, calorie-dense foods. Each of these behaviors also includes psychological distress such as depression, or anxiety surrounding food and body image. Mindfulness is hypothesized to be effective in reducing these behaviors. It is difficult to combat weight gain and obesity through traditional weight loss methods such as dieting, which has been shown to be ineffective in the long-term for many dieters (Sojcher et al., 2012). Typical diets consist of calorie deprivation and food restriction and therefore are not usually adequate

long-term lifestyle changes to maintain weight loss. The effect of MBIs on obesity-related eating behaviors is becoming increasingly examined in hopes of a new mode to achieve successful weight loss and maintenance.

Mindfulness-Based Interventions

Mindfulness relates to a state of mental awareness achieved when an individual is focused on the present moment, cultivating acceptance and releasing judgment during that time. Mindfulness-based interventions, as defined previously, have been used to achieve many different health outcomes.

Mindfulness Practices in Healthcare

Mindfulness practices have been taught and applied in the health field for ailments ranging from stress, and anxiety, to substance abuse and eating behaviors (O'Reilly et al., 2014). Mindfulness practices have been shown to promote self-efficacy and self-regulation by enhancing emotional and physical awareness of an individual's current state of being (O'Reilly et al., 2014). Mindfulness-based interventions have been used in the health field to aid in eating disorders such as anorexia nervosa, bulimia nervosa, and binge eating disorder, outcomes of which have been varied (Katterman et al., 2014). Previous studies have reported the effectiveness of mindfulness training in the reduction of psychological stress and the enhancement of psychological well-being for a variety of health conditions (Daubenmier et al., 2011). Studies have also focused on MBIs for depression, chronic pain, stress reduction, cancer care, speech pathologies, psychiatric disorders, and psychological health (O'Reilly et al., 2014). To examine the usefulness of MBIs on health related outcomes, there must first be a way to quantify mindfulness.

Measuring Mindfulness

The are a few ways mindfulness is measured in a health care setting. One method involves using the Kentucky Inventory of Mindfulness Skills (KIMS). This questionnaire was developed in 2004 by Baer, Smith, and Allen, and measures four separate and interrelated mindfulness skills including: Observing, Describing, Acting with Awareness, and Accepting without Judgment (Baer, Smith, & Allen, 2004). Observing entails acknowledgement of internal and external stimuli. Describing involves the ability to verbally explain one's experiences. Acting with Awareness describes the ability to give undivided attention to the happenings and sensations of the present moment. Accepting without judgment assesses the ability of an individual to accept a situation, especially one perceived as negative, without labeling it along a scale between good and bad (Daubenmier et al., 2011). The Kentucky Inventory of Mindfulness Skills is measured on a 5-point scale ranging from 1 (never, or very rarely true) to 5 (almost always, or always true).

Mindfulness has also been measured using the Five Facet Mindfulness Questionnaire (FFMQ). This 39-item questionnaire is similar to the KIMS in that it measures five factors including: observing internal experience, describing internal experience, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience (Kearney et al., 2012). Previous findings show the FFMQ has adequate convergent, incremental, and construct validity (Baer et al., 2008; Kearney et al., 2012).

A third method for quantifying mindfulness is the Body Responsiveness Scale (BRS). This scale measures an individual's ability to identify bodily sensations that guide behavior, and the degree of integration between physical and mental states (Daubenmier et al., 2011). It is

measured on a 7-point scale where higher scores indicate greater body responsiveness (Daubenmier et al., 2011). It is not only important to measure mindfulness when researching the effectiveness of MBIs, but it is also necessary to specify which mindfulness practices are used in different interventions.

General Mindfulness Practices

Studies cited in this literature review use an array of mindfulness practices under the category of MBIs. Body scan meditation is one such method that involves generating awareness of the breath, while focusing on a specific part of the body and continuing that attention to breath while "scanning" different parts of the body (O'Reilly et al., 2014). This method is aimed at relaxing the part of the body in focus, and is commonly used to reduce stress and increase bodily awareness.

Seated meditation is another practice commonly used to promote mindfulness. The aim of this method is to calm the mind and cultivate awareness as to the nature of the mind without emotional reaction (Sojcher et al., 2012).

The physical practice of yoga is a mindfulness practice that has become increasingly more prevalent in the United States. Twenty-one million Americans, or 9.5% of adults, have practiced yoga in the past twelve months (NIH, 2016$_a$). This number has increased from 6.1% of adults practicing yoga in 2007 up from 5.1% practicing in 2002 (NIH, 2016$_a$). Yoga has been used as a mindfulness practice to increase mental awareness of bodily sensations, physically strengthen the body, and increase psychological well-being (Gaiswinkler & Unterrainer, 2016). Body scan mediation, seated meditation, and yoga are general mindfulness practices that are aimed at cultivating a stronger connection with the self by enhancing awareness and acceptance

of physical and emotional sensations without judgment. Formal mindfulness-based therapies have also been used in relation to psychological and physical behaviors.

Mindfulness-Based Stress Reduction

Mindfulness-Based Stress Reduction (MBSR) has typically been used in a clinical setting as a therapy method for pain management and stress-related disorders (O'Reilly et al., 2014). Mindfulness-Based Stress Reduction was first developed in 1979 by Dr. Jon Kabat-Zinn with a central focus on intensive mindfulness meditation and its integration into aspects of everyday life and challenges (The Center for Mindfulness, 2014). Mindfulness-Based Stress Reduction is an eight-week program where participants meet for two and a half hours, once a week, plus one all-day class (The Center for Mindfulness, 2014). Methods typically taught in MBSR consist of sitting meditation, body scanning, gentle yoga, walking meditation, and loving-kindness meditation (a method of developing compassion) (Kearney et al., 2012).

Mindfulness-Based Stress Reduction was developed based on research exhibiting positive effects of mindfulness meditation on health. As shown in Figure 2, a randomized control trial, completed using flu vaccines, found participants in the experimental, MBSR group to have greater responses to the vaccine than the control group.

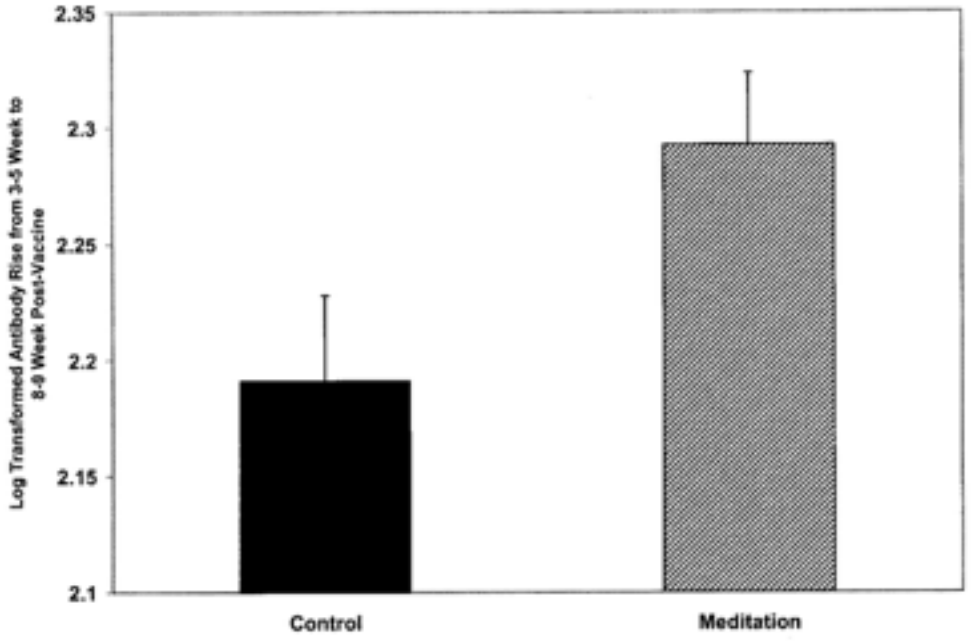

FIGURE 2. Means SE antibody rise from the 3- to 5-week to the 8- to 9-week blood draw in the Meditation and Control groups. The ordinate displays the difference in the log-transformed antibody rise between the 3- to 5- and the 8- to 9-week blood draws derived from the hemagglutination inhibition assay. From Davidson et al. (2003).

The amount a participant's brain changed was predictive of the effectiveness of the vaccine (Davidson et al., 2003). Mindfulness-Based Stress Reduction has since created versions of the program that can be tailored specifically to diet and eating behaviors.

Mindfulness-Based Cognitive Therapy

Mindfulness-Based Cognitive Therapy (MBCT) is a mindfulness program designed to prevent relapse of depression and treat borderline personality disorder (O'Reilly et al., 2014). Mindfulness-Based Cognitive Therapy uses traditional Cognitive Behavioral Therapy (CBT) methods (a common treatment used in psychology), with an added component of mindfulness. Both MBCT and MBSR have been shown to be effective in reducing psychological factors such as anxiety, depression, and stress (Sojcher et al., 2012). Mindfulness-Based Cognitive Therapy

also has modified versions which focus on eating behaviors by combining elements of mindfulness, with mindful eating and physical activity (Sojcher et al., 2012).

Mindfulness-Based Eating Awareness Training

Mindfulness-Based Eating Awareness Training (MB-EAT) is a cognitive therapy specifically designed to target eating behaviors. Mindfulness-Based Eating Awareness Training is a 12-session program, originally developed by Dr. Kristeller, which focuses on helping individuals create a functional relationship between food and themselves (Kristeller, 2015). Mindfulness-Based Eating Awareness Training incorporates practices related to mindfulness, mindful eating, emotional balance, and self-acceptance (Sojcher et al., 2012). The practice allows individuals to move from reacting to responding by creating a sense of awareness and consciousness (Kristeller, 2015).

Mindfulness practices can affect many areas of an individual's life, from psychological factors such as emotional state and awareness, to manifesting in physical forms, such as weight reduction. Mindfulness therapies have been used as a means for achieving personal goals and to target health outcomes. This literature review will next examine results of studies focusing on the effect of MBIs on obesity-related eating behaviors such as stress eating, emotional eating, and binge eating.

Effect of Mindfulness-Based Interventions on Obesity-Related Eating Behaviors

MBIs Effect on Stress Eating

Stress can alter biological pathways within an individual that may result in behaviors contributing to weight gain (Daubenmier et al., 2011). Due to the connection between the psychology of stress and the physiological outcomes of the body's response to stress, studies

have emerged which look at the effects of mindfulness practices aimed at reducing stress and their effects on stress eating.

Daubenmier et al. (2011) completed an exploratory randomized control study to measure the effects of a mindfulness program on stress eating (Daubenmier et al., 2011). The study assessed psychological distress, mindfulness, eating behavior, weight, cortisol awakening response (CAR), and abdominal fat pre- and post-assessment (Daubenmier et al., 2011). Forty-seven overweight and obese women with a mean BMI of 31.2kg/m^2 were randomly delegated, via computer-generated random numbers, to either a four-month intervention group, or a control group. The authors hypothesized that mindfulness practices would lead to a reduction in abdominal obesity by decreasing psychological distress, emotional eating, and cortisol secretion, while enhancing responsiveness to bodily sensations (Daubenmier et al., 2011). Participants were eligible if their BMI was between 25-40kg/m^2, weight less than 300 pounds, had no medical issues such as diabetes or medication use, and had no prior experience with Mindfulness-Based Stress Reduction, or any current practice with yoga or meditation.

The intervention group participated in a compilation of mindfulness practices drawn from components of MBSR, MBCT, and MB-EAT. The treatment group engaged in nine, 2.5 hour classes, and one seven hour day of guided silent meditation practice after class six (Daubenmier et al., 2011). Classes began with a mindfulness practice (body scan meditation, yoga, sitting meditation, loving-kindness directed towards the self and others, or self-forgiveness practices) followed by an open discussion of the practice and a review of the challenges and current progress. Guided meditations and discussions were also used to bring awareness to mindful

eating practices. Half-way through the intervention both groups took part in a two-hour nutrition and exercise information session aimed at weight loss (Daubenmier et al., 2011).

Results reported the treatment group showed a significant increase in mindfulness and a decrease in trait anxiety compared to the control group. Chronic stress remained constant in the treatment group, while increasing in the control group. Obese participants in the treatment group showed significant reductions in mean CAR (salivary cortisol levels taken in the morning) (-9.4 $\pm$ 11.0nmol/L, p = .03). The mean CARs of the overweight participants in the treatment group (1.5 $\pm$ 4.8nmol/L, p = .33), and the control group (-0.3 $\pm$ 8.7nmol/L, p = .92) did not change over time. Within the treatment group, weight was maintained in obese participants (-0.4 $\pm$ 3.5kg, p = .70) and overweight participants (0.4 $\pm$ 1.8kg, p = .53), while those in the control group gained weight (1.7 $\pm$1.5kg, p = .01). Reduction in CAR was significantly related to reduction in abdominal fat in the treatment group, but not control group (p = .02). The BRS relayed results showing a significant relationship between increased body responsiveness and greater decreases in abdominal fat among the treatment group only. Among all participants, increases in the KIMS sub-scales, Acting with Awareness (b= -0.08(0.04); 95% CI [-0.17-0.00]; p = .05) and Describing (b= -0.09(0.04); 95% CI [-0.17- -0.01]; p=0.03) were related to decreases in trunk/leg fat ratios (Daubenmier et al., 2011). The overall results indicate that mindfulness practices alone may not reliably reduce caloric intake in this specific population, but may help prevent periodic increases in overeating and eventual weight gain (Daubenmier et al., 2011).

The above mentioned clinical trial has little external validity to populations outside of this specific sample, due to the population being recruited from media outlets and flyers in the San Francisco Bay area. In addition, the small number of participants hinders the generalization

of the results to a wider population. Many of the *p*-values greater than 0.05 were labeled as "statistically significant." This may have occurred because this study gave no baseline value to define what measures classified as statistically significant. Therefore, authors' interpretation of the results may be different from a reader's interpretation depending on the rigor of significance standards implemented. However, this study did use standardized and validated methods of measurement, as well as trained staff for all outcomes measured giving increased reliability to the results. To further raise the reliability of the results of this study, this intervention must be repeated with defined levels of significance and a larger sample size that is more representative of a general population.

A second clinical trial by Epel et al. (2001) tested the effect of stress-induced cortisol on eating behavior in 59 pre-menopausal women (Epel et al., 2001). The authors hypothesized that women who secreted more cortisol (high cortisol reactors) in response to stress would eat more calories and choose foods higher in fat and sugar, than women who secreted less cortisol (low cortisol reactors). Women participated in four, three-hour laboratory sessions, with the first three being stressful and the fourth being a rest, or control session. The women were exposed to forty-five minutes of stress consisting of three tasks including: visuospatial puzzles, serial subtraction of a prime number from a high number, and deliverance of a videotaped speech supposedly evaluated by a committee watching behind a one-way mirror. The women were given an unrealistic time frame to complete these tasks in order to induce stress. To decrease bias, participants did not know their food intake was being studied (Epel et al., 2001).

Results retrieved via salivary cortisol showed a significantly higher level of cortisol on stress days (M=28.6, SE=1.7) compared to the rest day (M=22.6, SE=1.5, $p < .01$) (Epel et al.,

2001). Increases in average negative mood during stress days, measured by the Profile of Mood States (POMS), were correlated to food intake after stressors (r=0.32, $p < .05$). Average negative mood during the control session was not significantly correlated to intake (r=0.24, $p = .13$). As shown previously in Figure 1, high reactors, on average, consumed more calories on stress days (calories M=216.3, SE=29) than low reactors (calories M=137.3, SE=31.8), but high reactors had similar intakes (calories M=176.7, SE=27) to low reactors (calories M= 187.2, SE= 29.9) on the control day. On stress days, high reactors also ate significantly more sweet, high-fat foods (121.8 calories) than low reactors (72.9 calories; $p < .05$).

The Epel et al. (2001) study showed that cortisol levels may be related to ingestion of more calories, however, the small sample size and short, four-day experimental time period leaves room for study design improvement. There is little external validity in this experiment due to the specific characteristics of the participants, therefore it is difficult to say if the results would apply to a larger population. It is also difficult to rule out the effect of contributory factors other than cortisol on dietary patterns, such as physical activity, hunger level, and socioeconomic factors. Comparison with other studies may be beneficial in confirming the results of these findings.

Almost half of people who overeat report negative emotions about their body, which can correlate to their overall stress level (APA, 2016). To explore this, Alberts et al. (2012) completed a non-clinical intervention in twenty-six women with disordered eating behaviors and a mean BMI of 32.7kg/m^2. Amongst other factors, this study focused on the effect of MBIs on "body image concern," defined as negative perceptions towards ones physical appearance (Alberts et al., 2012). The intervention group participated in an eight-week MBCT-based eating

program. The idea behind exploring this factor was that mindfulness would breed acceptance of one's physical and emotional attributes thereby promoting more positive eating behaviors (Alberts et al., 2012). All participants completed multiple questionnaires before and after the intervention including the KIMS and the DEB-Q. The intervention consisted of an MBCT program that was specifically tailored to eating behaviors. The intervention consisted of five components: mindful eating, awareness of physical sensations, awareness of thoughts and feelings related to eating, acceptance and non-judgment of sensations, thoughts, feelings, and the body, and awareness of change in daily eating and physical activity patterns. The intervention also included 2.5 hours of exercise during eight, weekly sessions. Mindfulness practices being taught included body scan, sitting and walking meditation, mindful eating skills, acceptance of physical and emotional aspects of the self, and "dealing with the paradox of control" (Alberts et al., 2012).

Participants in the intervention group showed a significant increase in mindfulness ($p < .01$) on the KIMS questionnaire, compared to the control group who remained steady. Participants within the treatment group also showed significant decreases in body image concern (($p < .01$), compared to the control group, as measured by the BSQ (Alberts et al., 2012). The study is limited by a small sample size, however results show promise for future studies that mindfulness interventions may be effective in aiding psychological processes connected to stress-related eating behaviors.

Mindfulness interventions have been hypothesized to be effective in reducing stress and stress eating by cultivating awareness and acceptance of the current moment. Stress eating can result as a distraction from occurrences that weigh heavy on an individual both physically and

emotionally. Implementing a mindfulness practice during situations of stress and struggle is in its infancy, but results indicate positive outcomes associated with mindfulness and stress eating. Stress eating is similar to emotional eating, yet subtle and important differences exist that create a need for these outcomes to be studied separately.

MBIs Effect on Emotional Eating

Emotional eating differs from stress eating in that it results strictly from psychological factors perceived as negative, as opposed to both physical and mental factors (O'Reilly et al., 2014). In the same study by Alberts et al. (2012), examined previously for its findings related to mindfulness practices and body image concern, emotional eating was also a measured outcome of interest (Alberts et al., 2012). Emotional eating in this study was defined as eating in response to negative emotions (Alberts et al., 2012). Mindfulness practices were expected to improve emotional eating patterns in 26 women with the implementation of an eight-week MBCT-based eating intervention. This hypothesis was based on the idea that mindfulness promotes the willingness to explore, acknowledge, and accept emotions that arise, whether perceived as positive or negative (Alberts et al., 2012). Learning to accept and let go of one's inner monologue and deepest self-critiques by practicing mindfulness was hypothesized to be effective in reducing the frequency and severity of eating in response to those feelings (Alberts et al., 2012).

Participants in the treatment group of this study reported a significant decrease in emotional eating ($p = .03$), compared to the control group ($p = .30$), as measured by the DEB-Q. The treatment group also showed a significant increase in mindfulness ($p < .01$), compared the control group who showed a nonsignificant increase ($p = .08$) (Alberts et al., 2012). Participants

in the treatment group described a significant decrease in food cravings (p = .02), where no change in cravings was observed in the control group (p = .30).

Although no change in weight was observed in either participant group, this study shows promise for the effectiveness of MBIs in decreasing the amount of emotional eating in individuals with disordered eating patterns (Alberts et al., 2012). While it is difficult to connect a psychological factor with a physical outcome, this study attempts to draw an association between external cues, the acknowledgment of internal experiences, and the resulting action of an individual's eating behavior.

In contrast to the findings in the Alberts et al. (2012) study, Kearney et al. (2012) found no significant association between MBSR and reductions in emotional eating. In dissimilarity to all other studies in this review, this longitudinal follow-up study population (N=48) consisted of predominantly male (n=42) veterans, at an urban Veterans Administration medical center, concurrently enrolled in a larger study of various health outcomes with the use of MBSR. All participants had chronic health conditions at the beginning of the nine-month period, throughout which, five consecutive MBSR classes were held (Kearney et al., 2012). Baseline measures were taken two weeks before the first MBSR class. Follow-up measures occurred immediately after the MBSR intervention, and four-months after the program completion date. This intervention followed the specific MBSR protocol without tailoring the intervention to eating behaviors. To be considered compliant with study protocol, participants had to attend four or more class sessions, out of a possible nine, of which thirty-eight participants complied.

Results of this study differed from the authors' original hypothesis that MBSR would positively influence, among other factors, emotional eating and type and quantity of food

consumed (Kearney et al., 2012). At the post-MBSR, four-month follow-up assessment, mean scores for emotional eating were not significantly different from baseline scores. There were also no significant differences in the intake of energy, fat, sugar, fruit, or vegetables between baseline and follow-up times, as measured by a valid and reproducible food frequency questionnaire (FFQ) (Kearney et al., 2012). After limiting results to participants who attended four or more classes, changes in emotional eating were not significantly correlated with mindfulness as measured post-MBSR by the TFEQ and FFMQ respectively. Although no mathematical significance was observed for the measured outcomes, the authors' propose a clinical correlation between an increase in mindfulness and a decrease in emotional eating (Kearney et al., 2012). This proposition was made to encourage further research around this finding to determine the effectiveness of implementing mindfulness practices in a clinical setting.

This study may be limited because the MBSR intervention was not targeted towards specific eating behaviors, although these were the outcomes measured. This study also reports that some of the participants suffered from post traumatic stress disorder (PTSD), but this was not a confounding variable adjusted for. This study is one of the few that targeted a largely male population, however, the small sample size once again leaves room for study design improvement. Due to the selection criteria of the participants, selection bias and participation bias are likely present. Conflicting results in various scientific findings related to the effectiveness of MBIs aimed at improving emotional eating, leave room for further inquiry into the subject.

MBIs Effect on Binge Eating

MBIs have been studied in correlation to binge eating disorder because they aid in relieving stress, calming the mind, and cultivating acceptance of one's physical and emotional state (Sojcehr et al., 2012). With stress being the most commonly reported trigger of binge eating, and evidence correlating high cortisol levels with abdominal fat and food intake after laboratory stress, researchers are spending valuable time and resources analyzing how mindfulness interventions can effect behaviors associated with binge eating disorder (Gluck et al., 2004).

Mclver, Halloran, and McGartland (2009) completed a randomized trial with ninety women measuring the effects of a 12-week yoga program on reducing binge eating severity (Mclver et al., 2009). For this study, yoga was defined in a broad definition that included all major approaches and paths reflecting the pedagogical framework of yoga provided by Gowans (Mclver et al., 2009). Participants were randomized into either the control group (n=45) or the waitlist group (n=45) and were assessed for binge eating severity and physical activity levels. Participants were largely Australian (84%) and European (16%), with a BMI greater than 25kg/ m^2, and were between 25 and 65 years of age (Mclver et al., 2009). Participants were excluded if they regularly practiced yoga. Binge eating was measured using the BES tool. The yoga intervention consisted of weekly, 60-minute sessions of yoga for 12 weeks, with each class including five minutes of *pranayama*, 45 minutes of *haha yoga*, and 10 minutes of *yoga nidra* (deep relaxation). One aim of the yoga program focused on concentrative mediation which included instruction on eating mindfully (Mclver et al., 2009).

Results of the study showed a significant decrease in binge eating severity for the treatment group ($p < .01$), when comparing pre- and post-test mean scores on the BES. The control group scores did not show a significant change. A significant increase in physical activity from pre- to post-treatment was also seen in the yoga group ($p = .001$), while no significant change in the control group was seen. Binge eating scores for the yoga group changed from 29.9 at baseline, indicating a serious binge eating problem, to 14.5 at post-test, indicating the absence of a binge eating problem (Mclver et al., 2009). A three-month follow up test was conducted following post-test results showing outcomes were maintained for the treatment group, more so for scores on the BES ($p = .90$) than for physical activity ($p = .230$). This study related success rates for reducing the severity of binge eating (64%), comparable to rates achieved by psychological programs (66%) such as CBT, and dietary-led programs (57%) (Mclver et al. 2009).

This study may be limited by reporting bias, given the fact that participants self-reported their binge eating status, however, a validated and reliable method was used for measurement. This study was also implemented in a specific group of overweight and obese women with binge eating disorder and therefore results may not be generalizable to larger populations. This trial does provide optimistic results relating the efficacy of a yoga program aimed at reducing the severity of binge eating.

A study by Kristeller and Wolever (2014) was conducted to examine the effects of MB-EAT for treating binge eating disorder (Kristeller & Wolever, 2014). This randomized trial compared a waitlist-group (n=42) with an MB-EAT intervention group (n=50), and a psychoeducational/ cognitive-behavioral intervention (PCEB) group (n=48). Participants

included 140 individuals (12% male, 88% female), with an average age of 46.55 years and a mean BMI of 40.26 25kg/m^2. Sixty-six percent of participants met the DSM criteria for binge eating disorder (Kristeller et al., 2014). The intervention groups received nine weekly sessions with three month booster sessions, and 20 minutes of daily homework, all focused around raising awareness of inappropriate eating patterns. Tools and group support were provided to aid in making sustainable changes in eating habits (Kristeller et al., 2014). Binge eating disorder was measured with a semistructured interview used to confirm the DSM-IV diagnosis of BED. Binge eating was measured using the BES and the TFEQ (Kristeller et al., 2014)

Participants in the MB-EAT intervention group self-reported binges per week on a weekly monitoring sheet. At the end of the interventions, participants in the MB-EAT intervention reported the size of binges substantially decreased. Individuals in the MB-EAT group reported the majority of binge episodes, pre-intervention, to be "medium" and "large" in size. However, at post-treatment and follow-up, 60% of MB-EAT participants reported the majority their binges were "small" (Kristeller et al., 2014). At one-month follow-up, 80% of the MB-EAT participants no longer qualified for a BED diagnosis, compared to 38% of the control group ($p < .01$). At four months post-treatment, 95% of MB-EAT participants no longer qualified for a BED diagnosis, compared to 48% of the waitlist group ($p < .10$) (Kristeller et al., 2014).

This study took many cofounders into account including race, ethnicity, socioeconomic status, and education, increasing the acceptability. Validated and standardized methods were used to measure the outcome. The variability within the sample size allows for greater external validity to larger populations with similar characteristics to those sampled. The results of this

study show the MB-EAT program is effective in reducing the size and severity of binge eating episodes in overweight and obese participants with BED.

As seen in the outcomes of the two clinical trials described above, there is evidence supporting the effectiveness for various MBIs in aiding binge eating. Although more studies must be completed, repeated, and reviewed to come to an increasingly definite conclusion, trials thus far have shown a trend towards reducing the frequency, severity, and size of binge eating episodes when MBIs are implemented. Results of previous studies give value to the idea that MBIs may be effective in aiding binge eating, as well as stress eating and emotional eating.

MBIs Effect on Both Emotional Eating and Binge Eating

Binge eating is highly correlated to emotional cues and therefore a separate section is warranted for studies examining both emotional eating and binge eating as concurrent outcomes. A systematic review by Katterman et al. (2014) examined how binge eating, emotional eating, and/or weight, changed with the implementation of mindfulness meditation as the primary intervention (Katterman et al., 2014). The review included fourteen studies that met the following criteria: the original article was published in a peer reviewed journal, mindfulness training was included in some portion of each session, and binge eating, emotional eating, and/or weight was measured as an outcome. Eleven studies were conducted in the United States, two in the Netherlands, and one in Canada (Katterman et al., 2014).

Binge eating was measured in seven studies, of which all found a significant reduction in binge eating with the implementation of mindfulness practice (Katterman et al., 2014). Emotional eating was measured in five studies where two showed statistically significant improvements in emotional eating, and three showed no significant effect (Katterman et al.,

2014). Six of ten studies that focused on weight loss as a primary outcome showed a significant decrease in weight. Table 1 below shows an overview of the studies included in the Katterman et al. (2014) review, as well as the characteristics and main findings of each study.

TABLE 1. All studies included in the review.

Study	**Design**	**Mindful** ***n/total N***	**Population**	**Intervention length (weeks)**	**Primary outcome(s)** ***Secondary outcome(s)***	**Main findings**
Alberts et al. (2010)	MI + diet vs diet	10/19	Overweight adults with food cravings	10	Cravings *Weight*	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 *Weight*	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 *Weight*	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 *Emotional eating, weight*	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 *Weight*	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 *Weight*	Reduced binge eating in MI compared to controls, similar to CBT, weight change ns

Study	Design	Mindful *n/total N*	Population	Intervention length (weeks)	Primary outcome(s) *Secondary outcome(s)*	Main findings
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 (HgA1c)
Rosenzweig et al. (2007)	MI	11	Adults with DM-2	8	Glycemic control, blood pressure, stress *Weight*	HgA1c, 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 *Binge eating*	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; HgA1c = hemoglobin A1c.

Adapted from Katterman et al. (2014).

A literature review by O'Reilly et al. (2014) researched the effectiveness of MBIs for treating obesity-related eating behaviors (O'Reilly et al., 2014). Twenty-one papers were included in the review and all met the following criteria: described an MBI, or mindfulness exercise as an intervention, included at least one obesity-related eating behavior as an outcome, included quantitative outcomes, and was published in an English peer reviewed journal. Mindfulness interventions implemented included MBSR, combined mindfulness and cognitive behavioral therapies, acceptance-based therapies, mindful eating programs, and combinations of

mindfulness exercises. These various interventions targeted the eating behavior outcomes of binge eating, emotional eating, external eating, and dietary intake.

Eighteen, or 86% of studies reviewed, described positive changes in targeted eating behaviors (O'Reilly et al., 2014). Of 12 studies that targeted binge eating, 11 (91.7%) reported improvements in binge eating frequency and/or severity. Of the eight studies that examined emotional eating, five (62.5%) reported positive changes in the behavior (O'Reilly et al., 2014).

Although this review was vague in defining "improvements" for various eating behaviors, each study reviewed was available for further inquiry. The lack of one congruent definition of improvement may be due to the variability within each study's intervention and outcome measured. Overall, the two literature reviews described above that examine binge eating and emotional eating, amongst other behaviors, provide evidence to support the effectiveness of MBIs in aiding these eating actions. Table 2 gives an overview of all the studies examined in the section of this review that have discussed the effect of MBIs on the obesity-related eating behaviors of stress eating, emotional eating, and binge eating.

Table 2. A compilation of peer reviewed studies surrounding the effects of mindfulness practices on obesity-related eating behaviors.

Study	Study Design	Sample Size	Sample Characteristics	Exposure Measured	Outcome Measured	Assessment Method	Statistically Significant	Main Findings
Daubenmeir et al., (2011)	Clinical Trial	*N*=47	Overweight/ obese women	Mindfulness program	Stress eating	KIMS, Salivary cortisol (mean CAR), Weight, BRS	Yes	• Improvement in mindfulness, anxiety, and external-based eating for treatment group compared to control group. • Obese treatment group showed reduction in mean CAR and maintained body weight • Control group had stable CAR and gained weight
Epel et al., 2000	Clinical Trial	*N*=59	Pre-menopausal women (30-45y)	Stress-induced cortisol	Eating after stress	Salivary cortisol, POMS	Yes	• Cortisol levels higher on stress days • Increased negative mood on stress days related to food intake • High cortisol reactors consumed more calories, and ate more sweet, high-fat foods on stress days compared to low reactors, and compared to control days
Alberts et al., 2012	Clinical Trial	*N*=26	Women with disordered eating behavior	MBCT-based eating intervention	Body image concern and emotional eating	KIMS, BSQ DEB-Q	Yes	• Treatment group: Increase in mindfulness, decrease in body image concern, decrease in amount of emotional eating • Control Group: No change in mindfulness, body image concern or emotional eating
Kearney et al., 2012	Longitudinal Follow-up	*N*=48 (42 male, 6 female)	Predominantly male veterans at a large urban Veterans Administration medical center	MBSR without emphasis on eating	Emotional eating and type and quantity of food consumed	TFEQ,FFQ, FFMQ	No	• Emotional eating scores at follow-up did not significantly differ from baseline • No significant differences in intake of energies, fat, sugar, fruit, or vegetables between baseline and follow-up

Study	Study Design	Sample Size	Sample Characteristics	Exposure Measured	Outcome Measured	Assessment Method	Statistically Significant	Main Findings
McIver et al., 2009	Randomized Trial	*N*=90	Overweight and obese women with BED	Yoga	Severity of BED and physical activity	BES	Yes	• Significant decrease in binge eating severity within treatment group and no change for control group • Three-month follow-up showed treatment group retained reduction in binge eating severity • Increase in physical activity for treatment group, no change in control group
Kristeller et al., 2014	Clinical Trial	*N*=140	Overweight and obese male (12%) and females (88%) diagnosed with BED	MB-EAT	Size of bing eating episodes	BES, TFEQ, DSM-IV interview to classify BED	Yes	• Size of binge eating episodes reduced in treatment group from mainly "medium" and "large", to "small" • At four-month follow-up, 95% of MB-EAT participants no longer qualified for BED diagnosis, compared to 48% of wait-list group
Katterman et al., 2014	Systematic Review	*N*=14	Studies that investigated mindfulness meditation as the primary intervention	Mindfulness meditation	Binge eating, emotional eating, and/or weight change	Literature search	Yes	• Binge eating and emotional eating were effectively decreased • Mixed results related to weight change
O'Reilly et al., 2014	Literature Review	*N*=21	Studies that used a variety of MBI methods to measure outcomes.	MBI's	Binge eating, emotional eating, external eating, dietary intake	Literature search	Yes	• 86% of review studies reported positive changes in targeted eating behaviors • 91.7% showed improvements in binge eating • 62.5% percent of studies showed an improvement in emotional eating

Summary

Viktor E. Frankl, an Austrian neurologist and psychiatrist, once said, “Between stimulus and response there is a space. In that space is our power to choose our response. In our response lies our growth and our freedom” (Nicholson, 2016). Adopting a mindfulness practice allows individuals to pause and reflect on how their mind and body are reacting to a given situation. In this moment of mindfulness, the space that Frankl describes is created, and in that creation, change is possible.

All of the studies in this review, with the exception of one, show promising results for decreasing maladaptive eating behaviors with the use of MBIs. Successful outcomes were relayed in studies for which mindfulness interventions were specifically focused toward improving eating behaviors. Participants in the reviewed studies have shown that cultivating awareness of bodily sensations, coupled with acceptance of the present moment, and their personal state of being in that moment, can be effective in reducing the frequency and severity of stress eating, emotional eating, and binge eating.

While mindfulness has been shown to improve eating behaviors in seven of the eight studies reviewed, evidence suggests that mindfulness practices may work best at improving obesity-related eating behaviors when implemented in conjunction with other therapy methods such as physical activity and peer support groups. Interventions targeted toward weight loss, in addition to eating behaviors, seemed to have more success with reducing participants weight, than those that did not. Stress eating, emotional eating, and binge eating have deep rooted psychological ties, in addition to their physical nature. Because of this, many studies have

researched therapy methods such as mindfulness that target the foundation of behavior within the mind.

Mindfulness practice is a technique that targets a lifestyle behavior. When adopted, this practice can expand beyond eating behaviors and be implemented throughout all daily activities to promote quality of life. Mindfulness practices have been researched in conjunction with an array of psychological and physical outcomes such as depression, anxiety, chronic disease, among others with various findings. When an individual is able to step out of a heightened emotional predicament, whether positive or negative, and observe the energy state of body and mind, control can be gained. With this recognition, one is able to contemplate a more healthful reactive action, instead of reacting without intention. Overall, studies in this review show that mindfulness can be beneficial in targeting eating behaviors that have been shown to lead to weight gain.

While a variety of studies can show stress eating, emotional eating, and binge eating behaviors are reduced with the implementation of MBIs, it may be difficult to make the leap between a psychological factor and losing weight. Although studies have used biomarkers, such as cortisol, and standardized, validated methods of measuring psychological outcomes such as negative mood and mindfulness, it is difficult to directly connect a psychological state with a physical outcome. To partially accommodate this, many studies added emphasis on weight change in conjunction with the mindfulness aspects of the intervention. While successful weight loss was measured in a few studies, it is difficult to determine which exposure (mindfulness practice, or weight loss promotion) was responsible. As stated previously, studies that

incorporated both seemed to relay more successful outcomes related to weight reduction, than did studies without emphasis on weight change.

Due to the health risks associated with being overweight and obese, the United States is in need for alternative interventions for weight loss and weight maintenance. While studies have shown MBIs may reduce the frequency and severity of eating behaviors that lead to weight gain, the studies reviewed do not claim to help participants lose weight solely with the mindfulness practices within the intervention. If weight loss is the overall desired outcome, the studies in this review show it may be beneficial to implement a mindfulness aspect, however they do not suggest mindfulness is the only practice needed to induce weight change.

Limitations

Although 88% of the studies in this review reported improvements in stress eating, emotional eating, and/or binge eating with the implementation of MBIs, limitations exist in this body of research. Many of the studies examining a correlation between MBIs and obesity-related eating behaviors referenced each other as sources. This led many of the papers to draw similar conclusions. While each study design was unique, it is possible bias was present, and may be present in this review, because many drew from the same literature to support claims. While a lack of negative outcomes may speak to the effectiveness of MBIs, it is also possible that publication bias is present, and therefore differing results lack a platform.

Mindfulness practice encompasses an extensive variety of actions, thereby making it difficult for each study to follow one definition of "mindfulness-based intervention." With the great degree of variability defining the exposure measured, it is difficult to compare results. Because mindfulness is a psychological factor it has many facets. Mindfulness appears

differently in every being and therefore creates obstacles for researchers. While standardized and validated methods have been created to measure mindfulness, it is difficult to concretely draw comparisons between studies. It is especially tough to draw conclusions about behavioral outcomes based on a fluid psychological factor.

While research about the effects of MBIs on obesity-related eating behaviors encompasses a multitude of mindfulness definitions, the majority of research greatly lacks variation in the study population. Research has mainly examined overweight and obese Caucasian, adult females with diagnosed eating disorders. Research related to normal-weight individuals, or those without diagnosed eating disorders, that may still partake in obesity-related eating behaviors is lacking. In addition to this, and a deficit in diversity of gender, race and ethnicity, many studies do not account for confounding factors such as education or socioeconomic status. With little variety in the sample populations across most literature surrounding the topic of interest, it is difficult to generalize results to larger populations, and therefore hinders the accepted use of mindfulness techniques in a clinical setting.

Another limitation within the body of research related to their topic is the lack of long-term follow-up. No study reviewed followed-up with participants past four months post-intervention. The lack of follow-up data is a large downfall when studies suggest the potential for MBIs to aid in weight maintenance, opposed to solely weight loss. With the failure of the diet industry as being only short-term effective, the United States population is in desperate need of long-term weight solutions. Mindfulness can be adapted as a lifestyle behavior and therefore has the potential to be beneficial in long-term weight maintenance, however, studies largely lack long-term protocols.

Many of the studies collected measurements using self-reported questionnaires such as FFQ's, KIMS, DEB-Q, TFEQ, FFMQ, BSQ, and BES. While these methods are standardized and validated, there will always be inherent limitations to self-reporting questionnaires. A participant may exhibit recall bias due to dependency on memory. Reporting bias may be present due to the environment in which the survey is completed, information individuals believe researchers are looking for, or how participants believe they will be perceived if answers are not reported anonymously. Although questionnaires present barriers, it is difficult to measure psychological outcomes in an alternative way, therefore these limitations are related more to the nature of the measurements, than the authors' choice to use them. Overall, all studies surrounding the effect of MBIs on obesity-related eating behaviors have limitations. While some may be inherent, others may be modified and reduced in future studies.

Future Research

Future research provides an opportunity to correct the variety of limitations present in current studies surrounding MBIs and obesity-related eating behaviors. It would be beneficial for future research to narrow the scope of MBIs while creating a standardized definition of MBI. If researchers confidently measured the same outcome or exposure as others, adequate comparison of study results could occur.

Research should begin to focus on one particular eating behavior to reduce outcomes resulting from confounding factors. While mindfulness has been connected to a variety of health outcomes, it is difficult to account for aspects outside of the mindfulness program that could alter results. It would also be beneficial if interventions relying on self-reported food questionnaires for intake, used a biomarker when applicable, in conjunction with the food questionnaire. This

would validate the results retrieved from the assessment and therefore add validity and reliability to the overall outcome of the intervention.

Mindfulness interventions include a variety of practices from meditation, yoga and reflecting on breath, to established therapy programs. The multitude of ways mindfulness can be created may be beneficial in the applicability of these practices across many diverse populations. Following this theory, it would be interesting to see results from future studies incorporating more diversity into the sample population. This could also provide evidence to promote, or discourage the use of mindfulness practices across diverse groups of individuals in a clinical setting.

Studies suggest MBIs have the potential to promote weight maintenance. For this to be supported by evidence-based research, future interventions must incorporate longer follow-up periods. This would enable researches to compare results of the effectiveness of the intervention at the time of implementation, and then assess how the intervention has affected individuals across a few years. Follow-up assessments from six-months to five-years may be necessary due to the recidivism rate of gaining weight back after implementing a weight loss program.

Research on MBIs linked to obesity-related eating behaviors has much room for improvement, however, studies in this field are becoming more prevalent in the scientific community. The future looks optimistic in regards to new and continuing research surrounding this topic.

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