

Which facets of mindfulness are related to problematic eating among patients seeking bariatric surgery?

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Abstract

There has been growing research indicating the potential positive benefits of mindfulness-based interventions for obesity, but few studies have examined the relationship of mindfulness processes to obesity-related behaviors, particularly among clinical populations such as bariatric surgery candidates. The current study examined the relationship of specific mindfulness facets to a variety of problematic eating behaviors assessed through diagnostic interviews in a clinical sample of 820 patients seeking bariatric surgery. Results indicated that greater mindfulness on specific facets, particularly acting with awareness, were related to less binge and emotional eating. Greater mindfulness was also related, though less consistently, to less habitual overeating and grazing. The observing facet was generally unrelated to problematic eating, but in a few cases being more observant related to having greater eating problems. The results of the study and future directions are discussed in relation to research on problematic eating in obesity and mindfulness-based interventions.

Keywords: Mindfulness; Obesity; Eating behaviors; Emotional eating; Binge eating

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1. INTRODUCTION

There has been growing interest in incorporating mindfulness into interventions for obesity with promising results from initial studies. These interventions target obesity-related behaviors such as problematic eating (i.e., overeating, emotional eating, binge eating) by increasing nonjudgmental and accepting awareness of present moment experiences through meditative exercises (i.e., mindful breathing, mindful eating), mindfulness in daily activities, and eliciting and modeling mindful awareness within the therapeutic session. Positive results have been found in improving problematic eating, weight and other obesity outcomes through interventions that combine mindfulness with cognitive behavior therapy components (e.g., Leahey, Crowther & Irwin, 2008; Timmerman & Brown, 2012) as well as standalone mindfulness-based interventions without other treatment components (Alberts & Raes, 2012; Kristeller, Wolever & Sheets, in press). In addition, recent research with Acceptance and Commitment Therapy (ACT; Hayes, Strosahl & Wilson, 2011), which incorporates mindfulness with other values, acceptance, and behavior change components, has also found beneficial effects in reducing problematic eating behaviors and improving outcomes for obesity (e.g., Lillis et al., 2009; Forman et al., 2013; Weineland, Hayes & Dahl, 2011; Weineland, Arvidsson, Kakoulidis & Dahl, 2012).

Although there have been a number of recent outcome studies evaluating mindfulness-based interventions for obesity, there has been a relative lack of research examining how these mindfulness processes relate to obesity and problematic eating in a non-intervention context with only a few studies conducted among non-clinical samples to date. Preliminary studies with

college students have found that mindfulness deficits relate to binge eating (Roberts & Danoff-Burg, 2010) as well as uncontrolled and emotional eating (Lattimore, Fisher & Malinowski, 2011). Variables closely related to mindfulness also have been found to predict problematic eating including thought suppression (e.g., Barnes et al., 2013; Erskine & Georgiou, 2010) and acceptance (e.g., Jurascio et al., 2011; Lillis, Hayes & Levin, 2011). Additional research is needed to understand how mindfulness processes apply to obesity and problematic eating patterns, especially among treatment seeking populations, which could further inform mindfulness-based interventions for these problems.

Bariatric surgery candidates are a particularly important clinical population to focus such research on. Individuals seeking bariatric surgery often engage in problem eating behaviors (i.e., binge eating, emotional eating, grazing) and a significant proportion continue to do so following surgery (Colles, Dixon & O'Brien, 2008; Niego, Kofman, Weiss & Geliebter, 2007; Stout et al., 2007). Engaging in these problematic eating patterns, particularly post-surgery, is predictive of poorer weight loss outcomes from surgery (e.g., Canetti, Berry & Elizur, 2009; Colles et al., 2008; Niego et al., 2007). Recent studies indicate the potential efficacy of acceptance and mindfulness-based treatments for reducing emotional eating and binge eating among those who received bariatric surgery (Leahey et al., 2008; Weineland et al., 2011; 2012). However, there has been less outcome research among this sub-sample of obese individuals and no research has been conducted to date examining the role of mindfulness deficits in problem eating behaviors within this clinical population.

The role of mindfulness may vary across the range of eating behaviors that contribute to obesity and poor post-surgery outcomes. There are a variety of problematic eating patterns such as habitual overeating, grazing, binge eating, and emotional eating, each of which may have

different functions and causes (Carter & Jansen, 2012). There is a lack of research to inform which of these problematic eating patterns mindfulness applies to and how mindfulness-based interventions may impact these problems. Mindfulness may particularly apply to dysregulated forms of overeating in which individuals eat to cope with negative feelings or experience a loss of control while eating. Studies have found that mindfulness predicts the tendency to use substances to cope with negative affect (e.g., Bonn-Miller et al., 2010) and that mindfulness relates to a variety of dysregulated behaviors such as gambling, substance abuse, impulsivity, and self injury (Wupperman et al., 2012). Consistent with this, obesity research to date has primarily focused on the relationship of mindfulness to binge and disinhibited eating patterns (Lattimore et al., 2011; Robert & Danoff-Burg, 2010). However, mindfulness also may apply to more “mindless” patterns of problematic eating such as grazing and habitual overeating, in which individuals automatically eat in response to environmental cues with little awareness of their eating or the internal signs of hunger and satiation. Consistent with this, research has highlighted the role of insensitivity to cues for hunger and fullness in binge eating as well as the beneficial impact of improving appetite awareness (e.g., Allen & Craighead, 1999).

In addition to questions regarding specific eating behaviors, it is unclear which aspects of mindfulness are particularly important to focus on in psychosocial interventions for obesity and bariatric surgery patients. Mindfulness is typically defined as a multifaceted construct including a combination of being aware of, observing, and describing the present moment and with qualities such as being nonjudgmental and nonreactive (Baer et al., 2006). Research on facets of mindfulness in other problem areas suggest that there are variations in which facets are most relevant (e.g., Cash & Wittingham, 2010; Desrosiers, Klemanski & Nolen-Hoeksema, 2013). Consistent with this, a recent study found that acting with awareness, being nonjudgmental,

nonreactivity, and to a lesser extent describing, were related to less disinhibited eating, while observing was unrelated or in some cases was related to greater disinhibited eating (Lattimore et al., 2011). Similarly, studies have found that the tendency to suppress thoughts about food and to be non-accepting of cravings is predictive of greater eating problems (Barnes et al., 2013; Erskine & Georgiou, 2010; Jurascio et al., 2011), which is consistent with mindful qualities of being nonjudgmental and nonreactive.

A key issue when examining specific facets of mindfulness is that observing tends to be unrelated to or predictive of greater problems (e.g., Baer et al., 2006; Cash & Wittingham, 2010; Desrosiers et al., 2013). Theoretically, a greater tendency to observe present moment experiences, independent of mindful qualities such as nonreactivity and being nonjudgmental, could be indicative of hypervigilance or other maladaptive attentional biases. Consistent with this, a recent study found that the observing facet interacted with the nonreactivity facet of mindfulness such that those who were high in observing and high in nonreactivity were less likely to abuse substances, but those who were high in observing and low in nonreactivity were more likely to do so (Eisenlohr-Moul et al., 2012). Greater observing skills may similarly be a pathological process that contributes to problematic eating. For example, research indicates that greater sensitivity to external cues for eating is a predictor of problematic overeating (e.g., Van Strien et al., 2012), suggesting being more observant of such stimuli in the environment can contribute to eating problems. Overall, the research on specific facets of mindfulness suggest that deficits in acting with awareness, describing, being nonjudgmental and nonreactivity could be related to a variety of eating problems, while greater observing may be unrelated or predict greater problems. However, the available research is unclear with respect to which facets may be particularly related to which patterns of problematic eating.

The current report from the Rhode Island Bariatric Surgery (RIBS) study of the Methods to Improve Diagnostic Assessment and Services (MIDAS) project sought to examine the relationship of specific mindfulness facets to a range of problematic eating behaviors in a sample of patients being evaluated for bariatric surgery. This is the first study we are aware of that examined mindfulness facets in relation to problematic eating in a clinical sample of patients seeking treatment for weight problems. It was hypothesized that deficits in acting with awareness, being nonjudgmental, nonreactivity, and describing would be related to more dysregulated eating behaviors (i.e., binge eating, emotional eating) as well as habitual overeating and grazing. Given mixed findings with the observing facet, higher observing was hypothesized to relate to more problematic eating behaviors or to be unrelated to problem eating. The results of this study could further inform our understanding of how mindfulness may relate to problematic eating and ways to further refine and incorporate mindfulness-based interventions into treatment for obesity and bariatric surgery patients.

2. METHODS

2.1 Participants

The current study included 820 participants seeking bariatric surgery who completed psychiatric diagnostic interviews and a self-report measure of mindfulness. The sample was 80.8% female with a median age of 43 ($M = 42.93$, $SD = 11.40$, Range = 18 to 72). The racial distribution of the sample was 81.7% White/Caucasian, 8.0% Black/African American, 8.2% Hispanic/Latino, 0.2% Asian and 1.8% other. Relationship status varied with 54.0% married, 9.5% co-habiting, 14.4% divorced or annulled, 1.7% widowed, 1.3% separated and 19.0% never married. Regarding sample education, 6.0% did not graduate high school, 71.1% graduated high school but not college, 14.3% graduated from a 4-year college, and 8.5% received a

graduate degree. The average BMI was 46.40 ($SD = 7.07$, Median = 45.18) with BMI scores ranging from 30.45 to 80.58, indicating all of the participants were obese based on criteria from the National Institutes of Health (1998).

2.2 Procedure

Patients seeking bariatric surgery were referred by their surgeon for a comprehensive psychological assessment as part of the determination of appropriateness for surgery. The bariatric surgery assessments were conducted within the Rhode Island Hospital Outpatient Psychiatry practice. These assessments were integrated within the MIDAS research project and all patients who agreed to participate in the study provided informed consent. The study procedures for the RIBS were approved by the Rhode Island Hospital institutional review committee. Further descriptions of the RIBS project are outlined in Zimmerman and colleagues (2007).

Participants completed semi-structured diagnostic interviews conducted by psychologists and research assistants using the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon & Williams, 1995) as well as a supplementary module assessing eating history and factors related to bariatric surgery (only diagnostic interview data from the bariatric module was used for the current study). Extensive training was provided to each diagnostic interviewer as well as ongoing monitoring to prevent rater drift. Training for psychologists included observing 5 interviews followed by being observed conducting 15-20 interviews, while research assistants observed 20 or more interviews and were then observed conducting 20 or more interviews. Diagnostic interviewers were then required to demonstrate almost perfect diagnostic reliability with a senior diagnostician on 5 interviews. Ratings for every interview are reviewed by the

principal investigator (M.Z.), and cases are reviewed in a weekly diagnostic case conference with the research team.

2.3 Measures

2.3.1 Rhode Island Bariatric Surgery Interview (RIBSI; Zimmerman et al., 2007). The RIBSI is a semi-structured interview designed as an additional module of the SCID for bariatric surgery assessment. The clinician-administered interview includes a series of questions assessing past and current eating behaviors as well as other factors relevant to determining appropriateness for bariatric surgery (i.e., expectations for surgery, understanding of risks for surgery, dieting history, social support, stressors). The current study examined participants' responses to questions assessing if they have a history of engaging in any of the following problematic eating behavior patterns: habitual overeating (i.e., "eating an amount of food that is definitely larger than most people would eat during the course of a day"), rapid overeating (i.e., eating, within a 2-hour period, an amount of food that is definitely larger than most people would eat), binge eating (i.e., a sense of loss of control when consuming a large amount of food in a 2 hour time period), subjective binge eating (i.e., sense of loss of control when eating a small or normal amount of food), emotional eating (i.e., "non-binge eating that has its primary goal the reduction of emotional upset or distress"), and grazing between meals (i.e., "eating in an unplanned and repetitious way or without knowing how much you were going to eat"). These problem eating behaviors were assessed by the clinical interviewer, who classified participants based on whether or not they engaged in each behavior. Participants were also asked during the interview to indicate the frequency of each of these problematic eating episodes over the past 30 days.

During the pre-surgery period in which patients are being assessed for appropriateness for surgery they may be asked to change eating behaviors or may change their behaviors due to

expectations of an upcoming surgery. For example, some patients had recently seen a dietitian or other specialist and made significant changes in their lifestyle and eating habits. To help account for this factor, an additional item assessing pre-surgical behavior changes was included in the current study. Patients were asked whether they had met yet with the dietitian as well as what changes they had made to their eating and exercise habits in preparation for surgery. Interviewers rated the degree to which patients changed their habits in preparation for the surgery on a 5-point scale ranging from 0 “Many changes made in eating habits or lifestyle in preparation for surgery” to 4 “No change made in eating habits or lifestyle, and patient deliberately overeating before surgery limits consumption.”

2.3.2 Clinical Global Impression-Severity of depression (CGI-S; Guy, 1976). The CGI-S was included in this report as a measure of depression severity. This item was rated by the clinical interviewer conducting the RIBSI using a 6-point scale ranging from 0 “None” to 5 “Extreme.” The interrater reliability for the CGI-S was high based on results using the joint interview method with a subsample of 60 patients ($ICC = .83, p < .001$).

2.3.3 Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The FFMQ is a 39-item self-report questionnaire composed of five distinct subscales designed to assess specific facets of mindfulness including observing, describing, acting with awareness, being nonjudgmental and nonreactivity. The observing subscale is composed of 8 items assessing the degree to which participants’ attend to present moment experiences (i.e., “I notice the smells and aromas of things”). The describing subscale consists of 8 items assessing participants’ capacity to label and put words to their internal experiences (i.e., “I’m good at finding the words to describe my feelings”). The acting with awareness subscale consists of 8 items assessing participants’ tendency to be on “autopilot” and not attend to experiences in the present moment

while engaging in activities (i.e., “I find myself doing things without paying attention”). The nonjudgmental subscale consists of 8 items assessing the degree to which participants evaluate their thoughts and feelings as bad and criticize themselves for having these experiences (i.e., “I think some of my emotions are bad or inappropriate and I shouldn’t feel them”). The nonreactivity subscale consists of 7 items assessing the degree to which participants are able to notice thoughts and feelings without responding to or further engaging with them (i.e., “I perceive my feelings and emotions without having to react to them”). Items are rated on a 5-point scale ranging from 1 (“never or very rarely true”) to 5 (“very often or always true”). Past research has found the FFMQ to be a reliable and valid measure of mindfulness facets (Baer et al., 2006). However, it is important to note that the FFMQ has not been validated or otherwise used in previous research with bariatric surgery candidates. The FFMQ subscales had adequate internal consistency in the current study with Cronbach’s alpha values for each subscale of .80 for observing, .87 for describing, .88 for acting with awareness, .88 for being nonjudgmental, and .79 for nonreactivity. Self-report questionnaires including the FFMQ were completed by participants prior to the semi-structured diagnostic interview.

2.3 Data Analysis

A series of analyses were first conducted to examine whether patients with or without a history of engaging in problematic eating behaviors differed on mindfulness facet scores. For each problematic eating behavior, independent *t*-tests were conducted to compare differences on each FFMQ subscale between patients who did and did not endorse engaging in the problem behavior. These analyses were conducted for habitual overeating, rapid overeating, binge eating, subjective binge eating, emotional eating and grazing.

Analyses were then conducted with continuous variables assessing frequency of engaging in each of these problem eating behaviors over the past 30 days. As some patients recently made significant changes in eating habits as part of the pre-surgery procedures, analyses were only conducted among those reporting few to no changes in eating habits or lifestyle (or in some cases deliberately overeating before surgery) based on the clinician interview ($n = 410$). Participants were excluded from these 30 day frequency analyses if they reported several or many changes to diet/lifestyle ($n = 404$) or did not answer this assessment question ($n = 6$).

Descriptive statistics examined the degree of skewness and kurtosis for each 30 day frequency variable and transformations were conducted as needed to approximate a normal distribution. Zero order correlations examined the relationship of each mindfulness facet to each problem eating behavior. A series of regression analyses were then conducted to examine the relationship of each mindfulness facet to each problem eating behavior while controlling for the other mindfulness facets as well as depression. Depression was included as a covariate given past research indicating that it is related to problematic eating among obese individuals (Skinner et al., 2012) as well as being related to mindfulness (Cash & Wittingham, 2010; Desrosiers et al., 2013). The inclusion of all five mindfulness facets within a regression model allowed for further examination of the unique relationship of each facet to problematic eating patterns. When the problem eating variable approximated a normal distribution, hierarchical linear regressions were conducted in which depression was entered in the first step and then the mindfulness facets were entered as predictors in the second step. When transformed problem eating variables continued to have a high degree of skewness, Poisson regression models were conducted to examine the relationship of depression and mindfulness facets as this analytic approach allows for the analysis of count data with a skewed distribution.

3. RESULTS

3.1 Comparing patients with and without a history of problematic eating

Independent *t*-tests were conducted to examine differences in mindfulness facet scores between patients with and without a history of engaging in problematic eating patterns (see Table 1). Patients with a history of problematic eating behaviors tended to be lower on acting with awareness, being nonjudgmental, and describing, with some variation depending on the specific eating behavior. Patients who rapidly overate or engaged in subjective binges actually scored higher on observing relative to those with no history of these eating problems. There were no differences in the nonreactivity facet between patients with and without a history of any of these problematic eating patterns ($p > .10$).

3.2 Relationship between mindfulness and problematic eating over past 30 days

Zero order correlations were examined between mindfulness facets and the frequency of problematic eating behaviors over the past 30 days among patients reporting few or no changes in their eating habits or lifestyle in preparation for surgery ($n = 410$)(See Table 2). Each of the problematic eating variables was significantly positively skewed except for grazing, and an exponential transformation was conducted for each variable except grazing to approximate a normal distribution. However, the binge eating (skewness = 3.70, kurtosis = 12.36) and subjective binge variables (skewness = 2.46, kurtosis = 4.27) were still both substantially skewed and kurtotic even with this transformation.

Habitual overeating and grazing were not related to any mindfulness facets ($p > .10$). One or more facets of mindfulness were related to each of the other problematic eating behaviors, with the acting with awareness and nonjudgmental facets being most consistently related to problem eating. Correlations indicated that higher mindfulness was related to lower frequency of

problematic eating behaviors with the exception of the observing facet, in which greater observing was related to a higher frequency of binges, subjective binges and rapid overeating episodes. The correlations tended to be small with significant correlation coefficients ranging between .11 and .28.

3.3 Regression analyses controlling for mindfulness facets and depression

Hierarchical linear regressions were conducted to examine the relationship of mindfulness facets to problematic eating behaviors over the past 30 days when controlling for each mindfulness facet as well as depression (see Table 3). Depression was not significantly related to habitual overeating ($p > .10$) nor was the model in which mindfulness facets were added as predictors ($p > .10$). Similarly, depression was not significantly related to grazing ($p > .10$) nor was the model in which mindfulness facets were added as predictors ($p > .10$).

Depression was significantly related to frequency of rapid overeating and emotional eating over the past 30 days, such that greater depression was related to more episodes. In both cases, there was a significant increase in variance accounted for when adding mindfulness facets as predictors in the second step. Acting with awareness, being nonjudgmental, and observing were significantly related to rapid overeating, such that greater acting with awareness was related to fewer episodes, while greater scores on being nonjudgmental and observing were related to more episodes. Acting with awareness and describing were significantly related to emotional eating, as well as a trend for nonreactivity, such that greater acting with awareness, describing and nonreactivity were related to fewer episodes. Depression was no longer significantly related to emotional eating in the regression model that included the mindfulness facets.

Due to the highly skewed distributions for the binge eating and subjective binge variables, Poisson regression analyses were conducted with these two variables. The Poisson

regression model examining depression and mindfulness as predictors of the number of binge eating episodes was significant (likelihood ratio $\chi^2 = 156.80$, $df = 6$, $p < .001$). Model fit statistics indicated a degree of overdispersion (deviance = 1.66). Given that overdispersion in Poisson models tends to lead to underestimates of standard error values and increases the possibility of Type I error, robust standard errors were calculated. Depression was the only variable significantly related to binge eating ($\text{Exp}(b) = 1.99$, 95% CI = 1.37, 2.88, $p < .001$), such that higher depression was related to greater frequency of episodes.

A follow up analysis was conducted to examine the relationship of mindfulness to binge eating without the depression covariate. The overall model was significant (likelihood ratio $\chi^2 = 97.49$, $df = 5$, $p < .001$). However, none of the individual mindfulness facets were significantly related to frequency of episodes ($p > .10$).

The Poisson regression model with depression and mindfulness predicting number of subjective binges was also significant (likelihood ratio $\chi^2 = 227.61$, $df = 6$, $p < .001$). Model fit statistics indicated overdispersion (deviance = 3.46) and robust standard errors were calculated to reduce the potential for Type I errors. There was a significant effect for acting with awareness ($\text{Exp}(b) = .90$, 95% CI = .84, .96, $p = .002$) and a statistical trend for observing ($\text{Exp}(b) = 1.08$, 95% CI = .99, 1.16, $p = .08$), such that lower acting with awareness and greater observing were related to a higher number of subjective binge episodes. Depression was not significantly related to subjective binge episodes in the model ($\text{Exp}(b) = 1.07$, 95% CI = .77, 1.51, $p = .68$).

4. DISCUSSION

This study sought to examine the relationship of mindfulness facets to a range of problem eating behaviors in a clinical sample of obese patients seeking bariatric surgery. Results indicated that acting with awareness and being nonjudgmental, as well as describing and

nonreactivity to a lesser extent, were related to dysregulated forms of eating (i.e., binge and emotional eating). Mindfulness facets were unrelated to frequency of habitual overeating and grazing, although describing and nonjudgmental deficits were found when comparing those who did and did not engage in these eating patterns. When controlling for each facet of mindfulness as well as depression, acting with awareness was the only consistent mindfulness facet related to binge and emotional eating, with more inconsistent results for being nonjudgmental, nonreactivity and describing. In the case of emotional eating, mindfulness facets accounted for the relationship between depression and problematic eating. Consistent with study hypotheses, the observing facet related to problematic eating in the opposite direction, such that being more observant was related to having greater eating problems.

There are a variety of problematic eating behaviors that contribute to post-bariatric surgery outcomes and obesity and may be relevant to mindfulness-based interventions. These results suggest that mindfulness is particularly relevant to a subset of problem eating patterns that can be characterized as dysregulated forms of eating, such as binge and emotional eating. Past research with non-clinical samples similarly has found a relationship between mindfulness and both binge and emotional eating (e.g., Roberts & Danoff-Burg, 2010; Lattimore et al., 2011). Both binge and emotional eating occur in the context of aversive emotions and may function as maladaptive coping strategies seeking to reduce these states (e.g., Hilbert & Tuschen-Caffier, 2007; Schneider et al., 2012). Mindfulness has been found to predict using substance to cope with negative affect (Bonn-Miller et al., 2010) as well as more general tendencies to engage in avoidant coping strategies (Baer et al., 2006). Consistent with this, depression was no longer significantly related to emotional eating after including the mindfulness facets, suggesting that the relationship between distress and this problem eating behavior may be accounted for by

mindfulness processes. Rapid overeating has some overlap with dysregulated eating patterns, but analyses indicated that mindfulness deficits were particularly elevated in the subsample of those who lost control while rapidly overeating. These results are consistent with previous outcome studies among bariatric surgery patients, which have found that acceptance and mindfulness-based interventions reduce emotional and binge eating (Leahey et al., 2008; Weineland et al., 2011; 2012), as well as a recent study indicating that acceptance-based behavior therapy produces a greater impact on weight loss relative to standard behavioral treatment among clients who are more depressed, susceptible to food cues, disinhibited or higher in emotional eating (Forman et al., 2013).

There were fewer relationships between mindfulness facets and habitual overeating and grazing, suggesting mindfulness may be less applicable to other forms of overeating that are less directly connected to aversive internal states. However, few studies have examined the impact of mindfulness interventions on these other eating behaviors (although see Alberts & Raes, 2012; Timmerman & Brown, 2012) and further research is needed to determine whether mindfulness is as applicable to habitual overeating and grazing.

The current findings suggest that acting with awareness, being nonjudgmental, being nonreactive and describing are all related to dysregulated eating. Of note, acting with awareness was the most consistent facet related to problem eating, suggesting deficits in this process may be particularly relevant to binge and emotional eating. Theoretically, being on “autopilot” might increase patients’ potential to impulsively engage in dysregulated eating in response to triggers without the awareness needed to interrupt these behavioral patterns. Impairments in present moment awareness and in describing one’s internal experiences could also reduce opportunities to accurately identify negative internal states and use more effective emotion regulation

strategies rather than problematic eating. Consistent with this, research has found that obese individuals have greater difficulty identifying and differentiating emotions (Rommel et al., 2012), that these difficulties in identifying emotions are related to more emotional eating and other problematic eating patterns (e.g., Larsen et al., 2006; Moon & Berenbaum, 2009; Rommel et al., 2012; van Strien et al., 2005), and difficulty identifying emotions mediates the relationship of negative affect to problematic eating (e.g., Ouwens et al., 2009). Being reactive to and judgmental of one's internal experiences may further contribute to engaging in emotional and binge eating as avoidant coping strategies. For example, responding to negative emotions with suppression strategies leads to greater overeating (Evers et al., 2010). In addition, if patients judge their urges to eat as "bad" they may be more likely to attempt to suppress thoughts about food, which can produce a rebound effect and lead to greater problematic eating (e.g., Barnes et al., 2013).

The results also indicated that the observing subscale tended to correlate in the opposite direction with problem eating variables such that heightened awareness of the present related to greater eating problems. This is consistent with some past research demonstrating that the observing facet alone of mindfulness can be predictive of greater psychological problems (e.g., Baer et al., 2006). However, these results do not indicate that present moment awareness is a pathological process per se as deficits in acting with awareness were consistently related to eating problems. A primary distinction between the observing and acting with awareness subscale is the direction of the items, with observing assessing heightened awareness of the present and acting with awareness assessing a lack of awareness of the present. The marked differences in how these subscales relate to problem eating suggests that these two facets may not represent two poles on a continuum of mindful present moment awareness, particularly in a

non-intervention format. While a lack of awareness of the present moment as assessed by the negatively worded items in the acting with awareness subscale may indicate a lack of mindfulness, it is unclear whether patients reporting heightened awareness outside of a mindfulness intervention context are reporting mindful awareness as opposed to hypervigilance or other maladaptive attentional issues. This is consistent with psychometric analyses with the FFMQ which suggest that the observing subscale does not always load onto a latent variable of mindfulness with the other four mindfulness subscales (Baer et al., 2006). The other distinction between these two facets is in what aspects of experience are being attended to, with observing focusing more on sensory experiences related to external stimuli and acting with awareness focusing more on noticing one's actions. Thus, another important consideration is what is being attended to, and in the case of obesity, a heightened awareness of external stimuli such as food cues may contribute to greater eating problems (e.g., Van Strien et al., 2012).

Of note, the linear regression results surprisingly found that being nonjudgmental was related to greater rapid overeating, but this was not the case in the zero order correlation results. This may be due to covarying out the other mindfulness facets and depression or Type I error given the number of analyses conducted. It also raises the consideration that in some cases, being judgmental of one's emotions may motivate limiting overeating, while being nonjudgmental has the potential risk of promoting continued overeating. However, given that the overall pattern indicates being nonjudgmental is related to lower problematic eating this seems unlikely and requires further research.

The findings from the current study raise considerations for mindfulness-based obesity interventions, particularly among those seeking bariatric surgery. The results suggest that mindfulness processes may be particularly relevant for binge and emotional eating, which are

two of the most problematic eating behaviors for post-surgery success (Canetti et al., 2007; Niego et al., 2007) and could inform more targeted interventions in this population. It is less clear with the available research evidence the degree to which mindfulness applies to interventions targeting other problematic eating patterns such as habitual overeating and grazing. Grazing is another predictor of poor success following bariatric surgery (Colles et al., 2008) and further research is needed to determine whether mindfulness is applicable to reducing this problem behavior as well.

The contrasting findings with the observing and acting with awareness facets suggests that although a lack of awareness is problematic, heightening awareness of the present moment alone may not be sufficient and could even be problematic. This lends further credence to the multifaceted nature of many mindfulness interventions, which include a strong emphasis on being nonjudgmental, accepting and nonreactive to experiences that one notices in the present. Theoretically, enhancing patients' ability to notice difficult thoughts, feelings and cravings without judging them or reacting to them, may serve to reduce the link between these internal states and subsequent disinhibited eating. In addition, increasing awareness of one's actions in the moment may be particularly important in reducing disinhibited eating, which is consistent with literature indicating that mindful eating exercises can reduce impulsivity with unhealthy food (Hendrickson & Rasmussen, 2013) and increase the expected liking of healthy eating alternatives (Hong et al. 2011).

One limitation of the study was that the use of a cross sectional design did not allow for the examination of temporal relationships between mindfulness deficits and problem eating. Research has found that overeating and obesity can contribute to cognitive impairments in areas relevant to mindfulness such as prepotent inhibition and executive functioning (Volkow et al.,

2008), which suggests that problem eating may produce mindfulness deficits over time.

Longitudinal research could also examine mindfulness prior to bariatric surgery as a predictor of whether patients engage in problem eating behavior post-surgery, which is particularly important for surgery weight loss success (Colles et al., 2008; Niego et al., 2007) and could further inform both mindfulness interventions and the identification of protective factors in this area.

The study also did not include measures of other potential third variables that may relate to both problematic eating and mindfulness and better account for the observed relationships, such as impulsivity. Future research should include such measures, particularly given recent research in the area of substance abuse suggesting that impulsivity may better account for the relationship of mindfulness to problematic behaviors (Murphy & MacKillop, 2012).

Although the use of a clinical sample of obese patients was a strength of the study given that past research has typically focused on non-clinical populations, it also introduces some methodological limitations. Many of the patients had already received recommendations to improve eating habits while meeting with a dietitian or other health professional as part of their pre-surgical assessment to determine appropriateness for surgery. This introduced statistical noise that may have reduced the observed relationship between mindfulness and problematic eating behavior over the past 30 days. To adjust for this in the analyses, only participants who reported making few to no changes in eating were included in the 30 day analyses. However, this subgroup of individuals may not be representative of patients seeking bariatric surgery more broadly as they represent those who are more resistant to dietitian feedback.

Another limitation of using a bariatric surgery seeking sample is that patients may have been more inclined to underreport problem eating given they were being assessed for appropriateness for surgery. This is evidenced by the high rates of individuals denying any

history of engaging in problematic eating. Some obese individuals are likely to not have engaged in problem eating given that there are multiple pathways to obesity, not all of which are due to problematic eating (Marcus & Wildes, 2009). However, the rates of problem eating may be expected to be higher and could be a result of the assessment setting. These factors may have affected the generalizability of results to other clinical obese samples as well as obese individuals more broadly. Further research is needed to determine if the relationship between mindfulness facets and problem eating replicates across other clinical and non-clinical obese populations.

The study included a number of statistical tests, which increases risk for Type I error. However, these tests were necessary in order to fully explore the relationship of each specific mindfulness facet to a diverse range of problem eating behaviors. Different analytic approaches were used to determine a) if there were differences in mindfulness between those who did or did not engage in problem eating patterns in the full sample, b) among those who had not made changes to their diet in preparation for surgery, if mindfulness facets were related to recent frequency of eating behaviors, and c) whether mindfulness facets independently relate to problematic eating when controlling for depression and other facets of mindfulness (i.e., if there are more unique relationships with specific facets).

Currently, validated measures of mindfulness are only available in a self-report format, which introduces limitations in understanding how mindfulness relates to problematic eating. Limitations in introspection and response biases (i.e., social desirability) are particularly relevant for mindfulness as it relies on identifying and reporting one's degree of self-awareness and admitting negative qualities such as being judgmental or reactive. Yet, it is unclear how to assess mindfulness without using self-report. To address this limitation and more fully understand the role of mindfulness in eating problems, future research should examine whether improving facets

of mindfulness through targeted interventions mediates improvements in problematic eating patterns. The current study gives some suggestions as to what problem eating patterns and facets may be particularly relevant to focus such research on.

Overall, the current study adds to a body of literature indicating the potential benefits of targeting mindfulness processes in obesity interventions, particularly for binge and emotional eating among bariatric surgery patients. Although a number of outcome studies have tested mindfulness-based interventions for obesity and a few recent studies have examined mindfulness deficits with problem eating among non-clinical samples, there have been very few studies among bariatric surgery patients specifically. Such research is important given the need for psychosocial interventions that can improve surgery outcomes and decrease problematic eating post-surgery. The results of this study highlight the potential applicability of mindfulness to bariatric patients and further areas for research with this population.

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Highlights

- Examined relationship of mindfulness to problem eating with 820 bariatric patients
- Greater mindfulness was related to less binge and emotional eating
- Acting with awareness was a particularly strong predictor of lower problem eating
- Mindfulness was less consistently related to habitual overeating and grazing
- Greater observing sometimes related to greater eating problems

Table 1. *Differences in mindfulness facets between individuals with and without a history of problematic eating behaviors.*

		Observing	Describing	Act w/ Aware	Nonjudgment	Nonreactivity
		<i>M(SD)</i>	<i>M(SD)</i>	<i>M(SD)</i>	<i>M(SD)</i>	<i>M(SD)</i>
Habitual overeating	Yes (<i>n</i> = 383)	24.18 (5.97)	28.96 (5.76)	31.21 (5.65)	31.27 (5.83)	21.99 (4.97)
	No (<i>n</i> = 434)	24.77 (6.27)	29.83 (6.00)	31.50 (5.63)	31.08 (6.34)	22.58 (5.31)
	<i>Independent t-test (Cohen's d)</i>	-1.36 (<i>d</i> = -.10)	-2.11* (<i>d</i> = -.15)	-.72 (<i>d</i> = -.05)	.43 (<i>d</i> = .03)	-1.57 (<i>d</i> = -.11)
Grazing	Yes (<i>n</i> = 429)	24.35 (5.99)	28.98 (5.68)	31.30 (5.59)	30.64 (6.13)	22.05 (4.96)
	No (<i>n</i> = 391)	24.59 (6.09)	29.89 (6.09)	31.43 (5.69)	31.80 (6.01)	22.55 (5.32)
	<i>Independent t-test (Cohen's d)</i>	-.54 (<i>d</i> = -.04)	-2.21* (<i>d</i> = -.15)	-.32 (<i>d</i> = -.02)	-2.70** (<i>d</i> = -.19)	-1.34 (<i>d</i> = -.10)
Rapid overeating	Yes (<i>n</i> = 262)	25.01 (5.70)	29.10 (6.02)	29.81 (6.15)	30.22 (6.44)	22.13 (4.89)
	No (<i>n</i> = 556)	24.24 (6.32)	29.57 (5.84)	32.11 (5.23)	31.62 (5.89)	22.38 (5.28)
	<i>Independent t-test (Cohen's d)</i>	1.67† (<i>d</i> = .13)	-1.06 (<i>d</i> = .13)	-5.54*** (<i>d</i> = -.40)	-3.04*** (<i>d</i> = -.23)	-.63 (<i>d</i> = -.05)
Rapid overeating,	Yes (<i>n</i> = 164)	24.81 (5.32)	29.39 (5.88)	30.67 (5.26)	31.05 (5.76)	22.51 (4.91)
never lost control ^a	No (<i>n</i> = 556)	24.22 (6.31)	29.55 (5.83)	32.10 (5.23)	31.63 (5.90)	22.35 (5.26)
	<i>Independent t-test (Cohen's d)</i>	1.08 (<i>d</i> = .10)	-.31 (<i>d</i> = -.03)	-3.07** (<i>d</i> = -.27)	-1.11 (<i>d</i> = -.10)	.33 (<i>d</i> = .03)

Binge eating ^b	Yes ($n = 98$)	25.34 (6.29)	28.62 (6.24)	28.40 (7.18)	28.79 (7.28)	21.48 (4.83)
	No ($n = 160$)	24.81 (5.27)	29.44 (5.93)	30.78 (5.11)	31.16 (5.63)	22.43 (4.88)
<i>Independent t-test (Cohen's d)</i>		.74 ($d = .09$)	-1.05 ($d = -.13$)	-3.11** ($d = -.38$)	-2.87** ($d = -.36$)	-1.47 ($d = -.20$)
Subjective binge	Yes ($n = 101$)	26.14 (5.97)	27.98 (6.15)	29.69 (6.20)	28.99 (6.94)	22.36 (5.76)
	No ($n = 716$)	24.26 (6.13)	29.62 (5.84)	31.60 (5.52)	31.48 (5.91)	22.28 (5.07)
<i>Independent t-test (Cohen's d)</i>		2.88** ($d = .31$)	-2.64** ($d = -.27$)	-3.22** ($d = -.33$)	-3.85*** ($d = -.39$)	.14 ($d = .01$)
Emotional eating	Yes ($n = 355$)	24.87 (5.99)	28.72 (6.04)	30.29 (5.52)	30.05 (6.13)	21.97 (4.73)
	No ($n = 462$)	24.18 (6.23)	29.97 (5.71)	32.22 (5.57)	32.12 (5.92)	22.53 (5.44)
<i>Independent t-test (Cohen's d)</i>		1.59 ($d = .11$)	-2.99** ($d = -.21$)	-4.90*** ($d = -.35$)	-4.82*** ($d = -.34$)	-1.50 ($d = -.11$)

† $p < .10$, * $p < .05$; ** $p < .01$; *** $p < .001$. Significant between group differences are **bolded**.^a Comparing participants who rapidly overate (but never with loss of control) to those who never rapidly overate. ^b Comparing participants who rapidly overate with or without loss of control.

Table 2. *Zero order correlations between mindfulness facets and problematic eating behavior frequency over the past 30 days.*

	Observing	Describing	Act w/ Awareness	Nonjudgmental	Nonreactivity
Habitual Overeating	.03	.01	-.02	.02	.04
Grazing	-.03	.01	-.01	-.05	-.05
Rapid Overeating	.10 [†]	-.01	-.14**	-.02	-.04
Binge Eating	.15**	-.01	-.14**	-.13*	.02
Subjective Binge	.11*	-.05	-.15**	-.13**	-.07
Emotional Eating	-.03	-.25***	-.28***	-.22***	-.19***

[†] $p < .10$, * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 3. Hierarchical linear regression results testing depression and mindfulness facets as predictors of problematic eating behavior frequency over the past 30 days.

Variable	Step	CGI <i>b</i>	Observe <i>b</i>	Describe <i>b</i>	Act w/ Awareness <i>b</i>	Nonjudge <i>b</i>	Nonreact <i>b</i>	ΔR^2	ΔF
Habitual Overeat.	1	-.03						.00	.33
	2	-.03	.06	-.03	-.08	.09	.04	.01	.58
Grazing	1	-.01						.00	.01
	2	.02	.05	-.02	-.01	.07	.05	.01	.40
Rapid Overeating	1	.17**						.03	11.40***
	2	.18**	.16**	.00	-.14*	.18**	.03	.03	2.63*
Emotional Eating	1	.19***						.04	12.78***
	2	.05	-.01	-.13*	-.19**	-.06	-.11†	.10	7.16***

† $p < .10$, * $p < .05$; ** $p < .01$; *** $p < .001$. CGI = Depression symptom severity.