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REVIEW

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Mechanisms and moderators in mindfulness- and acceptance-based treatments for binge eating spectrum disorders: A systematic review

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Abstract

Objective: Increasing evidence suggests that mindfulness- and acceptance-based psychotherapies (MABTs) for bulimia nervosa (BN) and binge eating disorder (BED) may be efficacious; however, little is known about their active treatment components or for whom they may be most effective.

Methods: We systematically identified clinical trials testing MABTs for BN or BED through PsychINFO and Google Scholar. Publications were categorized according to analyses of mechanisms of action and moderators of treatment outcome.

Results: Thirty-nine publications met inclusion criteria. Twenty-seven included analyses of therapeutic mechanisms, and five examined moderators of treatment outcome. Changes were largely consistent with hypothesized mechanisms of MABTs, but substandard mediation analyses, inconsistent measurement tools, and infrequent use of mid-treatment assessment points limited our ability to make strong inferences.

Discussion: Analyses of mechanisms of action and moderators of outcome in MABTs for BN and BED appear promising, but the use of more sophisticated statistical analyses and adequate replication is necessary.

KEYWORDS
acceptance-based therapies, binge eating disorder, bulimia nervosa, eating disorders, mindfulness

1 | INTRODUCTION

1.1 | Treatments for bulimia nervosa and binge eating disorder

Binge eating, defined as eating an objectively large amount of food within a discrete time period while experiencing a sense of loss of control over eating, is a key feature of binge eating disorder (BED) and bulimia nervosa (BN). BN also involves inappropriate compensatory behaviours (e.g., self-induced vomiting and compensatory exercise; American Psychiatric Association, 2013). The current psychological treatment for BN and BED with the most empirical support is cognitive behavioural therapy (CBT; Fairburn, Wilson, & Schleimer, 1993) including the recently enhanced version (Fairburn & Beglin, 2008). Recent meta-analyses have demonstrated the efficacy of CBT in reducing behavioural and cognitive symptoms of eating

disorders (EDs) relative to alternative psychological treatments (Linardon, Wade, de la Piedad Garcia, & Brennan, 2017; Peat et al., 2017).

Despite clinically significant improvements following CBT for many individuals with BN and BED, approximately 50% of patients still remain symptomatic at post-treatment (Brownley et al., 2016; Linardon, Wade, et al., 2017; Södersten, Bergh, Leon, Brodin, & Zandian, 2017). Further, rates of relapse following CBT appear to often match rates of remission occurring between post-treatment and follow up in randomized controlled trials (RCTs), giving the false impression that no relapse occurs when reported statistically (Södersten et al., 2017). When examined more closely, however, relapse rates following CBT for EDs are greater than 30% (Södersten et al., 2017). Multiple studies have also found approximately 25% of participants enrolled in clinical trials of CBT for BN and/or BED discontinue treatment prematurely (Agüera et al., 2017; Grilo, Masheb, Wilson, Gueorguieva, & White, 2011; J. R. Shapiro et al., 2007). Such findings suggest significant room for improvement in treatment acceptability and outcome for BN and BED.

Highlights

- Analyses of mechanisms of action and moderators of treatment outcome in MABTs for BN and BED are crucial for enhancing the efficiency of treatment development and dissemination.
- Research to date supports improvements in theoretically consistent mechanisms of action from pre-treatment to post-treatment when using MABTs for BN and BED; however, conclusions relevant to whether these changes are occurring as theorized are limited by the use of substandard mediation methods, inconsistent measurement tools across studies, and infrequent use of mid-treatment assessment points.
- Recommendations for enhancing future research on mechanisms of action and moderators of treatment outcome are discussed.

1.2 | Mindfulness- and acceptance-based treatments for BN and BED

Mindfulness- and acceptance-based treatments (MABTs) have emerged within the past two decades for a variety of psychological disorders (Haynos, Forman, Butryn, & Lillis, 2016; Kahl, Winter, & Schweiger, 2012; Öst, 2008). MABTs are based on theoretical models targeting therapeutic change through psychological processes such as acceptance, mindfulness, psychological flexibility, cognitive defusion/distancing, and emotion regulation. Relative to traditional CBT theories that attribute psychopathology to maladaptive thought patterns and directly target their content and validity, MABTs posit that psychopathology is maintained through avoidance or problematic attempts to control distressing or undesired internal experiences, and thus, target increases in psychological flexibility and acceptance (Forman et al., 2012; Hofmann & Asmundson, 2008).

MABTs tested for BN and BED include the following therapeutic approaches: acceptance and commitment therapy (ACT), dialectical behaviour therapy (DBT), and mindfulness-based interventions (MBIs) such as mindfulness-based cognitive therapy and mindfulness-based stress reduction (Haynos et al., 2016). A brief description of the specific theoretical models underlying each MABT are presented in Table 1. Though research on these interventions to treat BN and BED is nascent, preliminary evidence suggests that such treatments may be efficacious for this population (Godfrey, Gallo, & Afari, 2015; Katterman, Kleinman, Hood, Nackers, & Corsica, 2014; Linardon, Fairburn, Fitzsimmons-Craft, Wilfley, & Brennan, 2017).

1.3 | Relevance of mechanisms of action and moderators within MABTs

Most studies evaluating MABTs for BN and BED consist of small, uncontrolled pilot trials or clinical trials comparing the MABT with a non-CBT control condition (e.g., supportive psychotherapy, treatment-as-usual [TAU], and waitlist). Additionally, much of the research evaluating these treatments to date, both for EDs and for varying forms of psychopathology broadly, is based on widely varied implementations (e.g., length/number of sessions, frequency of sessions, and group vs. individual). These limitations minimize our ability as a field to draw firm conclusions on if, and in what form, MABTs appear to be most efficacious. Thus, more robust clinical trials that compare manualized versions of MABTs with CBT are sorely needed. However, just as necessary is implementation of alternative experimental designs and statistical analyses increasing our knowledge of *how* and *for whom* specific treatments work (Brauhardt, de Zwaan, & Hilbert, 2014; Murphy, Cooper, Hollon, & Fairburn, 2009).

Although behavioural outcomes following MABTs for EDs appear to be comparable with CBT (Linardon,

TABLE 1 Brief description of theories underlying MABTs

MABT	Description of underlying model and treatment targets
1. Acceptance and commitment therapy (ACT)	ACT theorists posit that a primary source of psychopathology and human suffering is psychological inflexibility (i.e., patterns of behaviour rigidly guided by internal experiences, rather than by one's personal values or direct contingencies; Luoma, Hayes, & Walser, 2007). ACT-based treatments therefore seek to increase one's level of psychological flexibility or one's ability to fully and nonjudgmentally contact the present moment and, based on what the situation affords, change or persist in behaviours in the service of one's chosen values (Hayes et al., 2006). Clinicians seek to increase this flexibility through six core psychological processes: acceptance, defusion, contact with the present moment, self-as-context, values clarification, and committed action (Hayes et al., 2006).
2. Dialectical behavioural therapy (DBT)	The DBT model theorizes that problematic interpersonal styles and deficits in emotion regulation interact with personal and environmental factors in ways that facilitate and/or reinforce maladaptive behaviours (Feigenbaum, 2007). Therefore, the primary target within DBT-based interventions is an increase in emotion regulation skills (Telch et al., 2001). This is done through several psychological processes, often presented to clients in "modules" including mindfulness skills, distress tolerance skills, and interpersonal efficacy skills (Feigenbaum, 2007).
3. Mindfulness-based interventions (MBIs)	MBIs seek to cultivate mindfulness skills and facilitate their use in individuals' day-to-day lives. These interventions posit that by intentionally shifting one's attention with openness and nonjudgementalness elicits decreases in psychological distress and facilitates increases in quality of life (S. L. Shapiro et al., 2006). Different interventions utilize one or more of a variety of mindfulness skills (i.e., meditation, body scans, and grounding exercises) to cultivate this shift.

Fairburn, et al., 2017), several differences related to theory and technique are important to consider. MABTs emphasize skills and techniques facilitating increased acceptance of internal experiences (i.e., thoughts, feelings, and physical sensations), contrasted with traditional cognitive–behavioural approaches that emphasize modifying the content of dysfunctional cognitions to make them more adaptive (Hayes, Villatte, Levin, & Hildebrandt, 2011; Stotts & Northrup, 2015). Although a full outline of MABTs' proposed mechanisms of action (i.e., the steps or processes through which therapy works to produce change) is beyond the scope of this paper, several previous reviews exist (e.g., Hayes, Luoma, Bond, Masuda, & Lillis, 2006; Lynch, Chapman, Rosenthal, Kuo, & Linehan, 2006; S. L. Shapiro, Carlson, Astin, & Freedman, 2006).

Identification of mechanisms of action is crucial for enhancing the efficiency of treatment development and dissemination. A helpful first step is to examine mediators of treatment outcome (i.e., a construct showing important statistical relations between an intervention and an outcome but may not explain the precise process through which the change comes about; Kazdin, 2007). Such research will (a) clarify which treatment components should be prioritized and which could be reduced or eliminated and (b) support development of innovative treatments that focus on promoting change through targeted mechanisms (Kraemer, Wilson, Fairburn, & Agras, 2002). Despite calls for more research in this regard, (Murphy et al., 2009), few studies have evaluated the specific processes through which patient change occurs within ED treatment research (Brauhardt et al., 2014; Vall & Wade, 2015).

Additionally, discovering *for whom* treatments are effective using pre-treatment characteristics or conditions that differentiate more or less successful patients will provide data for facilitating treatment matching. Such characteristics might predict treatment outcome across individuals, regardless of treatment condition (i.e., nonspecific predictors) or differentially across two or more treatments (as a moderator). Considering the comparable behavioural outcomes observed between MABTs and CBT for EDs to date (Linardon, Fairburn, et al., 2017), this knowledge may be particularly helpful in determining which approach may be more efficacious on an individual patient basis. Researchers can also use this knowledge to better maximize power when stratifying patients in randomized clinical trials (Kraemer et al., 2002).

1.4 | Review aims

The purpose of the current review is to systematically examine the literature on MABT outcome studies for BN and BED to (a) determine how many studies have

assessed mechanisms of action and moderators of treatment outcome, (b) identify which mechanisms and moderators (if any) emerge, (c) describe if significant mechanisms of action reported are consistent with MABTs' putative mechanisms, and (d) make recommendations for treatment research investigating MABTs for BN and BED.

2 | METHODS

2.1 | Study selection

We conducted a systematic review of relevant treatment literature following PRISMA guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009; Figure 1). We utilized Google Scholar and PsycINFO electronic databases to conduct an independent search for all relevant English language, peer-reviewed publications dated through July 2018.

We systematically entered MABT-related search terms into each electronic database in conjunction with terms related to ED behaviours or diagnoses (e.g., "acceptance" and "binge*"). ACT terms included "acceptance," "acceptance-based therapy," "acceptance and commitment therapy," and "acceptance-based intervention." DBT terms included "dialectical behaviour therapy" and "DBT." MBI terms included "mindfulness," "meditation," "mindfulness-based intervention," "mindfulness-based therapy," and "mindful eating." ED terms included binge*, binge eat*, binge eating disorder*, bulimi*, bulimia nervosa, eating disorder*, and eating pathology. We also searched the reference sections of all articles meeting inclusion criteria from the online database search and articles cited by systematic reviews and meta-analyses.

The first author conducted an initial search of each database for eligible articles within each specified treatment category. A second search was then conducted individually by a subsequent author for one of the subgroups

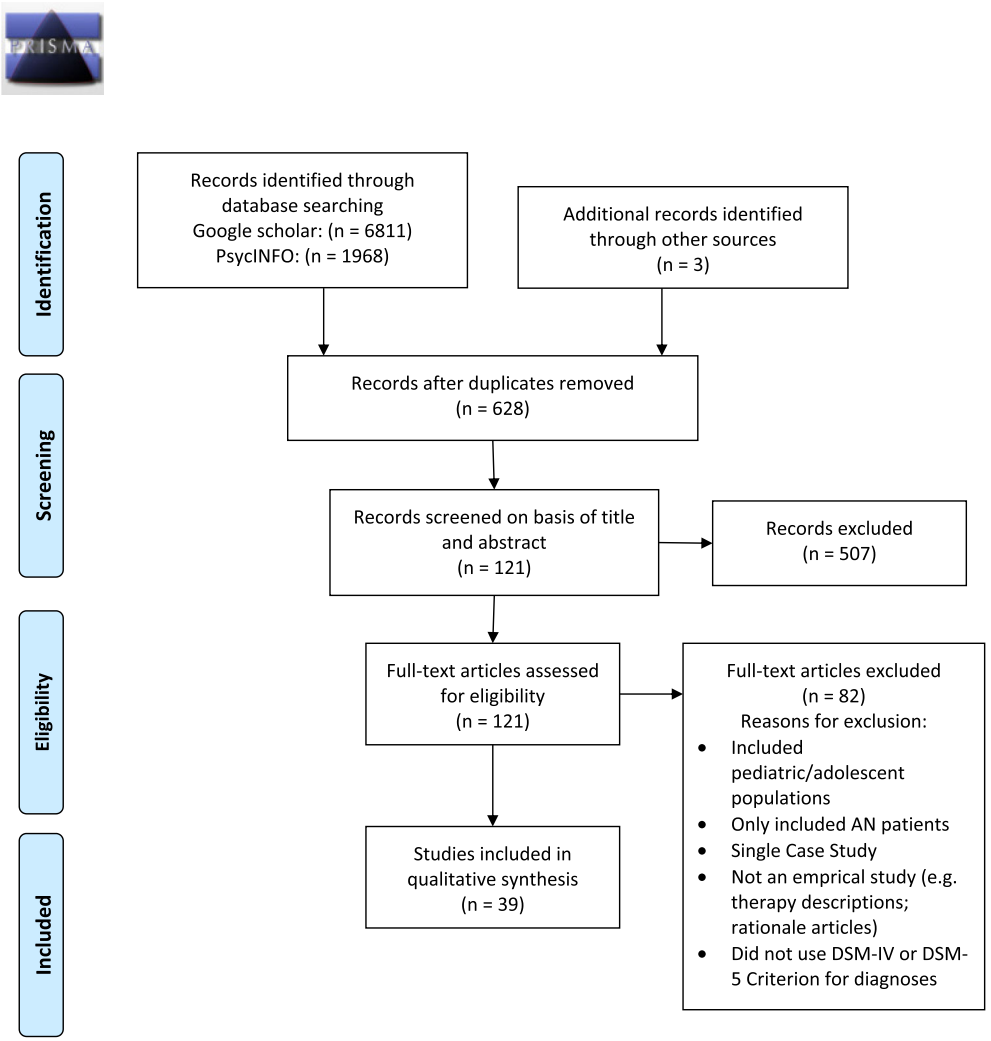

FIGURE 1 PRISMA 2009 flow diagram [Colour figure can be viewed at wileyonlinelibrary.com]

of therapy defined (ACT: S. M. M.; DBT & MBIs: H. B. M.). Studies identified for possible inclusion underwent a full review by both the first author and corresponding author conducting the relevant initial search based on the inclusion criteria outlined below. Any disagreement on articles between the two initial reviewing authors was opened to a full discussion with remaining authors to determine whether they met criteria for final inclusion.

2.2 | Study eligibility criteria

To be eligible for inclusion, studies must have (a) tested at least one MABT to treat BN or BED; (b) used an empirical design; (c) included more than one participant diagnosed with BN, BED based on DSM-IV, or DSM-V criterion or had clinically significant but subthreshold BN or BED eating pathology (i.e., individuals who do not meet DSM-IV or DSM-V thresholds for BN or BED diagnosis due to binge eating/purging less than two times per week or only experiencing binges classified as subjective binge episodes [Fairburn et al., 1993] but who are engaging in these behaviours at least once in the past 28 days); and (d) utilized only an adult sample. Due to the small number of RCTs conducted with ED treatments to date and the potential for alternative empirical designs to provide initial insight into mechanisms of action and moderators to examine in future research (Collins, Kugler, & Gwadz, 2016), we included non-randomized controlled trials and additional studies utilizing pre-post designs. Considering this broad inclusion criteria, we did not formally code studies based on design quality, and all conclusions were based on qualitative synthesis of study results. However, limitations posed by differing study designs and risk of bias were considered in reference to the Cochrane handbook (Higgins & Green, 2008) and are discussed where relevant throughout the review.

2.3 | Data extraction

In total, 39 publications met all inclusion criteria (Table 2). All data were initially extracted by the first author and then confirmed for accuracy by therapy subgroup by the same author who conducted the related secondary literature search. Information extracted from studies included study design; treatment type; sample characteristics (*N*, gender, ED diagnoses); process-relevant variables examined (theoretically relevant mechanisms of action/treatment targets, mediating variables, and/or moderating variables); and reported findings relevant to these variables. Studies were grouped based on the theory most consistently related to the MABT being examined. "ACT-based interventions" included studies using a complete ACT protocol or examining alternative treatments supplemented with an acceptance-based component consistent with ACT theory. "DBT-based interventions" included studies using a complete DBT protocol, studies only using certain components of full DBT (e.g., skills groups) as the sole intervention, and studies examining alternative treatments supplemented with a DBT component. MBIs included studies using complete protocols in which mindfulness or meditation is the primary emphasis or studies examining an alternative treatment supplemented with an additional mindfulness component.

Examination of mediating variables was qualified based on analysis approach using the following categories: (a) did not examine any relevant process variables ($n = 12$), (b) used pre-post change analyses only ($n = 20$), (c) used "proxy"-mediation analyses (e.g., examined the relationship between changes in process measure and ED symptoms through analyses such as Pearson correlations or regression, but no temporal precedence can be determined; $n = 5$), (d) used formal mediation analyses ($n = 2$), or (e) used ideal mediation analyses (none). Figures S1–S4 provide additional detail. Additionally, any manuscript examining a moderator of treatment outcome is listed in Table 3 along with relevant outcomes.

3 | RESULTS

In total, 39 studies were identified that met inclusion criteria (Table 2). Seven studies utilized an ACT-based intervention, 22 studies utilized a DBT-based intervention, and 10 studies utilized a MBI.

3.1 | ACT-based interventions

Of the seven studies examining either a full ACT protocol or an ACT-based intervention, four utilized a transdiagnostic ED sample, and the remaining three used samples consisting solely of individuals diagnosed with BED. Notably, only one study within this group conducted a fully randomized clinical trial, whereas the others utilized either a non-randomized groups or open trial design. Further, three out of the seven identified publications reported results from the same sample following the same ACT-based intervention. Regarding treatment delivery, one study reported results following an individual, face-to-face ACT protocol; one reported results following an internet-based intervention supported by clinician feedback; the remaining reported

TABLE 2 Mechanisms of Action in MABTs for BN and BED

	Publication	ED sample (diagnostic criteria)	Study design	MABT (*n*)	Comparison condition(s) (*n*)
ACT-based interventions					
1	Hill et al. (2015)	BED (DSM-5)	Case series	ACT (2)	N/A
2	Juarascio, Kerrigan, et al. (2013)	AN, BN, & EDNOS (DSM-IV)	NE/NR-G	Residential TAU with ACT (66)	TAU (74)
3	Juarascio, Shaw, et al. (2013)	AN, BN, & EDNOS (DSM-IV)	NE/NR-G	Residential TAU with ACT (66)	TAU (74)
4	Juarascio et al. (2015)	AN, BN, & EDNOS (DSM-IV)	NE/NR-G (analyses of treatment completers only)	Residential TAU with ACT (52)	TAU (53)
5	Juarascio et al. (2017)	BED (DSM-5)	Open trial	ABBT (19)	N/A
6	Manasse et al. (2016)	BED (DSM-5)	Open trial	ABGT (17)	N/A
7	Strandskov et al. (2017)	BN & EDNOS (DSM-IV)	RCT	ACT-influenced CBT	WLC
DBT-based interventions					
8	Ben-Porath, Wisniewski, and Warren (2009)	AN, BN, EDNOS (DSM-IV)	Open trial	DBT-informed PHP (40)	N/A
9	Ben-Porath, Federici, Wisniewski, and Warren (2014)	AN & BN (DSM-IV)	Open trial	PHP-TAU with DBT skills training (65)	N/A
10	Chen, Matthews, Allen, Kuo, and Linehan (2008) and Hepworth (2010)	BN & BED, must have comorbid BPD (DSM-IV)	Open trial	DBT (8)	N/A
11	Chen et al. (2017)	BN & BED (DSM-5)	A-RCT (staged randomization)	DBT (36)	CBTgsh (42) CBT+ (31)
12	Courbasson et al. (2012)	AN, BN, & BED, must have comorbid SUD (DSM-IV)	M-RCT	DBT (13)	TAU (8)
13	Erb, Farmer, and Mehlenbeck (2013)	Full or subthreshold BED (DSM-IV)	Open trial	Condensed DBT (6)	N/A
14	Hill et al. (2011)	Full or subthreshold BN (DSM-IV)	RCT	Appetite-focused DBT (18)	6 weeks DTC (14)
15	Kidd (2017)	BED (DSM-5)	Open trial	Group DBT (6)	N/A
16	Klein, Skinner, and Hawley (2012)	Full or subthreshold BN & full or subthreshold BED (DSM-IV)	Open trial	Adapted DBT (5)	N/A
17	Klein, Skinner, and Hawley (2013)		RCT	Group DBT (22)	

(Continues)

TABLE 2

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
ACT-based interventions				
1	Individual/10 weekly sessions	Body image-specific psychological flexibility; general psychological flexibility	↑ Body image flexibility & general cog. flexibility for both pts paralleled ↓ binge eating (no formal analyses conducted)	"Proxy" mediation
2	Biweekly ACT group supplementing residential TAU/varied	Cognitive acceptance; affective acceptance; willingness; cognitive defusion; psychological acceptance; emotion regulation; willingness to consume a "forbidden" food; dysfunctional thinking	Significant improvement on all process variables observed at EoT within both groups. Willingness significantly mediated effects of treatment condition on EDE-Q global scores pathology/behaviour (↑ Willingness predicted ↓ EDE-Q global scores and willingness trended towards greater improvements in the ACT condition). No other variables showed mediation effects	Formal mediation & "proxy" mediation
3	Biweekly ACT group supplementing residential TAU/varied	None (only examined moderators)	N/A	No process measures assessed
4	Biweekly ACT group supplementing residential TAU/varied	Emotion regulation; cognitive defusion; psychological flexibility	↑ Cognitive defusion ability and ↑ access to effective emotion regulation strategies were both significantly correlated with ↑ ED-related quality of life at EoT (across all participants)	"Proxy" mediation
5	Group/10 weekly sessions	Emotion regulation; non-acceptance of emotions; difficulties engaging in goal-directed behaviour; impulse control; emotional awareness; access to emotional regulation strategies; emotional clarity; general acceptance of internal experiences; food-specific	Significant improvement was observed on all process variables except difficulties engaging in goal-directed behaviour, emotional awareness, and emotional clarity. ↓ EDE global scores were significantly related to ↓ non-acceptance of emotions, ↑ access to emotion regulation strategies, ↑	"Proxy" mediation

(Continues)

TABLE 2 (Continued)

Publication		ED sample (diagnostic criteria)	Study design	MABT (*n*)	Comparison condition(s) (*n*)
		Full or subthreshold BN & full or subthreshold BED (DSM-IV)			Individual self-monitoring (DBT diary cards) supported by brief individual sessions (14)
18	Kröger et al. (2010)	AN & BN, must have comorbid BPD & previously failed to respond to ED inpatient treatment (DSM-IV)	Open trial	Inpatient DBT with added CBT-E module (24)	N/A
19	Masson, von Ranson, Wallace, and Safer (2013)	BED (DSM-IV)	RCT	DBTgsh (30)	WLC (30)
20	Navarro-Haro et al. (2018)	AN, BN, & EDNOS, must have comorbid BPD (DSM-IV)	NE/NR-G	DBT (71)	CBT (47)
21	Rahmani, Omidi, Asemi, and Akbari (2018)	BED, must have obese or overweight BMI (DSM-IV)	RCT	DBT (30)	WLC (30)
22	Robinson and Safer (2012)	BED (DSM-IV)	RCT	DBT-BED (50)	ACGT (non-directive Rogerian-based treatment) (51)
23	Safer and Joyce (2011)	BED (DSM-IV)	RCT	DBT-BED (50)	ACGT (non-directive Rogerian-based treatment) (51)
24	Safer et al. (2002)	BED (DSM-IV)	Open trial	DBT (32)	N/A
25	Safer et al. (2010)	BED (DSM-IV)	RCT	DBT-BED (50)	ACGT (non-directive Rogerian-based treatment) (51)
26	Safer, Telch, and Agras (2001)	Full or subthreshold BN (DSM-IV)	RCT	DBT (14)	WLC (15)
27	Telch, Agras, and Linehan (2000)	BED (DSM-IV)	Open trial	DBT (11)	N/A
28	Telch et al. (2001)	BED (DSM-IV)	RCT	DBT (22)	WLC (22)
29		BED (DSM-IV)		DBTgsh (60)	

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
		acceptance of internal experiences; negative urgency	acceptance of both general and food-specific internal experiences. ↓ EDE global scores were also significantly related to ↓ emotional clarity and ↓ emotional awareness, contradictory to study hypotheses	
6	Group/10 weekly sessions	None (only examined moderators)	N/A	No process measures assessed
7	Internet based with clinician support/ 8 weeks	None	N/A	No process measures assessed
DBT-based interventions				
8	Biweekly DBT skills group with additional weekly groups consisting of DBT-informed concepts/varied	General emotion regulation ability; ability to regulate emotions via cognitive strategies; ability to regulate emotions via behavioural strategies	Significant main effect of time on ↑ emotion regulation, however, also significant interaction between diagnosis and time such that, at pretreatment, individuals who had a comorbid BPD diagnosis reported significantly ↓ emotion regulation than individuals without a comorbid BPD diagnosis; however, at end of treatment, there was no difference between groups. (whether changes were significant within each group was not reported)	Pre-post only
9	CBT focused PHP with 2 hr of DBT skills training group each week/varied	Non-acceptance of emotions; difficulties engaging in goal-directed behaviour; impulse control; emotional awareness; access to emotional regulation strategies; emotional clarity	Significant ↑ with small to medium effect sizes in all emotion regulation skills except clarity of emotions (no change). Significant ↑ with small effect size on overall emotion regulation abilities	Pre-post only
10	Weekly DBT skills group; weekly individual psychotherapy; access to 24-hr phone coaching/24 weeks	None	N/A	No process measures assessed
11		None	N/A	No process measures assessed

(Continues)

TABLE 2 (Continued)

	Publication	ED sample (diagnostic criteria)	Study design	MABT (*n*)	Comparison condition(s) (*n*)
	Wallace, Masson, Safer, and von Ranson (2014)		RCT (secondary analyses only)		N/A (WLC in initial RCT)
Mindfulness-based interventions					
30	Azari, Fata, and Poursharifi (2013)	BED (DSM-IV)	RCT	MBCT (14)	CBT (14) WLC (14)
31	Baer, Fischer, and Huss (2005)	Full or subthreshold BED (DSM-IV)	Open trial	MBCT (6)	N/A
32	Courbasson, Nishikawa, and Shapira (2010)	BED, must have comorbid SUD (DSM-IV)	Open trial	MACBT (38)	N/A
33	Duarte, Pinto-Gouveia, and Stubbs (2017)	BED (DSM-IV)	RCT	CARE (low-intensity intervention focused on compassion, mindfulness, and acceptance developed for trial) (11)	WLC (9)
34	Hepworth (2010)	AN, BN, & BED (DSM-IV)	Open trial	Mindful eating group with long-term CBT (33)	N/A
35	Kristeller and Hallett (1999)	BED (DSM-IV)	Open trial	Meditation-based group treatment (18)	N/A
36	Kristeller et al. (2014)	Full or sub-threshold BED (DSM-IV)	RCT	MB-EAT (53)	PECB (50) WLC (47)
37	Pinto-Gouveia et al. (2016)	BED, must have obese or overweight BMI (DSM-IV)	RCT (but only analyses of treatment condition reported)	BEfree (combined psychoeducation, compassion, and mindfulness-focused intervention) (31)	N/A (WLC in initial RCT)
38	Pinto-Gouveia et al. (2017)	BED, must have obese or overweight BMI (DSM-IV)	RCT	BEfree (combined psychoeducation, compassion, and mindfulness-focused intervention) (19)	WLC (17)
39	Woolhouse, Knowles, and Crafti (2012)	AN, BN, & BED (DSM-IV)	Open trial	MMEG (intervention combining mindfulness & CBT components) (30)	N/A

Note. NE/NR-G: non-equivalent, non-random groups; RCT: randomized controlled trial; M-RCT: matched randomized controlled trial; BED: binge eating disorder; AN: anorexia nervosa; EDNOS: eating disorder not otherwise specified; BN: bulimia nervosa; BPD: borderline personality disorder; SUD: substance use disorder; BMI: body mass index; ACT: acceptance and commitment therapy; ABBT: acceptance-based behavioural treatment; ABGT: acceptance-based group treatment; DBT: dialectical behavioural therapy; DBTgsh: dialectical behavioural therapy guided self-help; MBCT: mindfulness-based cognitive therapy; MACBT: mindfulness-action based cognitive behavioural therapy; MB-EAT: mindfulness-based eating awareness training; MMEG: mindfulness moderate eating group; CBT: cognitive behavioural therapy; TAU: treatment as usual; PHP: partial hospitalization programme; WLC: waitlist control; CBTgsh: cognitive behavioural therapy guided self-help; ACGT: active comparison control group; PECB: psychoeducational cognitive behavioural treatment.

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
	Stage 1: All participants received CBTgsh manual and four weekly 20–30 min support sessions Stage 2: "Early strong responders" assigned to continue CBTgsh (i.e., continued CBTgsh for up to 24 weeks). "Early weak responders" randomized to 6 months of weekly group and individual DBT with 24-hr access to phone coaching or 6 months of weekly group and individual CBT with 24-hr access to psychiatry resident on-call			
12	Weekly group therapy & individual therapy as deemed necessary (TAU) or weekly skills-training group and weekly individual psychotherapy with access to 24 hr phone coaching (DBT)/1 year	General emotion regulation ability; ability to regulate emotions via cognitive strategies; ability to regulate emotions via behavioural strategies urges to eat in response to emotions; drive for thinness; body dissatisfaction; ineffectivenes; perfectionism; interpersonal distrust; interoceptive awareness	Analyses were only possible for DBT condition due to high attrition in TAU At EoT: Large time effect observed for improvements in general emotion regulation ability and moderate time effect observed for improvements in interoceptive awareness and ability to regulate emotions via behavioural strategies. Increased emotion regulation abilities were associated with ↑ perceived efficacy to resist substances and ↓ emotional eating but not ↓ substance use & severity or binge eating frequency At 3-month follow up: Large time effect observed (from baseline to follow up) for improvements in interoceptive awareness, general, and behavioural emotion regulation abilities. Moderate time effect observed for improvements in drive for thinness and perceived ineffectiveness At 6-month follow up: Large time effect observed (from baseline to follow up)	Pre-post & "proxy" mediation

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
			for improvements in interoceptive awareness, general, and cognitive emotion regulation abilities. Moderate effect sizes observed for improvements in drive for thinness and behavioural emotion regulation abilities	
13	Weekly DBT skills group/12 weeks	Urges to eat in response to emotions	↓ Urges to eat in response to emotions observed in treatment completers ($n = 3$). Changes were clinically significant in two out of three treatment completers.	Pre-post only
14	Weekly individual sessions/12 weeks	Emotion regulation; urge to eat in response to emotions; interoceptive awareness; emotional awareness; ED specific cognitions	Significant improvement on all process variables observed within ITT sample. At 6 weeks, treatment group reported significantly ↓ ED specific cognitions and significantly ↑ interoceptive awareness relative to control group but did not significantly differ on any other process variables	Pre-post only
15	Weekly DBT skills group/18 sessions	None	N/A	No process measures assessed
16	Weekly DBT skills group/16 sessions	Interoceptive awareness; drive for thinness; ineffectivenes; perfectionism; body dissatisfaction; interpersonal distrust	Parametric and non-parametric tests found significant improvement for ineffectiveness and interoceptive awareness at EoT. However, improvements in perfectionism and interpersonal distrust were only significant in parametric but not in non-parametric analyses	Pre-post only
17	Weekly individual or group (dependent on treatment condition)/15 sessions	Interoceptive awareness; drive for thinness; ineffectiveness;	Significant improvement in interoceptive awareness for both groups but significant improvements in	Pre-post only

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
		perfectionism; body dissatisfaction; ED specific cognitions	ineffectiveness, drive for thinness, body dissatisfaction, perfectionism, and ED specific cognitions observed in group DBT only	
18	Inpatient setting with 3 weekly DBT skills groups & 1 weekly individual session/3 months	None	N/A	No process measures assessed
19	Guided self-help including in person orientation to manual and six bi-weekly support phone calls/13 weeks	Emotion regulation	DBTgsh reported significant improvement in emotion regulation at EoT and 6-month follow up compared with baseline. At EoT, DBTgsh group's emotion regulation scores were significantly ↑ (better) than WLC	Pre-post only
20	Weekly individual and group sessions/ 24 sessions	Emotion regulation through cognitive reappraisal; emotion regulation through expressive suppression	Improvements in both groups were not statistically significant; however, improvement in emotion regulation through reappraisal was significantly greater in the DBT group compared with CBT	Pre-post only
21	Twice weekly DBT skills group/10 weeks	Emotion regulation	Significant improvement in emotion regulation skills observed within DBT group from pre to post treatment. Emotion regulation skills were significantly greater than those reported by WLC at EoT	Pre-post only
22	Weekly group/20 sessions	None (only examined moderators)	N/A	No process measures assessed
23	Weekly group/20 sessions	None (only examined moderators)	N/A	No process measures assessed
24	Weekly DBT skills group/20 sessions	None (only examined moderators)	N/A	No process measures assessed
25	Weekly group/20 sessions	Emotion regulation; urges to eat in response to emotions	Small effect sizes favouring DBT-BED over ACGT observed for urges to eat	Pre-post only

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
			in response to emotions at EoT. At 12-month follow up, small effect sizes favouring ACGT over DBT-BED were observed for emotion regulation	
26	Weekly individual psychotherapy/20 sessions	Emotion regulation; urges to eat in response to emotions	Medium effect size of time observed for both process variables at EoT; however, no significant group differences were observed	Pre-post only
27	Weekly group/20 sessions	Emotion regulation; urges to eat in response to emotions	Significant ↓ in urges to eat in response to emotions and significant ↑ in emotion regulation observed at EoT	Pre-post only
28	Weekly group/20 Sessions	Emotion regulation; urges to eat in response to emotions	No significant changes were observed on process variables	Pre-post only
29	Guided self-help including in person orientation to manual and six support phone calls approximately every 2 weeks/13 weeks	Emotion regulation	Improvement in emotion regulation predicted binge abstinence at EoT and at 4-, 5-, and 6-month follow up. Odds ratios indicated that for every one-unit increase in emotion regulation change scores at EoT, there was an approximately 4–6% increase in the odds of being binge abstinent at EoT and each follow-up point. Individuals who were binge abstinent at EoT reported significantly greater improvement in emotion regulation at EoT as compared with individuals who were not binge abstinent. The same pattern was observed at each follow up	"Proxy" mediation
Mindfulness-based interventions				
30	Weekly group/8 weeks	None	N/A	No process measures assessed
31	Weekly group/10 sessions	Observing skills; nonjudgmental acceptance; belief that eating helps manage negative affect;	Statistical significance could not be determined due to small sample size; however, beliefs that eating alleviates	Pre-post only

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
		belief that eating leads to feeling out of control; belief that eating alleviates boredom	negative affect decreased across participants (but was still above normal range). Decrease was also observed across participants in belief that eating leads to feeling out of control. Belief that eating alleviates boredom increased slightly. Moderate increases observed in observing skills and a substantial increase observed in nonjudgmental acceptance of internal experiences. Both scores at EoT were still above means reported by nonclinical samples	
32	Weekly group/16 sessions	None	N/A	No process measures assessed
33	Guided at home practice/4 weeks	Cognitive fusion with undesired thoughts about food cravings; body image shame; body image-specific psychological flexibility; trait mindfulness; self-compassion; compassion towards others; sense of personal inadequacy; self-hatred in response to setbacks; self-reassurance in response to setbacks	Significant improvement in cognitive fusion with undesired thoughts about food cravings, compassion towards others, body image-specific psychological flexibility, trait mindfulness, and sense of personal inadequacy were observed at EoT, and self-compassion trended towards significance ($P = 0.054$). Compared with WLC, the treatment group reported a significantly larger ↓ in body image shame and self-hatred in response to setbacks and significantly larger ↑ in self-reassurance in response to setbacks.Effects were maintained at 1 month follow up for cognitive fusion with food cravings, body	Pre-post only

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
			image-specific psychological flexibility, self-compassion, and compassion towards others	
34	Weekly group/10 weeks	None	N/A	No process measures assessed
35	Weekly group/6 weeks	Sense of control while eating; sense of mindfulness while eating; interoceptive awareness	Significant ↑ on all process variables at EoT. ↑ In perceived sense of control while eating, sense of mindfulness while eating, and awareness of satiety (but not hunger) were all associated with ↓ number of binges at EoT	"Proxy" mediation
36	Nine weekly groups followed by three monthly "booster" sessions/ approximately 4.5 months	Frequency of meditation practice; awareness of internal experiences; disinhibition; cognitive restraint; sense of control over eating behaviours	In both treatment conditions, significant ↑ were observed on sense of control over eating, awareness of internal experiences, and cognitive restraint. Significant ↓ in disinhibition observed within both groups. All effect sizes were larger in MB-EAT group than PECB group. In MB-EAT group only, ↑ time spent meditating was significantly associated with greater ↓ in binge eating and disinhibition	"Proxy" mediation
37	Weekly group/12 sessions	Psychological flexibility; body image specific cognitive fusion; engagement in values-driven behaviour; external shame; self-criticism; self-compassion; observing skills; describing skills; acting with awareness skills; non-judgmental action skills; non-reactivity to internal experience skills	Significant improvement observed on all process variables at EoT except observing skills and describing skills. All post-treatment therapeutic gains were maintained 3 and 6-month follow up. Psychological flexibility, body image cognitive fusion, and engagement in values-driven behaviour all significantly mediated the effect of intervention on binge eating frequency (in hypothesized directions). Changes in external shame, self-compassion, and self-criticism mediated decreases in binge eating (in	Formal mediation

(Continues)

TABLE 2 (Continued)

	Intervention delivery/length	Process variable(s) assessed	Summary of relevant findings	Mediation analysis category
			hypothesized directions). Only psychological flexibility and non-reactivity of internal experience skills significantly mediated decreases in global eating psychopathology	
38	Weekly group/12 sessions	Body image-specific psychological flexibility; body image specific cognitive fusion; engagement in values-driven behaviour; self-criticism; external shame	Significant medium to large effect of intervention observed on external shame, body image-specific psychological flexibility, body image-specific cognitive fusion, and self-criticism (all in hypothesized direction). Results suggest that improvements in body image-specific psychological flexibility, body image-specific cognitive fusion, external shame, and self-criticism were maintained at 3- and 6-month follow ups.	
39	Weekly group/10 sessions	Perceived control over eating; overeating in response to emotions; mindfulness	Significant improvements were observed on all process variables at EoT. Qualitative analyses of participant feedback indicate that participants perceived "spending more time in the present moment" to have significantly improved their well-being. Participants also perceived treatment to have provided a "shift from avoidance to awareness of emotions"	Pre-post only

TABLE 3 Moderators of third-wave treatments for BN and BED

Publication	ED sample (diagnostic criteria)	Study design	MABT used (*n*)	Comparison condition(s) (*n*)	Intervention delivery/length	Moderators assessed	Summary of relevant findings
ACT-based interventions							
1 Juarascio, Shaw, et al. (2013)	AN, BN, & EDNOS (DSM-IV)	NE/NR-G	Residential TAU + ACT (66)	TAU (74)	Biweekly ACT group supplementing residential TAU/varied	Severity of ED symptoms; prior hospitalization related to ED	↑ Baseline ED severity predicted worse treatment outcomes across groups. Condition × ED severity interaction trended towards significance suggesting that individuals with ↑ ED severity did better following TAU + ACT ($P = 0.09$). Individuals who reported prior hospitalization(s) trended towards larger improvements in the ACT + TAU condition ($P = 0.09$)
2 Manasse et al. (2016)	BED (DSM-5)	Open trial	ABGT (17)	N/A	Group/10 weekly sessions	Negative urgency; delay discounting; inhibition; inhibitory control	↑ Baseline negative urgency predicted more gradual ↓ in binge frequency during & after treatment. ↑ Baseline negative urgency also predicted less reduction in global ED pathology and ↑ difficulty sustaining symptom improvement relative to individuals with ↓ baseline negative urgency
DBT-based interventions							
3 Ben-Porath et al. (2009)	AN, BN, EDNOS (DSM-IV)	Open trial	DBT-informed PHP (40)	N/A	Biweekly DBT skills group with	Comorbid BPD diagnosis	Individuals with comorbid BPD diagnosis

(Continues)

TABLE 3 (Continued)

	Publication	ED sample (diagnostic criteria)	Study design	MABT used (*n*)	Comparison condition(s) (*n*)	Intervention delivery/length	Moderators assessed	Summary of relevant findings
						additional weekly groups consisting of DBT-informed concepts/ varied		appeared to benefit more with regard to ↑ emotion regulation skills following treatment. Significant difference was observed in emotion regulation skills between those with or without comorbid BPD at baseline (comorbid BPD group significantly lower); however, no group difference observed at EoT. Significance of within group change not reported
4	Robinson and Safer (2012)	BED (DSM-IV)	RCT	DBT-BED (50)	ACGT (non-directive Rogerian-based treatment) (51)	Weekly group/20 sessions	Age; sex; ethnicity; ED psychopathology; weight/BMI; onset of ED symptoms; emotional eating; general psychopathology; emotion regulation	Individuals with early onset of overweight BMI and/or early onset of dieting behaviours (≤15 years old) had significantly larger ↓ in number of binge days at EoT when assigned to DBT-BED as opposed to ACGT. Individuals who had a comorbid diagnosis of APD had significantly larger ↓ in number of binge days at EoT when assigned to DBT-BED condition as opposed

(Continues)

TABLE 3 (Continued)

	Publication	ED sample (diagnostic criteria)	Study design	MABT used (*n*)	Comparison condition(s) (*n*)	Intervention delivery/length	Moderators assessed	Summary of relevant findings
								to ACGT. Within DBT-BED group, individuals who had a comorbid diagnosis of APD had significantly ↑ number of binge days at EoT relative to those who did not have comorbid APD
5	Safer and Joyce (2011)	BED (DSM-IV)	RCT	DBT-BED (50)	ACGT (non-directive Rogerian-based treatment) (51)	Weekly group/20 sessions	Rapid response to treatment (RR; ≥65% reduction in binge eating days by Week 4)	RRs reported significantly ↑ binge abstinence and significantly ↓ eating concern, weight concern, shape concern, depressive symptoms, disinhibition, and susceptibility to hunger in both groups at EoT relative to non-RRs. Attrition was significantly ↑ among non-RRs in both groups compared with RRs. Within DBT-BED group, RRs reported significantly ↑ binge abstinence than non-RRs at EoT and 12-month follow up. Within ACGT group, RRs reported ↑ binge abstinence than non-RRs at EoT and 12-month follow up, but difference was not statistically

(Continues)

TABLE 3 (Continued)

	Publication	ED sample (diagnostic criteria)	Study design	MABT used (*n*)	Comparison condition(s) (*n*)	Intervention delivery/length	Moderators assessed	Summary of relevant findings
								significant at either time point
6	Safer et al. (2002)	BED (DSM-IV)	Open trial	DBT (32)	N/A	Weekly group/20 sessions	EoT Dietary restraint; EoT weight & shape concern; EoT urges to eat in response to emotions; EoT self-esteem; pre-treatment early onset of binge eating (<16 years old)	Analysis of predictors of relapse: Early onset of binge eating predicted failure to maintain abstinence ↑ EoT dietary restraint at EoT predicted relapse at 6 months

Note. NE/NR-G: non-equivalent, non-random groups; RCT: randomized controlled trial; BED: binge eating disorder; AN: anorexia nervosa; EDNOS: eating disorder not otherwise specified; BN: bulimia nervosa; ACT: acceptance and commitment therapy; ABGT: acceptance-based group treatment; DBT: dialectical behavioural therapy; DBT-BED: dialectical behavioural therapy for binge eating disorder; TAU: treatment as usual; PHP: partial hospitalization programme; ACGT: active comparison control group; PECB: psychoeducational cognitive behavioural treatment.

following a group-based intervention model. Three studies examining ACT-based interventions did not examine any process variables, and the remaining four conducted "proxy mediation" analyses on hypothesized mechanisms of action (i.e., process variables). One study also conducted formal mediation analyses in addition to "proxy" mediation analyses (Table 2).

The most frequently examined process variable in studies using ACT-based interventions was psychological flexibility ($n = 4$ studies), with two studies also examining problem-specific forms of psychological flexibility (e.g., psychological flexibility in relation to one's body image or food-specific internal experiences). All studies utilized either the Acceptance and Action Questionnaire-II (Bond et al., 2011), the Body Image Acceptance and Action Questionnaire (Sandoz, Wilson, Merwin, & Kellum, 2013), or Food-Specific Acceptance and Action Questionnaire (Juarascio, Forman, Timko, Butryn, & Goodwin, 2011) to assess these constructs. Additionally, one study assessed general levels of willingness, a theoretical mechanism of action related to psychological flexibility that assesses one's willingness to experience distressing emotions while engaging in valued living, using the Brief Symptom Questionnaire (Forman et al., 2012). Overall, findings across all studies indicated that both general and problem-specific forms of psychological flexibility increased following ACT-based treatment. Additionally, trends across two studies suggested that improvements in both general and psychological flexibility were associated with decreases in global eating pathology (Juarascio et al., 2017) or reported binge frequency (M. L. Hill, Masuda, Melcher, Morgan, & Twohig, 2015). However, each of these two studies contained insufficient sample sizes to conduct formal mediation or significance tests. Juarascio et al. (2013) also observed that willingness to experience distress significantly mediated the effects of treatment condition on global ED pathology within their inpatient sample such that willingness trended towards greater improvements within the ACT-based condition; across conditions, willingness significantly predicted lower global ED pathology scores at end of treatment. However, no other process variables examined in this study significantly mediated outcomes.

Additional process variables assessed within studies implementing ACT-based interventions include emotion regulation skills ($n = 2$), cognitive defusion ($n = 2$), cognitive acceptance ($n = 1$), affective acceptance ($n = 1$), negative urgency ($n = 1$), and dysfunctional thinking ($n = 1$). All studies observed significant improvements across all process variables. Results of "proxy" mediation analyses indicated that improvements in global ED pathology (assessed by the Eating Disorder Examination or Eating Disorder Examination Questionnaire; Cooper

& Fairburn, 1987; Luce & Crowther, 1999) were significantly related to increases in access to emotion regulation strategies following treatment (Juarascio et al., 2017; Juarascio, Schumacher, Shaw, Forman, & Herbert, 2015). Further, Juarascio et al. (2015) found that increases in cognitive defusion abilities were significantly associated with increases in ED-related quality of life at end of treatment. Importantly, all improvements and significant associations were observed across all participants, regardless of treatment condition (when a control or comparison condition was used), suggesting that these improvements may not be specific to ACT-based processes.

Only two ACT-based intervention studies reported analyses for at least one predictor or moderator of treatment outcome (Table 3). Although not statistically significant, Juarascio et al.'s (2013) findings trended towards those with more severe ED symptoms at baseline showing greater improvements in ED symptomatology following TAU + ACT compared with TAU only. Manasse et al. (2016) found that elevated levels of negative urgency at baseline were significantly associated with smaller reductions in binge frequency and global ED pathology following a 10-session ACT-based group treatment compared with those with low levels of negative urgency at baseline.

3.2 | DBT-based interventions

Twenty-two studies examining DBT-based treatments for BN and/or BED met our inclusion criteria. Nine of these studies utilized a transdiagnostic ED sample. The remaining studies evaluated their interventions using samples of only full or subthreshold BN ($n = 2$) or BED ($n = 11$). Notably, three studies also required that participants have a comorbid diagnosis of borderline personality disorder, and one required that participants have a comorbid substance use disorder. A slight majority of these publications reported results from a study utilizing an RCT design ($n = 12$), whereas the remainder used either an open trial ($n = 8$) or non-randomized group ($n = 1$) design.

Seven studies using a DBT-based intervention did not examine any process variables (Table 2). Among these seven, three studies did include analyses of at least one moderator of treatment outcome whereas the remaining four only reported ED symptom outcomes. Among the remaining 15 studies within this group, 13 conducted pre-post change analyses, one used both pre-post change and "proxy" mediation analyses, and one used only "proxy" mediation analyses. Three reported only on moderators of treatment outcome (Table 3), and one study reported results for both process variables and moderators.

Eleven DBT studies examined changes in emotion regulation, a core hypothesized mechanism of action in DBT. All but one utilized either one or both of two validated tools to measure emotion regulation: Negative Mood Regulation Scale (Catanzaro & Mearns, 1990) and Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004). Navarro-Haro et al. (2018), however, utilized the Emotion Regulation Questionnaire (Gross & John, 2003). Results across studies were widely varied: Three studies found no significant pre-post changes in patients' emotion regulation following the DBT-based treatment (Navarro-Haro et al., 2018; Safer, Robinson, & Jo, 2010; Telch, Agras, & Linehan, 2001), and the remaining nine studies showed variable levels of improvement ranging from small to large effect sizes (when reported). Interestingly, one study (D. M. Hill, Craighead, & Safer, 2011) found significant differences in ED symptoms but not in emotion regulation levels between treatment and delayed-treatment comparison participants when assessed at 6 weeks; however, when all participants' outcomes were included after they had completed treatment, significant improvements in emotion regulation were observed.

Six studies examined "urges to eat in response to negative affect" as measured by the Emotional Eating Scale (Arnow, Kenardy, & Agras, 1995). Two studies found no change in Emotional Eating Scale scores following individual DBT for BED (C. Courbasson, Nishikawa, & Dixon, 2012; Telch et al., 2001) whereas the other four studies found significant improvement (effect sizes varied from small to large). Several of these studies ($n = 3$) consisted of small sample sizes and reported high attrition rates, further limiting the conclusiveness of observed changes.

Other mechanisms assessed within DBT studies included interoceptive awareness ($n = 4$), perfectionism ($n = 3$), drive for thinness ($n = 3$), perceived personal ineffectiveness ($n = 3$), body dissatisfaction ($n = 3$), interpersonal distrust ($n = 2$), and ED-specific cognitions ($n = 2$). All studies observed significant increases in interoceptive awareness following DBT; however, no associations were evaluated between these increases and additional therapy outcomes such as global ED pathology or quality of life. Among the additionally assessed process variables, results were somewhat inconsistent across studies, but widely suggested that minor, statistically insignificant improvements across most variables occurred following DBT-based treatments.

Three studies examined moderators of DBT-based treatment outcomes for BN and BED. Robinson and Safer (2012) found that individuals with early onset (<15 years old) of overweight status and dieting had significantly fewer binge days when treated with DBT-BED

than when treated with the active treatment control. Safer and Joyce (2011)utilized data obtained from the same sample and found that rapid responders (RRs; ≥65% reduction in binge eating days by Week 4) in both of their treatment conditions reported significantly higher rates of binge eating abstinence, depression, and eating pathology at end of treatment (Table 3). However, they also noted that although RRs in both conditions reported higher rates of binge eating abstinence at both end of treatment and 12-month follow up than non-RR participants in the same condition, these differences were only statistically significant within the DBT group. Safer, Lively, Telch, and Agras (2002) found that early onset of binge eating (≤16 years old) and higher levels of dietary restraint at end of treatment significantly predicted relapse at 6 months among individuals who had successfully achieved abstinence from binge eating following DBT-BED.

3.3 | Mindfulness-based interventions

Ten studies examining MBIs met our inclusion criteria (Table 2). Two used a transdiagnostic ED samples, with participants having a diagnosis of AN, BN, or BED. The remaining eight studies consisted only of individuals diagnosed with full or subthreshold BED. One study using a BED-only sample also required participants to have a comorbid substance use disorder diagnosis. Five studies used an RCT study design, and five used an open trial design.

Among the 10 studies implementing MBIs, three did not examine process variables in any way, and no studies examined moderators of treatment outcome. Four studies conducted pre-post change analyses of at least one process variable; two conducted mediation "proxy" analyses; one utilized formal mediation analyses (Table 2).

Five studies examined changes in general mindfulness or specific mindfulness skills (e.g., observing, describing, acting with awareness, and non-reactivity to internal experiences). Overall, studies examining individuals' self-reported sense of mindfulness following MBIs ($n = 3$) observed significant improvements; however, findings relevant to specific mindfulness skills varied (see Table 2). Three studies also examined perceived sense of control over eating behaviours, and all reported significant increases at end of treatment. Further, Kristeller and Hallett (1999) found that increases in perceived sense of control over eating and sense of mindfulness while eating were both significantly associated with larger decreases in binge eating frequency following their meditation-based intervention for BED.

Three studies also examined problem-specific cognitive fusion and psychological flexibility. All three studies reported significant improvements for both variables at end of treatment within the MBI condition; however, two of the publications were reporting results from the same sample and intervention. Additional process variables assessed included external shame ($n = 3$); interoceptive awareness ($n = 1$), self-compassion ($n = 2$), self-criticism/sense of personal inadequacy ($n = 3$), engagement in values-driven behaviours ($n = 2$), response style to setbacks ($n = 1$), and beliefs about or experiences of over-eating in response to negative affect ($n = 2$). The majority of these studies observed significant increases at end of treatment on all process variables assessed (Table 2).

Kristeller, Wolever, and Sheets (2014) "proxy" mediation analyses indicated that participants who reported greater increases in time spent meditating following their MBI were significantly more likely to report larger decreases in binge eating behaviours and disinhibition. Pinto-Gouveia et al. (2016) conducted formal mediation analyses and found that changes in psychological flexibility, body image-specific cognitive fusion, engagement in values-driven behaviour, self-compassion, and self-criticism significantly mediated the effect of their MBI on binge frequency, with greater improvements in process variables predicting greater decreases in binge frequency. However, when assessing mediation of global ED pathology, only changes in psychological flexibility and non-reactivity to internal experience skills mediated outcomes. Notably, the majority of the mindfulness skills assessed as mediators in this study were not significant, despite mindfulness being a primary target of their intervention. However, these results should be interpreted with caution as the measurement tool utilized to assess mindfulness skills (the Five-Facet Mindfulness Questionnaire-15; Baer et al., 2008) had poor internal consistency in this study.

4 | DISCUSSION

To inform the development of more efficient and effective treatments that can be matched to individual patient needs, the current review sought to (a) determine how many MABT studies for BN and BED have assessed mechanisms of action and moderators of treatment outcome, (b) identify which mechanisms and moderators emerge as significant in extant studies, (c) determine whether emerging mechanisms of action are consistent with putative mechanisms of the corresponding theoretical models, and (d) make recommendations for future treatment research investigating MABTs for BN and

BED. Consistent with previous empirical observations, our review demonstrates that very few extant studies report examination of either mechanisms of action or moderators of treatment outcome.

In studies where analyses of hypothesized mechanisms of action were reported, results generally supported theoretically consistent improvements following the MABT being tested. The two ACT-based treatment studies that utilized formal or "proxy" mediation both found that improvement in psychological flexibility is associated with improvement in ED symptoms. Pre-post change analyses in DBT studies supported general improvements in hypothesized mechanisms of action such as emotion regulation skills, impulse control, and acceptance of negative emotion. Similarly, pre-post improvements in hypothesized mechanisms of MBIs, including mindfulness and awareness skills, non-judgmental self-acceptance, and self-efficacy around eating were found across included studies.

Only six studies assessed predictors or moderators of treatment response. This is particularly surprising given that the majority of studies assessed demographic and process variables at baseline, providing the opportunity to evaluate whether these variables predicted treatment outcome either within one treatment (as a non-specific predictor) or differentially across two or more treatments (as a moderator). Further, the few studies that reported on predictors and moderators showed inconsistent responses to treatment and lacked appropriate control group comparisons.

Overall, studies evaluating MABTs for BN and BED have focused on assessment of treatment outcome as their primary aim, with little or no attention afforded to assessment of mediators and moderators. Further, although the small amount of preliminary evidence to date in this regard appears promising, statistical methodologies for assessing such mechanisms of action and moderation should be more sophisticated. The most commonly used methods among studies in this review (assessment of pre-post change in process measures and tests of "proxy" mediation) fail to establish temporal precedence in process variable change, limiting the ability to establish causality.

4.1 | Future directions and recommendations

Recent NIH initiatives call for an increased emphasis on identifying mechanisms of action and moderators of treatment response to assess whether existing treatments truly impact their identified clinical targets (Insel, 2014). The results of our systematic review indicate that despite the growing interest in MABTs for BN and BED, there remains a substantial gap in our understanding of whom these treatments most benefit and how these treatments produce behavioural change. Conducting such research early and consistently across all empirical evaluations of ED treatments will inform more innovative and efficient treatment development and promote efficient use of financial resources when implementing RCTs and future clinical trials. Additionally, by identifying moderators of treatment response, we can begin to identify which patients may be best suited for a given treatment approach and utilize the processes known to best target individual patients' specific needs. Therefore, we propose several recommendations for future research.

4.1.1 | Reducing variability in theorized mechanisms and measurement tools

Our review demonstrated that even within each treatment approach (e.g., ACT, DBT, and MBIs), there were inconsistencies in (a) treatment implementation, (b) hypothesized moderators and mechanisms of action, and (c) the measurement tools used to assess moderators and mechanisms. For example, within MBIs, some treatments attempted to increase mindful eating directly whereas others aimed to reduce eating pathology by promoting a broader sense of mindful awareness outside of eating episodes directly. Discrepancies such as these can be limited by taking a more systematic approach to constructing treatment packages. Methods for doing so have been suggested through the multiphase optimization strategy approach to intervention research and might include conducting analogue studies comparing different techniques or using component analyses to identify which components of a treatment are active in producing behaviour change (Collins et al., 2016; Collins, Murphy, Nair, & Strecher, 2005).

Even within studies assessing one specific type of treatment with a strong and consistent theoretical background, there remains large variability in the measures chosen to assess mechanisms. Inclusion of different measures of the same construct makes comparison between trials and replication difficult, slowing progress in treatment development and the identification of key treatment "ingredients." Additionally, although many studies evaluated one or more hypothesized mechanisms of action consistent to the treatment being used, comprehensive evaluation of all theoretically relevant mechanisms was considerably lacking. For example, many of the core processes theoretically postulated by ACT, such as values clarity and committed action, have not yet been evaluated (or reported on) in MABTs for BN and BED. Understanding which

treatment components are truly driving treatment effects can facilitate the development or enhancement of more efficient therapy approaches by identifying therapy components that should be reduced, enhanced, or even removed if not functioning as theorized.

4.1.2 | Transparency in results and inclusion of null findings

In the 27 studies that reported on at least one process measure, it is unclear in many cases whether the authors reported all analyses that were conducted or only those that produced significant results (i.e., the "file drawer" effect). For both mechanisms and moderators, not including null findings in research reports stymies efficient treatment development and slows the pace of advancing research. Although part of this problem lies in the mores of research publication (i.e., that null findings are not considered important to publish), researchers may also "cherry pick" significant findings only to include in publication submissions. One strong recommendation to the field is to publish study methods prior to publishing study outcomes to increase researcher accountability in reporting on all observed outcomes. Further, researchers should describe all measures that patients complete during the course of a trial, including those that showed nonsignificant changes or changed in ways contrary to hypotheses. These null findings, if observed over several trials, can provide useful information about aspects of treatment that may be less necessary in producing treatment gains.

4.1.3 | Using appropriate study designs and analytic procedures to assess mechanisms of action

Only seven out of 39 studies included any type of mid-treatment assessment, which dramatically limits the ability to assess mechanisms of action. Statistical methods relying solely on pre-assessment and post-assessment are not sufficient to evaluate mechanisms of action, as they do not provide evidence of mediation beyond improvement in one variable being concurrently associated with improvement in another. Process measures should be administered at multiple time points within a trial to evaluate whether changes in the process measure truly *precede* changes in an outcome variable (DeRubeis, Gelfand, German, Fournier, & Forand, 2013). The best way to detect this temporal relationship is to administer these measures early in treatment, and often, especially given evidence that early treatment gains (Linardon, Brennan, & De la Piedad Garcia, 2016; Vall & Wade, 2015) and sudden treatment gains (Utzinger, Goldschmidt, Crosby, Peterson, & Wonderlich, 2016) appear particularly important in ED treatment.

Most studies (within the ED field and broadly) that utilize mediation analyses have examined change in the mediator from Time 1 to Time 2 predicting change in outcome from Time 1 to Time 3 (Figure S3). Experts in the field have criticized this approaches' validity (Lorenzo-Luaces, German, & DeRubeis, 2015), arguing that these analyses may only capture behavioural changes in the first half of treatment that are concurrently associated with change in the mediator and thus not capture temporal causality. Preacher (2015) outlines how, if seeking to draw causal inferences, analyses must account for elapsed time between a putative cause and its associated effect. Changes in process measures from pre-treatment to mid-treatment should predict *subsequent* change in the outcome variable from mid-treatment to post-treatment. Figure S4 depicts the process necessary to do so.

Further, Preacher (2015) provides detailed descriptions of three classes of robust longitudinal mediation models (i.e., methods based on the cross-lagged panel model, latent growth curve modelling, and latent change scores) developed and commonly used for such analyses. Macro downloads for SPSS now exist to conduct these analyses (Montoya & Hayes, 2017) and include dropdown menus and simple instructions for assessing mediation. Additional analytic approaches such as multilevel modelling (Hox, Moerbeek, & Van de Schoot, 2017) should also be explored as potential alternatives for evaluating how change is occurring over the course of a treatment. Notably, the majority of these analyses require large sample sizes ($n \geq 100$) to achieve the adequate power necessary to detect mediation effects (Fritz & MacKinnon, 2007). The fact that obtaining samples of this magnitude is often not feasible within clinical trials due to constrains such as time, resources, or location is certainly a limitation of these recommendations at this time. However, as dissemination options continue to increase through the use of various technologies, theoretical models continue to be refined, and novel statistical approaches continue to be explored, clinical researchers should still consider the possibilities of examining mediation effects wherever possible within their work. The use of these and similar statistical methods will greatly enhance the meaning and utility of resources invested in researching MABTs for BN and BED.

5 | SUMMARY AND CONCLUSIONS

MABTs show promise for the treatment of BN and BED, but assessment of mechanisms and moderators is crucial to enhance the study of treatment efficiency and efficacy. Extant research provides preliminary evidence that

theorized mechanisms of action improve across various MABTs for BN and BED, and associations between these improvements and symptom improvement were observed, providing initial support for the theoretical models being used. However, research utilizing more advanced statistical procedures and empirical designs is needed to further understand whether therapeutic changes are derived as theorized. Similarly, few studies have reported on moderators of outcome ($n = 4$), moderators examined varied, and results were largely inconsistent, precluding our ability to identify potential subtypes of individuals for whom certain MABTs may be most helpful. Overall, more research is needed comparing MABTs for BN/BED with treatments with the most empiric support (e.g., CBT), to elucidate the efficacy and efficiency of such treatments and to clarify the potential differences in therapeutic mechanisms and moderators.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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