

A Systematic Review of Moderators of the Association between Dietary Restraint and Binge Eating

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Abstract: Obesity interventions typically involve some form of dietary restraint (i.e., intentional limiting of food intake), yet the restraint model of binge eating proposes that engaging in dietary restraint is a causal factor for binge eating symptoms. Evidence for this model has been mixed and differs by measures, study design, and sample. Further, there also may be moderators of the association between dietary restraint and binge eating. The purpose of this systematic review was to compile the current evidence on moderators of the association between dietary restraint and binge eating. A literature search was conducted across electronic databases, resulting in the inclusion of 16 papers (with 15 different samples). The reviewed studies were primarily heterosexual White college student females and were primarily cross-sectional studies with self-report measures. There were no consistent moderators across the studies. However, there was some evidence for interactions between affective constructs and dietary restraint in relation to binge eating, as well as three-way interactions between affect, cognitive constructs, and dietary restraint. Although there were few studies, there was little current evidence for social, biological, and demographic factors as moderators. Overall, our systematic review shows a need for further research to clarify and validate the moderators, and to understand the complex interactions as well as the potential causal relationships between restraint and binge eating behaviors.



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1. Introduction

Obesity is associated with a constellation of mental and physical health problems [1–3] as well as an increased mortality risk [4]. Therefore, efficacious interventions and preventions for reducing and managing weight and preventing excess weight gain are imperative. The primary components of interventions and preventions for obesity include dietary restraint—i.e., attempting to limit one’s food intake, particularly consumption of highly palatable foods and fast food [5–7].

While some literature has demonstrated that dietary restraint is related to an increased risk of binge eating symptoms [8,9] and may not lead to lasting weight loss [10,11], other evidence suggests restraint is not universally associated with such outcomes across the literature [5,12–23]. That is, studies have shown that many individuals who engage in dietary restraint are successful in regulating their weight without experiencing binge eating symptoms [14–17]. However, given that interventions increasing dietary restraint may lead to binge eating in some individuals, it is important to increase our understanding of factors that may strengthen or weaken the restraint–binge eating association, also known as moderators.

The relationship between dietary restraint and binge eating is complex, and factors such as biological and psychological vulnerabilities may play a role in the development

of binge eating among individuals who engage in dietary restraint. There has been little theoretical work proposing moderators of the association between restraint and binge eating. Yet, of note, researchers have proposed a model in which negative affective states strengthen the association between restraint and binge eating [18]. This model proposes that when individuals are restraining their dietary intake but experience negative emotions, they are more likely to engage in binge eating. Similarly, the resource depletion model suggests that engaging in restraint is cognitively taxing and diminishes self-control over time, thereby predisposing individuals to disinhibited eating in the face of momentary factors such as negative affect [19]. However, beyond this, little theoretical work has described moderators of the relationships between dietary restraint and binge eating.

This review aimed to systematically evaluate the literature on moderators of dietary restraint and binge eating. Understanding moderators that influence the relationships between dietary restraint and binge eating can provide valuable insights into possible theoretical models of this association. Overall, this systematic review has implications for increasing the efficacy of obesity treatment while reducing development of binge eating and full-syndrome eating disorders. Further, the results of this review will increase our understanding of individual and contextual factors that may be associated with difficulty engaging in adaptive dietary restraint.

2. Method

Literature searches in the PsycInfo and PubMed databases were conducted across all dates through May 2023 using the following terms: “restraint” OR “restrict” AND binge* OR bulim* AND “moderator” OR “interaction”. Inclusion criteria were (1) empirical study, (2) binge eating as a dependent measure, and (3) examination of at least one moderator of dietary restraint or restriction. Exclusion criteria were (1) treatment study and (2) non-human participants. Articles were each screened for inclusion by two authors. Abstracts were first screened for inclusion, and abstracts that clearly did not meet inclusion criteria were excluded. Studies that possibly met inclusion criteria were further screened for confirmation. References of articles meeting criteria were searched for additional papers that may meet criteria. See Figure 1 for the flow diagram of article selection using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [20]. We identified 16 articles with 15 samples for inclusion in the review. Two authors extracted data; discrepancies were reviewed and discussed. Data were summarized and are presented in Table 1. Extracted data include sample size, sample characteristics, sample recruited, dietary restraint/restriction measure, moderator(s), binge eating measure, and moderation findings.

Table 1. Description of studies included in the systematic review.

Reference	Sample Characteristics	Sample Recruited	Dietary Restraint/ Restriction Measure	Moderator	Binge Eating Measure	Moderation Findings
Chervinko 2004 [21]	N = 139; 100% female; mean age = 20.2 years; 80.6% White, 0.7% Asian, 12.2% Black, 2.2% Hispanic, 0.7% Arabic, 2.2% Multiracial; mean BMI = 23.4; 4.3% LGBTQ	College/university	Eating Inventory—Cognitive Restraint subscale; Revised Restraint Scale	Affect intensity assessed with the Affect Intensity Measure; body shame assessed with the Objectified Body Consciousness Scale-Body Shame Scale; coping assessed with the Coping Inventory for Stressful Situations	Bulimia Test-Revised-Binge Control Scale	There were no interactions between restraint and any of the moderators (i.e., body shame, affect intensity, emotion-focused coping, and avoidance-focused coping) in relation to binge eating.
Emery et al. 2013 [22]	N = 460; 100% female; mean age = 18.04 years; 75.9% White, 7.4% Asian, 10.7% Black, 1.7% Hispanic, 3.0% biracial, 1.3% other race	College/university	Eating Disorder Examination Questionnaire—Restraint	Negative urgency assessed with UPPS Impulsive Behavior Scale	Eating Disorder Examination Questionnaire—binge eating frequency	Controlling for baseline binge eating, among those who reported binge eating, higher restraint increased binge eating frequency three months later for those with low and mean negative urgency; those with high negative urgency had higher binge eating frequency regardless of restraint level. There was no interaction between restraint and negative urgency predicting likelihood of binge eating vs. not binge eating.
Greenberg and Harvey 1987 [23]	N = 73; 100% female; mean age = 18.33 ± 0.73 years	College/university	Restraint Scale	Depressive symptoms assessed with the Beck Depression Inventory; depressive, hypomania, and biphasic symptom assessed with the General Behavior Inventory	Binge Scale	There was a significant interaction between restraint and biphasic symptoms in relation to binge eating, such that biphasic symptoms strengthened the association between restraint and higher binge eating

Table 1. Cont.

Reference	Sample Characteristics	Sample Recruited	Dietary Restraint/ Restriction Measure	Moderator	Binge Eating Measure	Moderation Findings
Linardon 2018 [24]	<i>N</i> = 237; 100% female; mean age = 24.93 ± 8.98; mean BMI = 23.30 ± 8.90	College/university and community	Cognitive Restraint Scale—Flexible Restraint and Rigid Restraint subscales	Eating self-efficacy assessed with the Eating Behavior Self-Efficacy Measure	Binge Eating Scale	There was a significant interaction between flexible restraint and eating self-efficacy in relation to binge eating, such that the association between flexible restraint and binge eating was greatest for those with moderate to strong self-efficacy. There was no interaction between eating self-efficacy and rigid restraint and binge eating.
Mason et al. 2016 [25]	<i>N</i> = 54; 100% female; mean age = 24.98 ± 7.8; 57.3% White, 25.9% Black, 1.9% Asian, 1.9% Native Hawaiian or Pacific Islander, 11.1% two or more races, 1.9% other race; mean BMI = 26.65 ± 7.16	College/university	Combination of four items from the Dutch Restrained Eating Scale; three items from the Dietary Intent Scale; four items from the Three-Factor Eating Questionnaire—Restraint subscale	Negative affect assessed with the Positive and Negative Affect Schedule; perceived social isolation assessed with the Friendship Scale	Combination of four items from the Eating Disorder Inventory—Bulimia Scale and seven items from the Eating Disorder Diagnostic Scale	Neither daily negative affect nor daily perceived social isolation moderated the association between daily restraint and binge eating.
Mason et al. 2018 [26]	<i>N</i> = 556; 100% female; mean age = 22.943 ± 6.61; 46.0% White, 34.7% Black, 12.0% two or more races, 7.2% other race; mean BMI = 25.00 ± 5.98; 15% LGBTQ	College/university	Dutch Eating Behavior Questionnaire—Restraint subscale	Negative affect assessed with the Positive and Negative Affect Schedule; impulsivity assessed with Barratt Impulsiveness Scale	Combination of four items from the Eating Disorder Inventory—Bulimia Scale and seven items from the Eating Disorder Diagnostic Scale	There was a three-way interaction between restraint, attentional impulsivity, and negative affect, such that participants with elevated levels of all three factors reported the greatest levels of binge eating. There were no interactions with motor or nonplanning impulsivity.
Mason et al. 2022 [27]	<i>N</i> = 221 tobacco product users; 45.7% female; mean age = 34.53 ± 13.28; 67.1% White, 13.2% Black, 5.5% Hispanic, 4.6% Asian or Pacific Islander, 0.9% American Indian or Alaskan Native, 0.9% other race, 7.8% Multiracial; mean BMI = 26.91 ± 6.11, 16.44–52.37	Community	Eating Pathology Symptoms Inventory—Restraint subscale	Body dissatisfaction assessed with EPSI	Eating Pathology Symptoms Inventory—Binge Eating subscale	Dietary restraint did not moderate the association between body dissatisfaction and binge eating.

Table 1. Cont.

Reference	Sample Characteristics	Sample Recruited	Dietary Restraint/ Restriction Measure	Moderator	Binge Eating Measure	Moderation Findings
Nadel 2014 [28]	N = 383; 52.5% female; mean age = 19.30 ± 1.41 ; 79.1% White, 3.9% Black, 1.8% Hispanic, 14.6% Asian, 0.3% American Indian or Alaskan Native, 0.3% other race; mean BMI = 25.00 ± 5.98 ; 16.76–43.08	College/university	Eating Disorder Examination Questionnaire–Restraint	Negative and positive affect assessed with the Positive and Negative Affect Schedule-X	Modified questions of the Eating Disorder Examination Questionnaire	There was an interaction between baseline restraint and daily anger, such that those with low restraint had a stronger relationship between daily anger and binge eating. There were no two-way interactions between baseline restraint and daily anxiety, daily positive affect, or daily depressive affect. No significant three-way interactions were found between gender, affect, and restraint.
Pearson et al. 2018 [29]	N = 50 adults with obesity; 84% female; mean age = 43.0 ± 11.9 ; 76.0% White; mean BMI = 40.3 ± 8.5	Community	One item—“I will eat less to lose weight or avoid gaining weight”	Eating expectancies assessed with one item—“If I eat this, I will feel better”; negative affect assessed with the Positive and Negative Affect Schedule	Eating episodes in which participants reported a “3” on 5-point scale for overeating and loss of control items	There was a three-way interaction between momentary restraint, negative affect, and eating expectancies, such that high levels of momentary restraint were related to binge eating only when both momentary negative affect and eating expectancies were high; low momentary restraint was generally associated with higher odds of binge eating, particularly when momentary negative affect and eating expectancies were higher.
Racine et al. 2009 [30]	N = 344; 100% female; mean age = 19.04 ± 1.44 ; 100% White	College/university	Combination of items from the Eating Disorder Examination subscale and Dutch Eating Behavior Questionnaire—Restraining subscale	Impulsivity assessed with Barratt Impulsiveness Scale; serotonin genes (5-HT)	Minnesota Eating Behaviors Survey—Binge Eating subscale	There were no two- or three-way interactions between dietary restraint, impulsivity, and serotonin genes in relation to binge eating.
Racine et al. 2011 [31]	N = 1678 twins; 100% female; mean age = 18.87 ± 3.3 ; 98% White	Minnesota Twin Family Study and Michigan State University Twin Registry	Eating Disorder Examination Questionnaire—Restraining	Genetic, shared, and non-shared environmental factors for binge eating	Minnesota Eating Behaviors Survey—Binge Eating subscale	Dietary restraint did not moderate shared environmental factors for binge eating. Genetic and non-shared environmental factors for binge eating increased at elevated levels of dietary restraint.

Table 1. Cont.

Reference	Sample Characteristics	Sample Recruited	Dietary Restraint/ Restriction Measure	Moderator	Binge Eating Measure	Moderation Findings
Racine et al. 2017 [32]	N = 988 twins; 100% female; mean age = 16.88 ± 2.60; 80% White	Michigan State University Twin Registry	Youth Eating Disorder Examination Questionnaire—Restraint	Negative urgency assessed with UPPS Impulsive Behavior Scale	Minnesota Eating Behaviors Survey—Binge Eating subscale	Restraint did not moderate the association between negative urgency and binge eating
Sehm and Warschburger, 2015 [33]	N = 1039 adolescents; 49.3% female; mean age = 14.37 ± 1.56; 80% White	Community	Child Eating Disorder Examination Questionnaire—Restraint	Gender	Overeating and loss of control items from the German Eating Disorder Examination-Questionnaire for Children	There were no interactions between gender and dietary restraint in relation to binge eating vs. healthy controls or binge eating vs. elevated internalizing symptoms
Stice et al. 2000 [18]	N = 631; 51% female; 25 Asian, 15 Black, 498 White, 60 Latino, 7 Native American, and 26 who specified other.	High school adolescents	Dutch Restrained Eating Scale; Dietary Intent Scale	Negative affect assessed with the Positive and Negative Affect Schedule -X	Revised Bulimia Test—binge control subscale	Cross-sectionally, there were interactions between each dietary restraint measure and negative affect, such that higher negative affect strengthened the positive association between dietary restraint and binge eating; similar moderation was found for both females and males. Longitudinally, there were no interactions between each dietary restraint measure and negative affect predicting binge eating onset for either females or males.
Wenzel et al. 2014 [34]	N = 166; 100% female; mean age = 19.00 ± 1.21; 75.9% White, 6.0% Black, 16.7% Asian; 0.6% two or more races, 1.8% other race; mean BMI = 23.02 ± 4.16; 15% LGBTQ	College/university	Dietary Intent Scale; Three-Factor Eating Questionnaire	Negative urgency assessed with UPPS Impulsive Behavior Scale	Bulimia Test Revised	There were no interactions between dietary restraint and negative urgency in relation to bulimic symptoms.
Woods et al. 2010 [35]	N = 497; 100% female; mean age = 19.5 ± 0.47	College/university	Restraint Scale	Stress assessed with the Social Readjustment Rating Scale	Eating Disorder Inventory 2—Bulimia subscale	There was a three-way interaction between restraint, daily stress, and life event stress, such that for individuals with high life event stress, restraint strengthens the association between daily life stress and binge eating.

Note. BMI = body mass index.

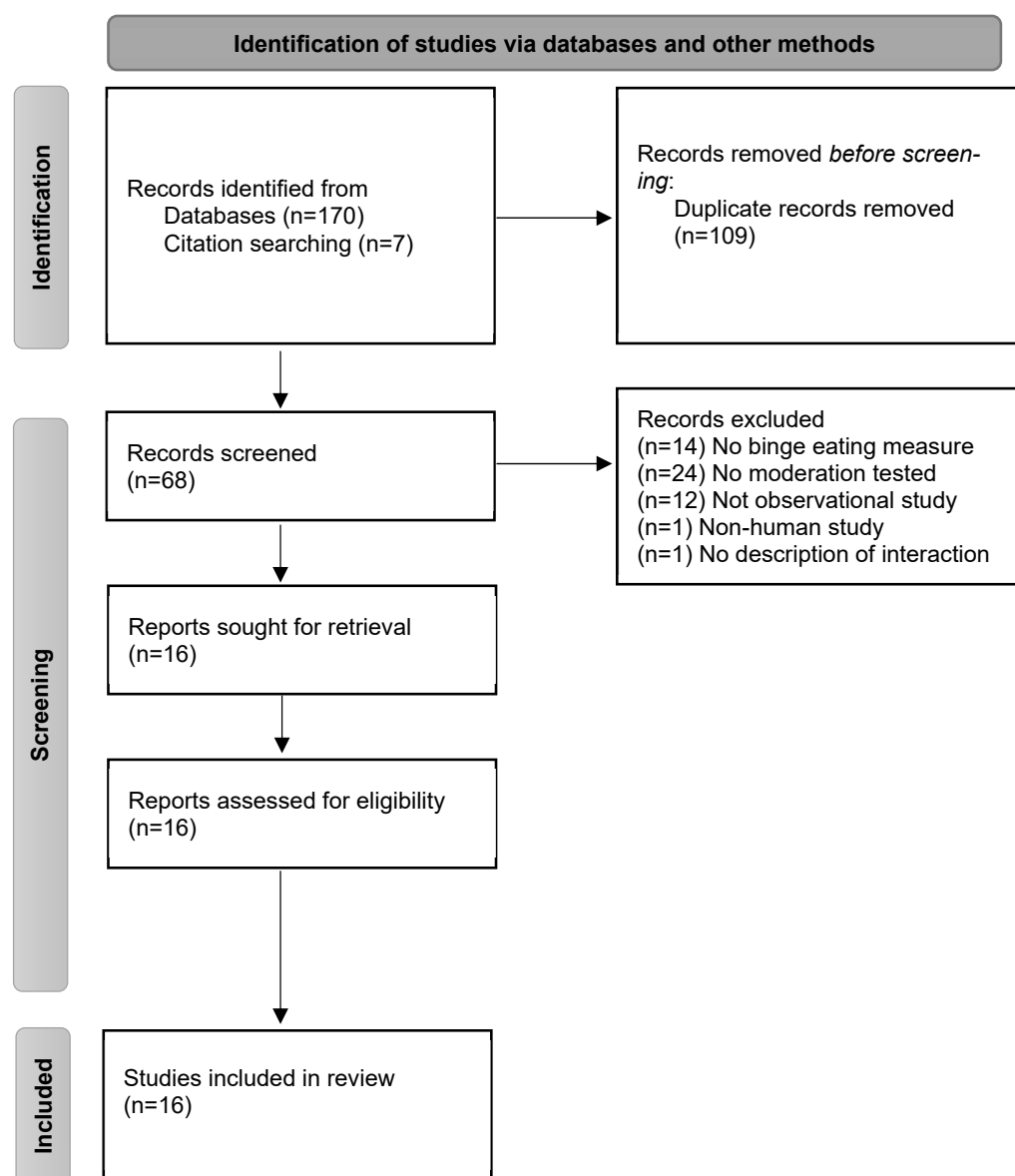


Figure 1. PRISMA diagram of study selection and review process.

3. Results

3.1. Descriptive Findings

The mean sample size was 470 ($SD = 442.29$; Range: 50–1678), with five studies having sample sizes less than 200. The mean percentage of women was 86.41% ($SD = 22.32$; range: 45.70–100). Of 13 studies reporting race/ethnicity, the mean percentage of White individuals was 76.52% ($SD = 14.31$; range: 46–100), suggesting minimal racial/ethnic diversity across the studies. Of the 15 studies reporting age, the mean age was 22.26 years ($SD = 7.43$; range: 14.37–43.00). Of the eight studies reporting body mass index (BMI), the mean BMI was 26.70 kg/m² ($SD = 5.69$; range: 23.02–40.30). Of the three studies reporting sexual identity, the mean percentage of LGBTQ individuals was 11.43% ($SD = 6.18$; range: 4.3–15). Most of the studies included college/university samples (56.3%; $k = 9$), followed by mixed samples (i.e., multiple categories; 18.8%; $k = 3$), children/adolescents (12.5%; $k = 2$), and community samples (12.5%; $k = 2$).

There was a great deal of variability in the measure of restraint used, with most studies using the Eating Disorder Examination Questionnaire ($k = 5$), Restraint Scale ($k = 3$), a combined or study-developed scale ($k = 3$), Dutch Eating Behavior Questionnaire ($k = 2$), or

Dietary Intent Scale ($k = 2$); the following scales were used in single studies: Three-Factor Eating Questionnaire Eating Inventory, Cognitive Restraint Scale, and Eating Pathology Symptoms Inventory. Similarly, there was variability for the binge eating measures, with most studies using the Eating Disorder Examination Questionnaire ($k = 3$), Revised Bulimia Test ($k = 3$), Minnesota Eating Behavior Scale ($k = 3$), or a combined or study-developed scale ($k = 3$); the following scales were used in single studies: Binge Scale, Binge Eating Scale, Eating Disorder Inventory, and Eating Pathology Symptoms Inventory. Two studies were intensive longitudinal studies using daily or momentary measures of restraint and binge eating. No studies examined clinical samples of individuals diagnosed with eating disorders. Affect and cognitive variables were most commonly examined as moderators, with 44% of studies examining affective factors and 44% examining cognitive factors.

3.2. Primary Findings

Demographic factors. Two studies (one study of college students and one of adolescents) examined gender as a moderator of the relationship between dietary restraint and binge eating and found no moderation effects [28,33].

Genetic factors. In a sample of emerging adult female twins, dietary restraint did not moderate the shared environmental factors for binge eating, but genetic and non-shared environmental factors for binge eating increased at elevated levels of dietary restraint [31].

Body image. Two studies examined body image variables (i.e., body shame and body dissatisfaction) as moderators of the association between dietary restraint and binge eating, and both studies found no significant interactions [21,27]. The samples in the two studies were different with one being female college students and the other being adults who used tobacco products.

Affect, stress, and coping. Three studies examined negative urgency (i.e., tendency to be impulsive when experiencing negative affect) as a moderator of the association between dietary restraint and binge eating, with only one finding a significant interaction. In a sample of female college students, Emery and colleagues [22] found that only among those who reported binge eating, controlling for baseline binge eating, higher dietary restraint was related to increased binge eating frequency three months later for those with low and mean negative urgency; those with high negative urgency had increased binge eating frequency regardless of restraint level. Yet, two other studies using cross-sectional data from college student females and female twins found no moderation effects of negative urgency [32,34].

Chervinko [21] found that there were no interactions between restraint and affect intensity, emotion-focused coping, and avoidance-focused coping in relation to binge eating in female college students. However, Stice and colleagues [18] reported that there were cross-sectional interactions between dietary restraint measures and negative affect in high school adolescents, such that higher negative affect strengthened the positive association between dietary restraint and binge eating in both females and males. However, there were no interactions longitudinally.

Another study of female college students found a significant interaction between restraint and biphasic symptoms (i.e., fluctuations from high to low mood/energy) in relation to binge eating, such that biphasic symptoms strengthened the association between restraint and higher binge eating [23]. One study of female college students examined the three-way interaction between restraint, daily stress, and life event stress; for individuals with high life event stress, restraint strengthened the association between daily life stress and binge eating [35].

Two studies used daily diary methodology to study the associations between daily affect and binge eating in female college students. Nadel [28] reported an interaction between baseline restraint and daily anger, such that those with low restraint had a stronger relationship between daily anger and binge eating. However, both studies found that daily negative affect did not moderate the relationship between daily restraint and binge

eating [25,28]; also, Nadel [28] reported no moderation effect for daily positive affect or anxiety and binge eating.

3.3. Cognitive Factors

In a mixed sample of female college students and female adults from the community, there was a significant interaction between flexible restraint (i.e., a less strict approach to restraint in which no foods are forbidden) and eating self-efficacy in relation to binge eating [24]. The pattern of findings for the interaction suggested that having moderate or poor eating self-efficacy was associated with the highest levels of binge eating regardless of flexible restraint. However, elevated flexible restraint increased binge eating for individuals with high eating self-efficacy, but binge eating levels were still lower than those with moderate and low eating self-efficacy. There was no interaction between eating self-efficacy and rigid restraint (i.e., a highly strict form of restraint with many food rules) and binge eating.

3.4. Social Factors

In a daily diary study, Mason and colleagues [25] found that daily perceived social isolation did not moderate the relationship between daily restraint and binge eating in female college students.

3.4.1. Affect and Cognitive Factor Interactions

Among female college students, there was a three-way interaction between restraint, attentional impulsivity, and negative affect, such that the high levels of all three factors were associated with the greatest levels of binge eating [26]. A separate study of young and middle-aged adults with obesity reported a three-way interaction between momentary, within-subject restraint, negative affect, and mood improvement eating expectancies, such that high levels of momentary restraint were related to binge eating only when both momentary negative affect and mood improvement eating expectancies were high; low momentary restraint was generally associated with higher odds of binge eating, particularly when momentary negative affect and eating expectancies were higher [29].

3.4.2. Genetic and Cognitive Factor Interactions

There were no two- or three-way interactions between dietary restraint, impulsivity, and serotonin genes in relation to binge eating among female college students [30].

4. Discussion

This systematic review examined the literature on moderators of the association between dietary restraint and binge eating. The existing literature was highly heterogeneous and inconsistent across the studies. The studies varied across sample composition, methodology (e.g., different measures of restraint and binge eating), constructs examined as moderators, and number of moderators. Overall, the findings were nuanced with little consistent evidence for any one candidate moderator as an important moderator of the association between dietary restraint and binge eating.

Most studies had large samples, suggesting adequate power to test for interactions, although a few studies may have been underpowered to detect interaction effects [36]. Similarly to most research on eating behaviors, the samples were primarily heterosexual White female college students, which limits the diversity and generalizability of the findings to other groups. Only a minority of the studies reported BMI, with study means ranging from falling in the healthy category to the obesity category. The measurement of body composition is important to clarify how effects may differ as a function of weight status.

The measures of dietary restraint differed across the studies, which may be of concern given the differences in conceptualization and foci of varying measures of restraint (e.g., flexible vs. rigid restraint). For example, the Eating Disorder Examination Questionnaire Restraint subscale focuses on rigid forms of restraint such as strict food rules, limiting

to influence shape/weight, and food exclusion [37], whereas the Three-Factor Eating Questionnaire Cognitive Restraint subscale and Dutch Eating Behavior Questionnaire focus primarily on portion control and eating less [38,39]. Due to the varying conceptualizations of dietary restraint [40,41], different forms of restraint may dissimilarly interact with other variables to predict binge eating, necessitating improved and rigorous assessment of dietary restraint in future research. Recently, Polivy and colleagues [40] similarly concluded the need for carefully defining dietary restraint constructs and research questions to ensure the accurate measurement of dietary restraint and to be able to understand how different restraint constructs are associated with outcomes of interest. Similarly, the measures of binge eating varied across studies. Binge eating measures differ in examining the frequency of episodes vs. the severity of symptoms, as well as focusing on behavioral symptoms (e.g., overeating, loss of control) and/or associated psychological features (e.g., guilt, shame). The choice of measures may affect the findings and should be chosen in alignment with the research question and theoretical framework.

There was mixed evidence for affective factors alone as moderators of the association between dietary restraint and binge eating, and there were differences across affective constructs and study design. One early cross-sectional study showed that negative affect intensity strengthened the association of dietary restraint with binge eating in adolescents [18]. This fits with models suggesting that dietary restraint and negative affect have a multiplicative effect in depleting self-regulatory resources, and, thus, increasing binge eating risk [19]. Yet, this effect did not emerge in other studies that were reviewed, particularly ones using more rigorous intensive longitudinal methodology [25,28], and the findings varied somewhat depending on the affective constructs being studied (e.g., general negative affect, anger, stress). Future research would be strengthened by the examination of different affective constructs as moderators as well as by the development of theoretical models informing the choice of the affective constructs being studied as moderators.

However, a few studies found that the interplay between cognitive and affective factors with dietary restraint may be most strongly related to binge eating. For instance, Mason and colleagues [26] showed that female college students with elevated attentional impulsivity, negative affect, and dietary restraint engaged in the greatest binge eating. In addition, Pearson and colleagues [29] showed that the combination of elevated momentary restraint, negative affect, and mood improvement eating expectancies predicted the greatest probability of a subsequent binge eating episode in daily life. Taken together, negative affect may impact restraint–binge eating relationships only in combination with other cognitive factors. Therefore, there appears to be an important interactive role of cognitive and affective processes in interrupting the ability to engage in appropriate dietary restraint. This is consistent with recent calls for more research integrating cognitive and affective constructs into eating disorder models [42].

Interestingly, body image concerns did not moderate the association of dietary restraint and binge eating. Since individuals with body image concerns are at strong risk of binge eating [43,44], it might be expected that dietary restraint could be a precipitating factor for binge eating among those with this high vulnerability. For example, individuals with body image concerns have elevated attentional bias to body- and food-related cues [45], which could increase the probability of binge eating when engaging in restraint. Given the null findings for body image as a moderator, it will be important to examine other models of how body image may impact the restraint and binge eating association (e.g., including influence of attention biases). Furthermore, body image is a multifaceted construct and so other sub-constructs of body image should be explored as moderators in future studies (e.g., overvaluation of shape and weight).

There was a significant interaction between flexible restraint (i.e., a less strict approach to restraint in which no foods are forbidden) and eating self-efficacy in relation to binge eating such that those with strong self-efficacy who reported high flexible restraint increased in binge eating, although these individuals still engaged in less binge eating than those with moderate and poor eating self-efficacy [24]. There was no interaction between eating

self-efficacy and rigid restraint (i.e., a highly strict form of restraint with many food rules) in relation to binge eating. These results show complexities in the association between cognitive factors, restraint, and binge eating, in that individuals with positive eating-related traits may increase binge eating to a small extent in response to restraint.

Social and biological factors were rarely tested as moderators of the association between dietary restraint and binge eating. The current review found no evidence of social factors as moderators, although only one study looked at a social factor (i.e., daily perceived social isolation). A study of female twins found that dietary restraint moderated the genetic risk of binge eating, suggesting the need for future work on specific biological mechanisms that may increase binge eating in individuals engaging in restraint [31]. However, another study reported null interactions between serotonin genes and restraint in relation to binge eating, and, thus, serotonin genes may not be an important candidate genetic moderator of restraint and binge eating [30]. The small number of studies examining social and biological factors as moderators precludes any conclusions on their roles as moderators of dietary restraint and binge eating. Instead, the current findings of our review indicate much more research is needed in this area across an array of social and biological factors.

Gender did not moderate the relationships between dietary restraint and binge eating, suggesting that males and females may have similar associations between dietary restraint and binge eating. It is possible that sex-differentiated risk factors (e.g., sexism, sexual harassment, drive for muscularity) may explain how dietary restraint is associated with binge eating for males and females. Other demographic characteristics were not studied as moderators, yet it is possible that the association between restraint and binge eating may differ based on other characteristics, such as race, ethnicity, age, income, sexual and gender identity, and weight status. Furthermore, there may be unique moderators of the association between restraint and binge eating for demographic subgroups, which should be examined in future research.

This systematic review had several limitations to note, which are primarily shortcomings of the available literature. Most of the studies reviewed were cross-sectional, so directionality and causality cannot be concretely determined. Most of the studies did not examine differences based on demographic factors, which may be due to limited sample diversity. The measures used to assess dietary restraint, moderators, and binge eating were extremely varied across the studies, making it difficult to develop firm conclusions, particularly regarding any specific aspect of dietary restraint or moderators. Given the high variability in the constructs studied, a meta-analysis of studies could not be conducted.

In sum, much more research is needed to understand the complex interactions of trait and state moderators of the association between dietary restraint and binge eating. There are different conceptualizations of restraint (e.g., flexible vs. rigid). Further, eating disorder-related restraint measures (e.g., Eating Disorder Examination Questionnaire) measure key restrictive eating behaviors (e.g., fasting, strict food rules), whereas other restraint measures (e.g., Three-Factor Eating Questionnaire) focus on approaches like limiting and portion control. This necessitates careful consideration of restraint measures and/or use of multiple measures. In addition, it will be important to study moderation by weight-related factors (i.e., weight status, weight suppression, weight-related treatment), which may impact the association between dietary restraint and binge eating. More diverse methodological approaches using longitudinal, experimental, and/or intensive longitudinal designs will help contribute to a more comprehensive understanding of moderators of the association between dietary restraint and binge eating. All the studies examined in our review used traditional survey measures, except for two that used daily diaries or ecological momentary assessment. In particular, ecological momentary assessment can help identify in which people dietary restraint predicts subsequent binge eating and in what internal and external contexts dietary restraint predicts binge eating. Ecological momentary assessment can also reduce the impact of self-report biases inherent in questionnaires requiring retrospective reporting over longer periods of time. Ultimately, expanding this body of research will help

to understand whether, how, and for whom adaptive and maladaptive forms of restraint potentiate binge eating behavior.

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References

1. Cecchini, M.; Sassi, F.; Lauer, J.A.; Lee, Y.Y.; Guajardo-Barron, V.; Chisholm, D. Tackling of unhealthy diets, physical inactivity, and obesity: Health effects and cost-effectiveness. *Lancet* **2010**, *376*, 1775–1784. [\[CrossRef\]](#) [\[PubMed\]](#)
2. Duarte-Guerra, L.S.; Coêlho, B.M.; Santo, M.A.; Wang, Y.P. Psychiatric disorders among obese patients seeking bariatric surgery: Results of structured clinical interviews. *Obes. Surg.* **2015**, *25*, 830–837. [\[CrossRef\]](#) [\[PubMed\]](#)
3. Simon, G.E.; Von Korff, M.; Saunders, K.; Miglioretti, D.L.; Crane, P.K.; Van Belle, G.; Kessler, R.C. Association between obesity and psychiatric disorders in the US adult population. *Arch. Gen. Psychiatry* **2006**, *63*, 824–830. [\[CrossRef\]](#) [\[PubMed\]](#)
4. Flegal, K.M.; Graubard, B.I.; Williamson, D.F.; Gail, M.H. Excess deaths associated with underweight, overweight, and obesity. *JAMA* **2005**, *293*, 1861–1867. [\[CrossRef\]](#)
5. Curioni, C.C.; Lourenco, P.M. Long-term weight loss after diet and exercise: A systematic review. *Int. J. Obes.* **2005**, *29*, 1168. [\[CrossRef\]](#) [\[PubMed\]](#)
6. Karfopoulou, E.; Brikou, D.; Mamalaki, E.; Bersimis, F.; Anastasiou, C.A.; Hill, J.O.; Yannakoulia, M. Dietary patterns in weight loss maintenance: Results from the MedWeight study. *Eur. J. Nutr.* **2017**, *56*, 991–1002. [\[CrossRef\]](#) [\[PubMed\]](#)
7. Montesi, L.; El Ghoch, M.; Brodosi, L.; Calugi, S.; Marchesini, G.; Dalle Grave, R. Long-term weight loss maintenance for obesity: A multidisciplinary approach. *Diabetes Metab. Syndr. Obes.* **2016**, *9*, 37. [\[CrossRef\]](#) [\[PubMed\]](#)
8. Heatherton, T.F.; Polivy, J. Chronic dieting and eating disorders: A spiral model. In *The Etiology of Bulimia Nervosa: The Individual and Familial Context*; Crowther, J.H., Tennenbaum, D.L., Hobfoll, S.E., Stephens, M.A.P., Eds.; Series in Applied Psychology: Social Issues and Questions; Hemisphere: Washington, DC, USA, 1992; pp. 133–155.
9. Stice, E. A prospective test of the dual-pathway model of bulimic pathology: Mediating effects of dieting and negative affect. *J. Abnorm. Psychol.* **2001**, *110*, 124–135. [\[CrossRef\]](#)
10. Field, A.E.; Austin, S.B.; Taylor, C.B.; Malspeis, S.; Rosner, B.; Rockett, H.R.; Colditz, G.A. Relation between dieting and weight change among preadolescents and adolescents. *Pediatrics* **2003**, *112*, 900–906. [\[CrossRef\]](#)
11. Mann, T.; Tomiyama, A.J.; Westling, E.; Lew, A.M.; Samuels, B.; Chatman, J. Medicare’s search for effective obesity treatments: Diets are not the answer. *Am. Psychol.* **2007**, *62*, 220–233. [\[CrossRef\]](#)
12. Bartholomay, J.; Schaefer, L.M.; Forester, G.; Crosby, R.D.; Peterson, C.B.; Crow, S.J.; Wonderlich, S.A. Evaluating dietary restriction as a maintaining factor in binge-eating disorder. *Int. J. Eat. Disord.* **2023**, *57*, 1172–1180. [\[CrossRef\]](#)
13. Schaumberg, K.; Anderson, D.A.; Anderson, L.M.; Reilly, E.E.; Gorrell, S. Dietary restraint: What’s the harm? A review of the relationship between dietary restraint, weight trajectory and the development of eating pathology. *Clin. Obes.* **2016**, *6*, 89–100. [\[CrossRef\]](#) [\[PubMed\]](#)
14. Catenacci, V.A.; Odgen, L.; Phelan, S.; Thomas, J.G.; Hill, J.; Wing, R.R.; Wyatt, H. Dietary habits and weight maintenance success in high versus low exercisers in the National Weight Control Registry. *J. Phys. Act. Health* **2014**, *11*, 1540–1548. [\[CrossRef\]](#) [\[PubMed\]](#)
15. Klem, M.L.; Wing, R.R.; McGuire, M.T.; Seagle, H.M.; Hill, J.O. A descriptive study of individuals successful at long-term maintenance of substantial weight loss. *The Am. J. Clin. Nutr.* **1997**, *66*, 239–246. [\[CrossRef\]](#)
16. Phelan, S.; Liu, T.; Gorin, A.; Lowe, M.; Hogan, J.; Fava, J.; Wing, R.R. What distinguishes weight-loss maintainers from the treatment-seeking obese? Analysis of environmental, behavioral, and psychosocial variables in diverse populations. *Ann. Behav. Med.* **2009**, *38*, 94–104. [\[CrossRef\]](#) [\[PubMed\]](#)
17. Wing, R.R.; Phelan, S. Long-term weight loss maintenance. *Am. J. Clin. Nutr.* **2005**, *82*, 222S–225S. [\[CrossRef\]](#) [\[PubMed\]](#)
18. Stice, E.; Akutagawa, D.; Gaggan, A.; Agras, W.S. Negative affect moderates the relation between dieting and binge eating. *Int. J. Eat. Disord.* **2000**, *27*, 218–229. [\[CrossRef\]](#)
19. Loth, K.A.; Goldschmidt, A.B.; Wonderlich, S.A.; Lavender, J.M.; Neumark-Sztainer, D.; Vohs, K.D. Could the resource depletion model of self-control help the field to better understand momentary processes that lead to binge eating? *Int. J. Eat. Disord.* **2016**, *49*, 998–1001. [\[CrossRef\]](#) [\[PubMed\]](#)
20. Parums, D.V. Review articles, systematic reviews, meta-analysis, and the updated preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines. *Med. Sci. Monit.* **2021**, *27*, e934475-1. [\[CrossRef\]](#)

21. Chervinko, S.M. *Potential Moderators of the Relationship between Dietary Restraint and Binge Eating: Affect Intensity, Body Shame, and Coping Styles*; Michigan State University: East Lansing, MI, USA, 2004.
22. Emery, R.L.; King, K.M.; Fischer, S.F.; Davis, K.R. The moderating role of negative urgency on the prospective association between dietary restraint and binge eating. *Appetite* **2013**, *71*, 113–119. [\[CrossRef\]](#)
23. Greenberg, B.R.; Harvey, P.D. Affective lability versus depression as determinants of binge eating. *Addict. Behav.* **1987**, *12*, 357–361. [\[CrossRef\]](#)
24. Linardon, J. The relationship between dietary restraint and binge eating: Examining eating-related self-efficacy as a moderator. *Appetite* **2018**, *127*, 126–129. [\[CrossRef\]](#)
25. Mason, T.B.; Heron, K.E.; Braitman, A.L.; Lewis, R.J. A daily diary study of perceived social isolation, dietary restraint, and negative affect in binge eating. *Appetite* **2016**, *97*, 94–100. [\[CrossRef\]](#)
26. Mason, T.B.; Smith, K.E.; Lavender, J.M.; Lewis, R.J. Independent and interactive associations of negative affect, restraint, and impulsivity in relation to binge eating among women. *Appetite* **2018**, *121*, 147–153. [\[CrossRef\]](#)
27. Mason, T.B.; Dolgon-Krutolow, A.; Smith, K.E.; Leventhal, A.M. Body dissatisfaction and binge eating: The moderating roles of sweet taste reward sensitivity and dietary restraint among tobacco product users. *Int. J. Environ. Res. Public Health* **2022**, *19*, 15523. [\[CrossRef\]](#)
28. Nadel, A.L. Impulsivity, Negative Affect, and Binge Eating in College Students: A daily Diary Approach. Doctoral Dissertation, Fairleigh Dickinson University, Teaneck, NJ, USA, 2014.
29. Pearson, C.M.; Mason, T.B.; Cao, L.; Goldschmidt, A.B.; Lavender, J.M.; Crosby, R.D.; Peterson, C.B. A test of a state-based, self-control theory of binge eating in adults with obesity. *Eat. Disord.* **2018**, *26*, 26–38. [\[CrossRef\]](#)
30. Racine, S.E.; Culbert, K.M.; Larson, C.L.; Klump, K.L. The possible influence of impulsivity and dietary restraint on associations between serotonin genes and binge eating. *J. Psychiatr. Res.* **2009**, *43*, 1278–1286. [\[CrossRef\]](#)
31. Racine, S.E.; Burt, S.A.; Iacono, W.G.; McGue, M.; Klump, K.L. Dietary restraint moderates genetic risk for binge eating. *J. Abnorm. Psychol.* **2011**, *120*, 119–128. [\[CrossRef\]](#)
32. Racine, S.E.; VanHuysse, J.L.; Keel, P.K.; Burt, S.A.; Neale, M.C.; Boker, S.; Klump, K.L. Eating disorder-specific risk factors moderate the relationship between negative urgency and binge eating: A behavioral genetic investigation. *J. Abnorm. Psychol.* **2017**, *126*, 481–494. [\[CrossRef\]](#)
33. Sehm, M.; Warschburger, P. The specificity of psychological factors associated with binge eating in adolescent boys and girls. *J. Abnorm. Child Psychol.* **2015**, *43*, 1563–1571. [\[CrossRef\]](#)
34. Wenzel, K.R.; Weinstock, J.; Vander Wal, J.S.; Weaver, T.L. Examining the role of negative urgency in a predictive model of bulimic symptoms. *Eat. Behav.* **2014**, *15*, 343–349. [\[CrossRef\]](#) [\[PubMed\]](#)
35. Woods, A.M.; Racine, S.E.; Klump, K.L. Examining the relationship between dietary restraint and binge eating: Differential effects of major and minor stressors. *Eat. Behav.* **2010**, *11*, 276–280. [\[CrossRef\]](#) [\[PubMed\]](#)
36. Sommet, N.; Weissman, D.L.; Cheutin, N.; Elliot, A.J. How many participants do I need to test an interaction? Conducting an appropriate power analysis and achieving sufficient power to detect an interaction. *Adv. Methods Pract. Psychol. Sci.* **2023**, *6*, 25152459231178728. [\[CrossRef\]](#)
37. Fairburn, C.G.; Beglin, S.J. Assessment of eating disorders: Interview or self-report questionnaire? *Int. J. Eat. Disord.* **1994**, *16*, 363–370. [\[CrossRef\]](#)
38. Stunkard, A.J.; Messick, S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J. Psychosom. Res.* **1985**, *29*, 71–83. [\[CrossRef\]](#) [\[PubMed\]](#)
39. Van Strien, T.; Frijters, J.E.; Bergers, G.P.; Defares, P.B. The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *Int. J. Eat. Disord.* **1986**, *5*, 295–315. [\[CrossRef\]](#)
40. Polivy, J.; Herman, C.P.; Mills, J.S. What is restrained eating and how do we identify it? *Appetite* **2020**, *155*, 104820. [\[CrossRef\]](#) [\[PubMed\]](#)
41. Bond, M.J.; McDowell, A.J.; Wilkinson, J.Y. The measurement of dietary restraint, disinhibition and hunger: An examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). *Int. J. Obes.* **2001**, *25*, 900–906. [\[CrossRef\]](#) [\[PubMed\]](#)
42. Schaefer, L.M.; Forester, G.; Dvorak, R.D.; Steinglass, J.; Wonderlich, S.A. Integrating aspects of affect, reward, and cognition to develop more comprehensive models of binge-eating pathology. *Int. J. Eat. Disord.* **2023**, *56*, 1502–1510. [\[CrossRef\]](#)
43. Ahrberg, M.; Trojca, D.; Nasrawi, N.; Vocks, S. Body image disturbance in binge eating disorder: A review. *Eur. Eat. Disord. Rev.* **2011**, *19*, 375–381. [\[CrossRef\]](#)
44. Levine, M.P.; Piran, N. The role of body image in the prevention of eating disorders. *Body Image* **2004**, *1*, 57–70. [\[CrossRef\]](#) [\[PubMed\]](#)
45. Rodgers, R.F.; DuBois, R.H. Cognitive biases to appearance-related stimuli in body dissatisfaction: A systematic review. *Clin. Psychol. Rev.* **2016**, *46*, 1–11. [\[CrossRef\]](#) [\[PubMed\]](#)

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