Difficulties with emotion regulation and weight/shape concerns as predictors of eating disorder behaviors among adolescents

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Data availability Statement:

Deidentified data are available upon request from the senior author (D.M.), pertaining to approval from the authors’ institutional ethics committee.

Authors’ contributions:

Nora Trompeter: Conceptualization, Formal analysis, Investigation, Writing - Original Draft, Project administration; Kay Bussey: Conceptualization, Methodology, Writing - Review & Editing, Supervision; Miriam K Forbes: Conceptualization, Formal analysis, Writing - Review & Editing, Supervision; Scott Griffiths: Methodology, Writing - Review & Editing; Jonathan Mond: Methodology, Writing - Review & Editing; Phillipa Hay: Methodology, Writing - Review & Editing; Alexandra Lonergan: Methodology, Writing - Review & Editing; Jack Tame: Project administration, Writing - Review & Editing;
Deborah Mitchison: Conceptualization, Methodology, Writing - Review & Editing,
Supervision, Project administration, Funding acquisition.
Abstract

Background: Difficulties with emotion regulation are a proposed key transdiagnostic factor of mental health difficulties, including eating disorders. However, it remains unclear whether difficulties with emotion regulation prospectively predict engagement in eating disorder behaviors. The current study examined whether difficulties with emotion regulation were associated with eating disorder behaviors after one year, in addition to weight and shape concerns. Methods: A community sample of high school students ($n = 3074$; 53.2% girls) completed self-report measures of eating behaviors, weight/shape concerns, and difficulties with emotion regulation at two timepoints, one year apart. Results: Findings indicated that greater difficulties with emotion regulation were uniquely associated with engaging in binge eating, fasting, and purging after one year. However, only greater weight and shape concerns, not difficulties with emotion regulation, were uniquely associated with engaging in driven exercise. Limited associations were detected for frequency of eating disorder behaviors. Additionally, exploratory analyses were conducted to examine potential onset and persistence of eating disorder behaviors. Few gender differences were observed across analyses, with the exception of driven exercise, which was linked to difficulties with emotion regulation only among adolescent boys, but not girls. Conclusions: Findings suggest that difficulties with emotion regulation are a distinct factor in the occurrence of some eating disorder behaviors among adolescents. Exploratory findings further suggest that difficulties with emotion regulation appear to be particularly involved in the persistence of these behaviors in adolescents.

Keywords: Difficulties with emotion regulation; Weight and shape concerns; Eating disorders; Disordered eating; Adolescence
General Scientific Summary:

Difficulties with emotion regulation are a key correlate for eating disorders. The current study supports emerging literature positioning difficulties with emotion regulation as a risk and maintenance factor for some eating disorder behaviors among adolescents.
Difficulties with emotion regulation and weight/shape concerns as predictors of eating disorder behaviors among adolescents

Eating disorders are characterized by disturbances in body image perception and eating behaviors (American Psychiatric Association, 2013), and are associated with heightened mortality, psychiatric and physical comorbidity, and quality of life impairment (Ágh et al., 2016; Arcelus et al., 2011; Rojo-Moreno et al., 2015). Eating disorders typically develop during adolescence, making this period critical for early intervention efforts (Hudson et al., 2007; Nagl et al., 2016). Effective early intervention is predicated on robust knowledge of risk factors and their prospective relationship with eating disorder symptoms. One risk factor proposed in the onset of eating disorders is difficulties with emotion regulation (Aldao et al., 2010; Haynos & Fruzzetti, 2011; Leehr et al., 2015; Trompeter et al., 2021).

Difficulties with emotion regulation refer to difficulties with emotional experiences, resulting in emotional responses that are poorly regulated. For example, this includes difficulties with identifying emotions and selecting appropriate regulatory strategies (Gratz & Roemer, 2008; Keenan, 2000). The current study examines the unique prospective relationship between difficulties with emotion regulation, in addition to weight/shape concerns, with eating disorder behaviors in adolescents.

Theoretical models of eating pathology posit that both difficulties with emotion regulation and weight/shape concerns are associated with eating disorder behaviors (Fairburn et al., 2003). Specifically, the cognitive behavioral therapy transdiagnostic model of eating disorders (“CBT-E model”) – arguably the most widely used and supported theoretical model of eating disorders (Dakanalis et al., 2014; Hay et al., 2014; Linardon et al., 2017) – proposes that weight/shape concerns are at the core of eating disorder pathology. Additionally, the model proposes that difficulties with emotion regulation are an additional maintenance factor that is specifically linked to binge eating and purging (but not dietary restraint or driven...
exercise). However, cross-sectional research examining this model suggests that difficulties with emotion regulation are associated with all facets of eating disorder behaviors outlined in the theory, including dietary restraint and driven exercise (Dakanalis et al., 2014; Jones et al., 2020). While the CBT-E model is a maintenance model focused on persistence of eating disorder symptoms, it also recognizes that other factors may be involved in symptom development. Indeed, weight/shape concerns are one of the most established risk factors for eating pathology across different theoretical models (Pennesi & Wade, 2016). Therefore, the transdiagnostic model may require consideration of the role of difficulties with emotion regulation in both the development and maintenance of eating disorder symptoms.

Our previous research showed that both difficulties with emotion regulation and weight/shape concerns were uniquely related with eating disorder behaviors among adolescents (Trompeter et al., 2022). That study, as well as the current study, distinguished between the frequency of an eating disorder behavior (i.e., how often a person engaged in the behavior) and the likelihood of an eating disorder behavior (i.e., the likelihood of someone engaging in the behavior at any frequency vs not engaging in the behavior at all). Findings showed that difficulties with emotion regulation were associated with higher frequency/likelihood binge eating and purging, as proposed in the CBT-E model. However, regarding fasting, it was the frequency of this behavior rather than its probability that was positively related to severity of difficulties with emotion regulation. Thus, there may be a difference between the role of difficulties with emotion regulation in the likelihood of eating disorder behaviors vs their frequency – and this may map onto development vs maintenance. However, this research was limited to cross-sectional data and longitudinal data are required to determine the time-ordering of effects.

Few studies have examined the longitudinal relationship between difficulties with emotion regulation and eating pathology (McClure et al., 2022; McLaughlin et al., 2011).
One of these studies found that among adolescents, difficulties with emotion regulation predicted subsequent increases in eating disorder pathology after 7 months (McLaughlin et al., 2009). Interestingly, the study showed that eating disorder pathology did not predict subsequent difficulties with emotion regulation. While these findings suggested that difficulties with emotion regulation preceded eating disorder symptoms, the study was limited due to the use of a global eating pathology measure. As such, the authors were unable to draw conclusions about the unique relationships with the array of specific and differing eating disorder behaviors and weight/shape concerns. This distinction is important when considering the development of eating disorders, as weight/shape concerns typically emerge prior to eating disorder behaviors (Rodgers et al., 2014) and are a key risk factor for the development of eating disorder behaviors (Stice et al., 2021). Other longitudinal research examining specific eating disorder behaviors found that high levels of emotion regulation at age 15 predicted lower dietary restraint at age 16 (Shriver et al., 2019), and that maladaptive emotion regulation predicted increases in bulimic symptoms over four years among adolescents (Nolen-Hoeksema et al., 2007). Additionally, among young adult women, McClure et al (2022) found that difficulties with emotion regulation predicted both the onset and persistence of binge eating and compensatory behaviors (purging and driven exercise) after 8 months. However, none of these studies adjusted for weight/shape concerns to examine whether difficulties with emotion regulation were a unique predictor of eating disorder behaviors. Given the central role of weight/shape concerns in predicting eating disorder behaviors, it is unclear from this research whether difficulties with emotion regulation are merely co-occurring alongside weight/shape concerns or add additional risk to the development or maintenance of eating disorder behaviors. Whilst the CBT-E model includes both weight/shape concerns and difficulties with emotion regulation as key factors that contribute to eating disorder behaviors, the model does not describe the relationship
between these constructs or theorize their relative importance in the occurrence of eating disorder behaviors.

Further, to facilitate effective early intervention for eating disorder symptoms, it is important to examine potential gender differences in these associations. While girls tend to report higher levels of eating disorder behaviors compared to boys, evidence suggests that the impact of these behaviors does not differ across genders (Bentley et al., 2015). Similarly, studies have consistently reported greater difficulties with emotion regulation among adolescent girls compared to boys (Neumann et al., 2010). Further, lower emotion-focused coping has been linked to higher emotional distress in adolescent girls, but not boys (Hampel & Petermann, 2006). Some developmental theories suggest that this gender difference could be accounted for by differential reactions to interpersonal stress (Rudolph, 2002).

Accordingly, as girls experience higher levels of interpersonal stress compared to boys, this may lead to higher overall levels of distress and associated difficulties for girls compared to boys. Additionally, some aspects of difficulties with emotion regulation have notable gender differences in socialization (Garside & Klimes-Dougan, 2002; Nolen-Hoeksema, 2012). For example, women are generally more emotionally expressive than men (Fischer & LaFrance, 2014), and men have more difficulty identifying emotions compared to women (Levant et al., 2009). Thus far there has been little research examining potential gender differences in the relationship between difficulties with emotion regulation and eating disorder behaviors, especially among adolescents. Research among adults found no evidence that the relationship between difficulties with emotion regulation and disordered eating differs by gender (Horvath et al., 2020). However, existing prevention programs tend to be more effective in reducing eating disorder symptoms among adolescent girls, compared to boys (Chua et al., 2020; Zuair & Sopory, 2022). Thus, research examining potential targets for early intervention, such as
difficulties with emotion regulation, should consider gender differences to help resolve these conflicting findings.

To address these gaps, the current study examined whether difficulties with emotion regulation predict the occurrence and frequency of disordered eating behaviors (i.e., fasting, binge eating, purging, and driven exercise, each assessed separately). Specifically, we hypothesized that difficulties with emotion regulation would predict the occurrence and frequency of all eating disorder behaviors. Lastly, we wanted to examine whether these associations differed between male and female adolescents. No *a-priori* hypotheses were made regarding potential gender differences, as no study to date has investigated potential gendered effects in these relationships.

**Methods**

**Participants and procedure**

This study used longitudinal data from the second (T1) and third waves (T2) of the EveryBODY study, a large longitudinal project investigating body image and eating disorders among Australian adolescents. These waves were selected because no data on difficulties with emotion regulation were available at wave one of the project. The project is a school-based survey among high school students, whereby all students in years 7-12 (ages 11-19) were invited to participate in the yearly survey (see Trompeter et al., 2018 for full study methodology). At the baseline survey, around 70% of enrolled students completed the study. Additionally, students who participated previously and had left school, were invited to participate in the online survey again. Participants who had left school were offered an incentive of a $10 gift card ($20 at wave three) or the chance to go into a gift card draw (1 of $100 gift cards). Participants at school were offered the chance to go into the draw for the gift card as well. While all schools were retained from wave two to three, drop-out was expected
with students changing schools, leaving school and absenteeism on the day of the survey. In total, 3198 students participated at T1, of which 1926 students participated again (60% retention rate).

Participants came from four independent schools and four government schools. These varied in terms of socio-economic status (SES) to provide a representative sample of the Australian adolescent population. The Index of Community Socio-Educational Advantage (ICSEA) is a standardized ($M = 1000, SD = 100$) measure of educational advantage provided to each school and based on parental occupation and education, geographic location and proportion of Indigenous enrolments. ICSEA scores of schools in the overall sample of the second wave of the EveryBODY study ranged from 915 to 1134 ($M = 1057.38, SD = 62.24$), indicating that schools were within the average range of SES. Participants who participated at T1 were included in analyses, regardless of whether they participated again at T2.

Additionally, 101 participants were excluded due to non-serious responses at T1—as indicated by bogus or inappropriate responses to open-ended question (e.g., entering “the moon” as their country of birth; $n = 68$), non-serious responses at T2 ($n = 21$), and high amounts of missing data (less than 10% complete) at T2 ($n = 12$). Due to the focus on male and female adolescents in the current study, 15 non-binary participants and 8 participants with missing data on their gender at T1 were excluded. The final sample ($n = 3074$) included 1440 boys (46.8%) and 1635 girls (53.2%) with a mean age of 14 years and 5 months ($SD = 1$ year and 3 months) at T1. Most participants were born in Australia (82.9%), followed by Asia (11.9%). 5.7% of participants identified as Aboriginal and/or Torres Strait Islander. This is in line with the national average of young people in Australia (Australian Institute of Health and Welfare, 2021).

**Measures**
**Difficulties with emotion regulation.** To assess participant's difficulties with emotion regulation the Difficulties in Emotion Regulation Scale – Short Form (DERS-SF) was used (Kaufman et al., 2016). This measure is a short form of the original Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2008), a widely used measure of difficulties with emotion regulation. In line with the original scale, the measure examines six factors: non-acceptance of emotional responses, difficulties engaging in goal-directed responses, impulse control difficulties, lack of emotional awareness, lack of emotion regulation strategies and lack of emotional clarity. A total score measuring participant’s difficulties with emotion regulation was obtained by a mean score of all items, whereby higher scores indicate greater difficulties in emotion regulation. Previous research has shown the DERS-SF to be both valid and reliable among adolescents (Kaufman et al., 2016). The scale showed good internal consistency in the current study for boys (Cronbach’s $\alpha = .88$; McDonald's $\omega = .90$), and girls (Cronbach’s $\alpha = .92$; McDonald's $\omega = .93$).

**Weight/Shape Concerns.** Participants’ weight/shape concerns were assessed using the combined weight and shape concerns subscale of the eating disorder examination questionnaire (EDE-Q; (Fairburn et al., 2008). The measure comprises 12 items assessing eating disorder related body image concerns over the previous 28 days and asks participants to rate the frequency/severity of their weight and shape concerns (e.g., *How dissatisfied have you been with your shape?*) on a 7-point Likert scale (0 = *No days/Not at all* to 6 = *Everyday/Markedly*). Items on the combined subscales are averaged to provide a mean score, whereby higher scores indicate higher severity. The subscale has shown good reliability among Australian adolescent boys and girls (Bentley et al., 2015; Gall et al., 2016). The scale showed excellent internal consistency in the current study for boys (Cronbach’s $\alpha = .94$; McDonald's $\omega = .93$), and girls (Cronbach’s $\alpha = .96$; McDonald's $\omega = .96$).
**Disordered eating.** To examine participants’ disordered eating, the behavioral frequency items from the eating disorder examination questionnaire (EDE-Q; Fairburn et al., 2008) were used to obtain a frequency score for fasting, binge eating, purging (vomiting and laxative use), and driven exercise. Participants were asked the number of times they had engaged in binge eating, purging (self-induced vomiting and laxative use), and driven exercise episodes over the past 28 day using an open response frequency format. For fasting, participants were asked to provide the number of days over the past 28 days in which they had gone for 8 or more hours without food in order to influence their weight or shape.

**Body mass index (BMI).** All participants provided their self-reported height and weight measurements, which were used to determine BMI (weight (kg)/ height (m)²). BMI percentiles were calculated in line with the CDC guidelines to account for both age and gender (Centers for Disease Control and Prevention, 2017). Previous research has found that self-reported height and weight measurements are strongly correlated with anthropometric measurements in adolescents (Goodman et al., 2000).

**Transparency and openness**

All analysis code and the pre-registered analysis plan are available at [https://osf.io/79ezw/?view_only=17812d27313345a8b3a7ac6fef644fc7](https://osf.io/79ezw/?view_only=17812d27313345a8b3a7ac6fef644fc7). Data were analyzed using Mplus version 8 (Muthén & Muthén, 2018). The analysis plan was preregistered on the Open Science Framework. All deviations from the a priori analytic plan are explicitly described and explained below.

**Data analytic plan**

Due to drop-out between waves (60% retention rate), there were high levels of missing data. Little’s MCAR test indicated that the data were not missing at random: $X^2(214) = 1364.62, p < .001$. Further analysis of missing data patterns showed that the most
common patterns were data missing on all T2 variables, as would be expected with a 60% retention rate. Patterns were comparable between boys and girls. Analyses were conducted in a zero-inflated Poisson regression framework using full information maximum likelihood estimation through a Monte Carlo integration, which uses all available data to estimate model parameters.

The zero-inflated Poisson regression uses a mixture of a Poisson distribution of count data with an excess of zero counts. Using this regression, the occurrence of the behavior (zero-inflated part) and the frequency of the behavior accounting for excess zeros (Poisson part) are examined separately in the same model. Using zero-inflated models is recommended for use with highly skewed clinical data, such as eating disorder behavior (Schaumberg et al., 2018). As occasional episodes of eating disorder behaviors were reasonably expected in the community sample, a zero-inflated Poisson regression was deemed more appropriate than a hurdle approach, which assumes a truly dichotomous process (i.e., abstinence of the behavior reflects true non-occurrence).

In line with our pre-registration, we adjusted for frequency of behaviors at baseline. However, this approach does not distinguish adolescents who engaged in eating disorders at baseline from those who did not, (i.e., the distinction observed in the outcome variable in a zero-inflated Poisson regression). To examine whether both difficulties with emotion regulation and weight/shape concerns were involved in the onset and/or maintenance of eating disorder behaviors we added additional analyses to examine this. Specifically, we analyzed two separate groups for each behavior: a potential onset group (no instances of the behavior reported at T1) and a persistence group (at least one instance of the behavior reported at T1). In the persistence group we also adjusted for frequency of behaviors at T1 in the Poisson part of the analyses. For all models, multi-group analyses were conducted to test
for potential gender differences in each of the regression coefficients to examine whether
gender invariance held.

While our pre-registered analyses included an interaction between difficulties with
emotion regulation and weight/shape concerns, we have since found little evidence for such
an interaction in our cross-sectional analyses (Trompeter et al., 2022). Given this and the very
large sample required to detect small interaction effects (Blake & Gangestad, 2020), we
decided not to pursue such an analysis. For completeness based on our preregistered analytic
plan, we report findings from the interaction analyses in Supplementary 1. No interaction
terms were significant.

Due to the large range of values on the eating disorder behaviors variables, values
were winsorized to three standard deviations. To control for multiple comparisons, the
Benjamini–Hochberg procedure was used with a paper-wide false discovery rate of .05,
resulting in a critical alpha of .033. All analyses adjusted for age and BMI percentile. The
potential clustering effect of schools was assessed using mixed model analysis with school as
a random factor. The random factor was not significant, thus school was not adjusted for in
any analyses.

**Results**

**Sample characteristics**

As can be seen in Table 1, all variables of interest showed relative between-person
stability over the two timepoints. About one third of participants reported engaging in binge
eating, fasting, and driven exercise respectively, while less than 10% reported purging. For
those reporting eating disorder behaviors at T2, around half had also reported the same
behavior at T1 (persistence group). One notable exception was purging, were most
participants who reported engaging in purging at T2 did not report purging at T1 (onset group).

Table 1. *Descriptive statistics at both timepoints. Means and standard deviations or percentages are presented as appropriate.*

<table>
<thead>
<tr>
<th>Variables</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>M (SD)</em></td>
<td><em>M (SD)</em></td>
</tr>
<tr>
<td>Weight/shape concerns</td>
<td>1.13 (1.46)</td>
<td>1.16 (1.44)</td>
</tr>
<tr>
<td>Difficulties with emotion regulation</td>
<td>2.23 (0.75)</td>
<td>2.30 (0.76)</td>
</tr>
<tr>
<td>Binge Eating Frequency (past 28 days)</td>
<td>2.62 (5.96)</td>
<td>2.50 (5.90)</td>
</tr>
<tr>
<td>Fasting Frequency (past 28 days)</td>
<td>1.51 (4.40)</td>
<td>1.82 (5.82)</td>
</tr>
<tr>
<td>Purging Frequency (past 28 days)</td>
<td>0.77 (4.55)</td>
<td>1.05 (7.20)</td>
</tr>
<tr>
<td>Driven Exercise Frequency (past 28 days)</td>
<td>2.88 (6.68)</td>
<td>2.61 (6.32)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>N (%)</th>
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<tbody>
<tr>
<td>Binge Eating Presence (% yes)</td>
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<tr>
<td>Onset</td>
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<tr>
<td>Persistence</td>
</tr>
<tr>
<td>Fasting Presence (% yes)</td>
</tr>
<tr>
<td>Onset</td>
</tr>
<tr>
<td>Persistence</td>
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</tbody>
</table>
Purging Presence (% yes) 274 (9.1) 162 (8.9)

Onset - 104 (64.2)
Persistency - 58 (35.8)

Driven Exercise Presence (% yes) 937 (31.3) 533 (29.1)

Onset - 232 (43.5)
Persistency - 301 (56.5)

**Note. Un-winsorized results are reported.**

**Correlations**

Table 2 shows correlations between the study variables to assess within-person stability. All eating disorder behaviors showed small to moderate associations with difficulties with emotion regulation and weight/shape concerns. Additionally, there were moderate correlations within eating disorder behaviors from T1 to T2, indicating moderate within-person stability.

**Table 2: Spearman’s correlations of study variables**

<table>
<thead>
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<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Weight/shape concerns T1</td>
<td>-</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Weight/shape concerns T2</td>
<td>.69*</td>
<td>-</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td>3. Difficulties with emotion regulation T1</td>
<td>.49*</td>
<td>.41*</td>
<td>-</td>
<td></td>
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<tr>
<td>4. Difficulties with emotion regulation T2</td>
<td>.41*</td>
<td>.49*</td>
<td>.59*</td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>5. Binge eating T1</td>
<td>.29*</td>
<td>.21*</td>
<td>.27*</td>
<td>.18*</td>
<td>-</td>
<td></td>
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</tbody>
</table>
6. Binge eating T2  .23* .28* .23* .22* .39* -

7. Fasting T1  .42* .32* .32* .24* .30* .18* -

8. Fasting T2  .34* .42* .28* .33* .15* .29* .36* -

9. Purging T1  .25* .16* .21* .13* .27* .14* .44* .18* -

10. Purging T2  .23* .25* .19* .23* .09* .27* .24* .42* .32* -

11. Driven exercise T1  .41* .31* .21* .18* .24* .15* .39* .25* .33* .17* -

12. Driven exercise T2  .27* .38* .16* .19* .12* .24* .20* .36* .14* .36* .36* -

Note. Benjamini-Hochberg corrected critical value = 0.033. Significant associations are indicated (*). Un-winsorized results are reported.

Planned analysis

For the planned analyses we ran four separate zero-inflated Poisson regression models for each outcome (binge eating, fasting, purging, and driven exercise at T2). Each model included weight/shape concerns, difficulties with emotion regulation, age and BMI percentile at T1 as predictors. Additionally, models adjusted for frequency of the relevant eating disorder behavior at T1. For each model we tested the invariance of the regression models between boys and girls. As relevant, findings are either presented separately for boys and girls or for the whole sample.

Gender differences

No gender differences were observed for the models predicting binge eating ($\chi^2(10) = 10.76$, $p = .376$), fasting ($\chi^2(10) = 15.18$, $p = .126$) or purging ($\chi^2(10) = 7.75$, $p = .654$) at T2. However, differences were observed in the examined associations for driven exercise ($\chi^2(10) = 24.64$, $p = .006$). Results were therefore interpreted for the whole sample for binge eating,
fasting, and purging, whereas for driven exercise the results for boys and girls were examined separately. Full results from the regression analyses are shown in Table 3.

Table 3. Regression analysis examining probability and frequency of eating disorder behaviors at T2 as predicted by weight/shape concerns and difficulties with emotion regulation at T1 in the total sample.

<table>
<thead>
<tr>
<th>Probability of behavior</th>
<th>Frequency of behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOR</td>
<td>p* value</td>
</tr>
<tr>
<td>Binge eating (N = 3065)</td>
<td></td>
</tr>
<tr>
<td>Weight/shape concerns</td>
<td>1.19*</td>
</tr>
<tr>
<td>Difficulties with emotion regulation</td>
<td>1.32*</td>
</tr>
<tr>
<td>Fasting (N = 3065)</td>
<td></td>
</tr>
<tr>
<td>Weight/shape concerns</td>
<td>1.30*</td>
</tr>
<tr>
<td>Difficulties with emotion regulation</td>
<td>1.73*</td>
</tr>
<tr>
<td>Purging (N = 3065)</td>
<td></td>
</tr>
<tr>
<td>Weight/shape concerns</td>
<td>1.41*</td>
</tr>
<tr>
<td>Difficulties with emotion regulation</td>
<td>1.44*</td>
</tr>
<tr>
<td>Driven exercise – Boys (N = 1437)</td>
<td></td>
</tr>
<tr>
<td>Weight/shape concerns</td>
<td>1.31*</td>
</tr>
<tr>
<td>Difficulties with emotion regulation</td>
<td>1.19</td>
</tr>
<tr>
<td>Driven exercise – Girls (N = 1628)</td>
<td></td>
</tr>
<tr>
<td>Weight/shape concerns</td>
<td>1.31*</td>
</tr>
<tr>
<td>Difficulties with emotion regulation</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Note. Benjamini-Hochberg corrected critical value = .033. Significant associations are indicated (*). Analysis adjusted for age, BMI percentile, and T1 frequency of eating disorder behaviors. AOR = Adjusted odds ratio

Probability of eating disorder behaviors
Findings from the binomial regression showed that both greater weight/shape concerns and greater difficulties with emotion regulation were uniquely associated with an increased likelihood of engaging in binge eating, fasting, and purging at T2 (see Table 3). Only weight/shape concerns, not difficulties with emotion regulation, were associated with an increased likelihood of driven exercise in both boys and girls.

**Frequency of eating disorder behaviors**

Findings from the Poisson regression showed only one significant association between weight/shape concerns and difficulties with emotion regulation and increased frequency of eating disorder behaviors at T2. That is, greater difficulties with emotion regulation predicted more frequent driven exercise among boys.

**Exploratory analysis: Onset group**

For the exploratory analyses we wanted to examine whether difficulties with emotion regulation and weight/shape concerns would further predict the onset of eating disorder behaviors. As such we ran four separate zero-inflated Poisson regression models for each outcome (binge eating, fasting, purging, and driven exercise at T2) among the sub-sample that did not endorse any occurrence of the examined behavior at T1. Each model included weight/shape concerns, difficulties with emotion regulation, age and BMI percentile at T1 as predictors. As above, we tested the invariance of the regression models between boys and girls for each model and present findings as relevant.

**Gender differences**

No gender differences were observed in the regression models predicting binge eating \( (\chi^2(8) = 3.77, p = .877) \), fasting \( (\chi^2(8) = 7.23, p = .512) \), and purging \( (\chi^2(8) = 6.69, p = .571) \) at T2. However, differences were observed for driven exercise \( (\chi^2(8) = 20.06, p = .010) \). Results were therefore interpreted for the whole sample for binge eating fasting and purging.
and for boys and girls separately for driven exercise. Full results from the regression models are shown in Table 4.

Table 4. Regression analysis examining probability and frequency of eating disorder behavior onset at T2 as predicted by weight/shape concerns and difficulties with emotion regulation at T1, with the subsample of adolescents not reporting eating disorder behaviors at T1.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Probability of onset</th>
<th>Frequency of behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AOR</td>
<td>p-value</td>
</tr>
<tr>
<td>Binge eating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N = 1877)</td>
<td>Weight/shape concerns</td>
<td>1.25*</td>
</tr>
<tr>
<td></td>
<td>Difficulties with emotion regulation</td>
<td>1.21</td>
</tr>
<tr>
<td>Fasting</td>
<td>Weight/shape concerns</td>
<td>1.37*</td>
</tr>
<tr>
<td>(N = 2317)</td>
<td>Difficulties with emotion regulation</td>
<td>1.79*</td>
</tr>
<tr>
<td>Purging</td>
<td>Weight/shape concerns</td>
<td>1.33*</td>
</tr>
<tr>
<td>(N = 2722)</td>
<td>Difficulties with emotion regulation</td>
<td>1.40*</td>
</tr>
<tr>
<td>Driven exercise – Boys</td>
<td>Weight/shape concerns</td>
<td>1.31*</td>
</tr>
<tr>
<td>(N = 1024)</td>
<td>Difficulties with emotion regulation</td>
<td>1.16</td>
</tr>
<tr>
<td>Driven exercise – Girls</td>
<td>Weight/shape concerns</td>
<td>1.36*</td>
</tr>
<tr>
<td>(N = 1035)</td>
<td>Difficulties with emotion regulation</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Note. Benjamini-Hochberg corrected critical value = .03. Significant associations are indicated (*). Analysis adjusted for age and BMI percentile. AOR = Adjusted odds ratio

Probability of eating disorder behavior onset
Findings from the binomial regression showed that both weight/shape concerns and difficulties with emotion regulation were uniquely associated with an increased likelihood of fasting onset and purging onset by T2. Only weight/shape concerns, not difficulties with emotion regulation, were associated with an increased likelihood of binge eating, and driven exercise onset by T2, in both boys and girls.

**Frequency of eating disorder behaviors**

Findings from the Poisson regression showed only two significant associations between weight/shape concerns and difficulties with emotion regulation and the frequency of eating disorder behaviors at T2 among adolescents who did not report these eating disorder behaviors at T1. Specifically, greater difficulties with emotion regulation predicted higher frequency of driven exercise among boys following onset of driven exercise at T2. Additionally, lower weight/shape concerns at T1 predicted higher frequency of driven exercise among boys following onset of driven exercise at T2.

**Exploratory analysis: Persistence**

For the second set of exploratory analyses, we examined whether difficulties with emotion regulation and weight/shape concerns also predicted the persistence of eating disorder behaviors. As such we ran four separate zero-inflated Poisson regression models for each outcome (binge eating, fasting, purging, and driven exercise at T2) among the subsample that did endorse at least one occurrence of the examined behavior at T1. Each model included weight/shape concerns, difficulties with emotion regulation, age and BMI percentile at T1 as predictors. Additionally, in the Poisson part of the regression model, T1 frequency of the eating disorder behaviors was also included. As above, we tested the invariance of the regression models between boys and girls for each model and present findings as relevant.

**Gender differences**
No gender differences were observed for the regression models predicting binge eating ($\chi^2(9) = 5.39, p = .799$), fasting ($\chi^2(9) = 11.24, p = .260$), or driven exercise ($\chi^2(9) = 12.08, p = .209$) at T2. However, differences were observed for purging ($\chi^2(9) = 33.09, p < .001$). Results were therefore interpreted for the whole sample for binge eating, fasting, and driven exercise, and for boys and girls separately for purging. Full results from the regression models are shown in Table 5.

<table>
<thead>
<tr>
<th>Probability of persistence</th>
<th>Frequency of behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOR $p$-value 95% CI</td>
<td>B $p$-value 95% CI</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Binge eating</strong></td>
<td><strong>Weight/shape concerns</strong></td>
</tr>
<tr>
<td>($N = 1118$)</td>
<td><strong>Difficulties with emotion regulation</strong></td>
</tr>
<tr>
<td><strong>Fasting</strong></td>
<td><strong>Weight/shape concerns</strong></td>
</tr>
<tr>
<td>($N = 678$)</td>
<td><strong>Difficulties with emotion regulation</strong></td>
</tr>
<tr>
<td><strong>Purging – Boys</strong></td>
<td><strong>Weight/shape concerns</strong></td>
</tr>
<tr>
<td>($N = 116$)</td>
<td><strong>Difficulties with emotion regulation</strong></td>
</tr>
<tr>
<td><strong>Purging – Girls</strong></td>
<td><strong>Weight/shape concerns</strong></td>
</tr>
<tr>
<td>($N = 157$)</td>
<td><strong>Difficulties with emotion regulation</strong></td>
</tr>
<tr>
<td><strong>Driven exercise</strong></td>
<td><strong>Weight/shape concerns</strong></td>
</tr>
</tbody>
</table>
Difficulties with emotion regulation

\[
\begin{array}{cccc}
(N = 936) & \text{Difficulties with emotion regulation} & 1.04 & 0.738 [0.79, 1.36] & -.06 & 0.719 [-0.41, 0.28]
\end{array}
\]

\textbf{Note.} Benjamini-Hochberg corrected critical value = .03. Significant associations are indicated (*). Analysis adjusted for age and BMI percentile. Poisson regression also adjusted for T1 eating disorder behaviors. AOR = Adjusted odds ratio

\section*{Probability of eating disorder behavior persistence}

Findings from the binomial regression showed that greater difficulties with emotion regulation, but not weight/shape concerns, was uniquely associated with an increased likelihood of binge eating persistence and fasting persistence from T1 to T2 (see Table 5).

Only weight/shape concerns, not difficulties with emotion regulation, were associated with greater likelihood of driven exercise persistence. No significant relationships emerged for purging for boys or girls.

\section*{Exacerbation of eating disorder behaviors}

Findings from the Poisson regression showed only one significant association between weight/shape concerns and difficulties with emotion regulation with increased frequency of eating disorder behaviors. Among boys who persistently engaged in purging, greater weight/shape concerns predicted an exacerbation of their purging from T1 to T2.

\section*{Discussion}

The current study examined whether both difficulties with emotion regulation and weight/shape concerns were uniquely associated with eating disorder behaviors after one year among adolescents. Findings suggested that both increased difficulties with emotion regulation and weight/shape concerns uniquely predicted the probability of binge eating, fasting, and purging after one year, but only increased weight/shape concerns predicted higher probability of engaging in driven exercise. Similar patterns emerged when examining
onset of eating disorder behaviors, whereby fasting and purging onset were both predicted by higher weight/shape concerns and higher difficulties with emotion regulation. However, binge eating onset after one year was associated only with higher pre-morbid weight/shape concerns, but not difficulties with emotion regulation. In contrast, probability of persistence of binge eating and fasting were uniquely predicted by difficulties with emotion regulation, but not weight/shape concerns. These findings suggest that difficulties with emotion regulation may be particularly important in explaining the maintenance of both binge eating and fasting, and additionally the onset of fasting. Interestingly, this pattern was not observed for purging, although, this may in part be due to the low percentage of adolescents who endorsed this behavior, which resulted in small groups of adolescents represented in the onset/persistence groups.

Few studies to date have distinguished between the probability of engaging in eating disorder behaviors after a specified time versus the frequency of those eating disorder behaviors over the same time period, with most previous studies examining eating disorder behaviors on a continuum. However, findings from the current study suggest that there are considerable differences in predicting the probability of any level of frequency of eating disorder behaviors versus the frequency with which they occur, with findings suggesting that both difficulties with emotion regulation and weight/shape concerns uniquely predict increased probability of any eating disorder behavior, but not their frequency. This may be due to the relatively high stability of eating behaviors over the course of one year observed both in the current study, as well as previous research (Hautala et al., 2008), which makes it difficult to detect factors accounting for behavioral frequency beyond baseline frequency levels.

Interestingly, the current study found few unique associations between emotion dysregulation and driven exercise, when accounting for weight/shape concerns. Within the
exercise literature, exercise is well-established as a mood regulation tool (see for review Meyer et al., 2011). However, the role of driven exercise in eating pathology is more complicated. Findings from the current study suggest that weight/shape concerns are more likely to determine the propensity of individuals to engage in driven exercise, than difficulties with emotion regulation. This is consistent with the idea that driven exercise, unlike more “healthy” forms of exercise, is inherently linked to eating pathology (Mond et al., 2004, 2006).

Regarding gender, the current study found that the associations between difficulties with emotion regulation, weight/shape concerns and eating disorder behaviors were mostly similar for boys and girls. However, some differences were evident for purging and driven exercise. Notably, greater difficulties with emotion regulation were linked with increased frequency of driven exercise among boys, but not girls. This may in part be due to differences in gendered appearance ideals. Compared to girls, boys place greater emphasis on being muscular, with many boys striving to obtain a bigger body (Cohane & Pope Jr., 2001), which is primarily achieved through driven body-building exercise. Research among individuals with anorexia nervosa has further found that driven exercise was more prominent in men compared to women, and that men in particular may use exercise to regulate negative emotions (Murphy et al., 2014). Further, boys may have been socialized to express their emotions through physical exercise more than girls (Garside & Klimes-Dougan, 2002).

However, findings from the current study contrast with findings from Goodwin et al. (2014), who found difficulties with emotion regulation to significantly predict driven exercise in both boys and girls after one year. However, that study did not consider weight/shape concerns, which may have impacted the relationship. Indeed, findings from the current study are in line with our cross-sectional findings whereby greater difficulties with emotion regulation was associated with a higher probability of engaging in driven exercise among boys, but not girls.
Thus, difficulties with emotion regulation could be a relevant factor in explaining driven exercise among boys, but not girls. Further research should explore this relationship to determine how difficulties with emotion regulation and driven exercise relate to one another in the context of the CBT-E model.

While the current study had numerous strengths, including the longitudinal design, several limitations should also be considered. Firstly, eating disorder behaviors were measured using a single-item frequency measure that only examines behaviors over the previous month. While the EDE-Q is considered a valid and reliable measure among adolescents (Mond et al., 2014), previous studies have shown that adolescents reported fewer incidents of both binge eating and purging in the EDE-Q compared to clinical interviews (Binford et al., 2005; Pretorius et al., 2009). Secondly, while the exploratory analyses in the current study examined eating disorder onset and persistence, these analyses only included two distinct timepoints and did not consider any prior history or fluctuation of eating disorder behaviors. Additionally, to align our findings with the zero-inflated Poisson approach, we used a lenient cut-off of any occurrence of eating disorder behaviors to classify participants into the onset and persistence groups. Future research should consider whether these findings extend to clinically-relevant thresholds of frequency (e.g., at least once per week; American Psychiatric Association, 2013). This may be particularly relevant for driven exercise, which can may be difficult to distinguish from regular non-pathological types of exercise (Mond et al., 2006). Further, the use of a zero-inflated Poisson regression over a hurdle model may have been more appropriate for more common behaviors, like binge eating, but less appropriate for less common behaviors, like purging (Schaumberg et al., 2018). As such, future research should consider additional statistical approaches to further our understanding of these processes. Lastly, the type of statistical analyses used in the current study do not formally disaggregate between- and within-person variance. As such, it is unclear whether
changes in both difficulties with emotion regulation and weight/shape concern at the within-
person level (i.e., experiencing greater than usual difficulties with emotion regulation and
weight/shape concern for oneself) or at the between-person level (i.e., experiencing greater
than average difficulties with emotion regulation and weight/shape concerns compared to
peers), or whether both are linked to prospective eating disorder behaviors.

Despite these limitations, the current study has important clinical implications. In
particular, findings provide additional evidence regarding the prospective relationship
between difficulties with emotion regulation and eating disorder behaviors. Results suggest
that difficulties with emotion regulation do not merely co-occur with weight/shape concerns,
but place adolescents at additional increased risk for engaging in future eating disorder
behaviors. Interestingly, difficulties with emotion regulation appeared to be particularly
relevant for the persistence of binge eating and fasting. These findings provide further
evidence for the potential use of emotion regulation treatments (e.g., dialectical behavioral
therapy), which are effective among adults with eating disorders (Sloan et al., 2017).

Additionally, the findings may have theoretical implications for the CBT-E model
(Fairburn et al., 2003). Currently the CBT-E model links difficulties with emotion regulation
to both binge eating and purging, in addition to weight/shape concerns. Findings from the
current study provide some support for these associations. Difficulties with emotion
regulation were significantly associated with binge eating and particularly involved in the
persistence of binge eating. Further, greater difficulties with emotion regulation were
associated with a higher likelihood of purging as well as onset of purging after one year. This
is in line with our cross-sectional findings (Trompeter et al., 2022), as well as previous
research among adults (Pisetsky et al., 2017). However, no significant findings emerged
regarding persistence, potentially due to the small subsample size. While the current CBT-E
model does not include paths from difficulties with emotion regulation to fasting and driven
exercise, we have previously argued that these should be included (Trompeter et al., 2021).

Findings from the current study together with our previous work add to the evidence to suggest that difficulties with emotion regulation may give rise to fasting behaviors among adolescents and could be a valuable addition to the CBT-E model. However, the evidence regarding driven exercise is mixed. Lastly, the current study provides important insights into the prospective associations outlined in the CBT-E model regarding the unique additional risk posed by difficulties with emotion regulation, in addition to the core risk factor of weight/shape concerns.

In conclusion, the current study supports the notion that weight/shape concerns are a key risk factor for adolescents engaging in eating disorder behaviors. Further, findings add to a growing body of literature positioning difficulties with emotion regulation as an additional eating disorder risk factor among adolescents. In particular, difficulties with emotion regulation were able to account for persistence of binge eating and fasting, which were not accounted for by weight/shape concerns.


