Testing for interactive and non-linear effects of risk factors for binge eating and purging eating disorders

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ABSTRACT

Almost no research has tested whether risk factors interact in the prediction of future eating disorder onset, which might suggest qualitatively distinct etiologic pathways. Accordingly, this prospective study tested for possible interactions between risk factors in the prediction of binge eating and purging eating disorders in adolescents. It also examined sex differences in pathways to risk. Two analytical approaches were used: (1) classification tree analysis (CTA), which is ideally suited to identifying non-linear interactions and the optimal cut-points for defining risk, with follow-up random forest analyses; and (2) two-way interaction terms in a series of logistic regression models. Data were drawn from the Western Australian Pregnancy Cohort (Raine) Study, a population-based study that followed participants from pre-birth to young adulthood. This study involved 1297 adolescents (49% male), 146 (11%) of whom developed bulimia nervosa, binge eating disorder or purging disorder in late adolescence. In CTA, sex was the first and most potent predictor of eating disorder risk with females showing a 5-fold increase in risk relative to males. For males and females, weight and eating concerns were the next most potent predictor of risk and three risk groups emerged, reflecting non-linear risk. For females with intermediate weight and eating concerns, externalizing problems emerged as an additional predictor. Interaction terms in logistic regression models did not produce significant results after correcting for multiple testing. Findings advance knowledge on risk pathways to eating disorder onset, highlight non-linear risk processes, and provide cut-points for prospectively identifying high-risk youth for prevention programs.

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Eating disorders are serious mental illnesses that affect up to 15% of adolescent females and 3% of adolescent males (Allen, Byrne, Oddy, & Crosby, 2013a; Stice, Marti, & Rohde, 2013). These disorders are associated with long-term psychosocial impairment (Johnson, Cohen, Kasen, & Brook, 2002; Solmi et al., 2015), carry increased mortality (Berkman, Lohr, & Bulik, 2007), and are difficult and expensive to treat (Begg et al., 2007; Simon, Schmidt, & Pilling, 2005). An improved understanding of the risk factors that predict future onset of eating disorders is vital for developing optimally effective prevention programs and for identifying the youth most in need of these programs. This is important because even the most effective prevention programs could produce larger effects.

Factors shown to predict eating disorder onset in at least two prospective studies include perceived pressure to be thin, body dissatisfaction, weight and eating concerns, negative affect or depressive symptoms, dietary restraint, and social support deficits (e.g., Allen, Byrne, Oddy, Schmidt, & Crosby, 2014; Beato-Fernandez, Rodriguez-Cano, Belmonte-Llario, & Martinez-Delgado, 2004; Ghaderi & Scott, 2001; Martinez-Gonzalez et al., 2003; The McKnight Investigators, 2003). Weight-related constructs have also been found to predict disorder onset, in the form of Body Mass Index (BMI), childhood overweight, and/or parent-perceived childhood overweight (e.g., Allen et al., 2014; Stice, 2016). These findings primarily relate to eating disorders characterized by binge eating and purging (subsequently referred to as binge eating and purging disorders: bulimia nervosa [BN], binge eating disorder [BED] and purging disorder [PD]), rather than

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anorexia nervosa (AN). However, very few studies have tested for interactions between risk factors, which is an important focus because we know that risk factors do not operate independently (Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004). The current study sought to extend work on risk factors for binge eating and purging disorders, with a particular focus on how risk factors may interact to increase the likelihood of these disorders developing.

Interaction effects can be investigated using cross-product terms in traditional regression analyses. However, classification tree analysis (CTA), a recursive partitioning analytic approach, is ideally suited to this work because it can identify non-linear associations between risk factors and the outcome of interest, and determine specific and optimal cut-points for defining high risk groups. The latter feature is particularly useful in psychological research because many proposed risk factors occur on a continuum. Identifying specific cut-points for risk would guide the implementation of prevention programs to at-risk sub-populations after screening a full population.

Only three studies have used CTA to identify predictors of eating disorder onset. The first (Stice, Marti, & Durant, 2011) identified a three-way interaction between body dissatisfaction, depression, and dieting in the prediction of eating disorder onset in a community sample of adolescent girls (n = 496). Girls in the top 24% of body dissatisfaction showed an incidence of eating disorder onset of 24% versus 6% for those with lower body dissatisfaction. In the high dissatisfaction group, girls in the top 32% of depressive symptoms showed an eating disorder incidence of 43% versus 15% for those with lower depressive symptoms. In the low body dissatisfaction group, girls in the top 12% of dieting showed an eating disorder incidence of 18% versus 5% for those lower in dieting. These results suggest that prevention programs may be beneficial for girls with high body dissatisfaction and high depressive symptoms, and girls with low body dissatisfaction but high dieting frequency.

The second study (Jacobi et al., 2011) involved young women with weight concerns from the control condition of a prevention trial (n = 236). It found that negative comments by a coach or teacher about eating showed the strongest relation to future eating disorder onset. Women reporting negative comments showed an eating disorder incidence of 39% versus 8% for those who did not receive such comments. For women who did not receive comments, those with a history of major depression showed an eating disorder incidence of 30% relative to 4% for those without a history of depression. These results suggest targeted prevention may be helpful for women with weight concerns who have received negative comments about weight, as well as those who have not received such comments but who have a history of major depression.

The third study (Stice, Marti, Spoor, Presnell, & Shaw, 2008) used data from a randomized prevention trial with adolescent girls who reported body dissatisfaction (n = 481) and found that denial of the costs of pursuing the thin ideal was the most potent predictor of eating disorder onset. Girls in the top 17% of denial showed eating disorder incidence of 23% versus 6% for girls with lower denial scores. Among girls with high denial, eating disorder incidence was 0% for those who completed a dissonance-based prevention program versus 18% for those who completed alternative prevention programs and 50% for those in the control condition. Among girls with low denial, those in the upper 18% of emotional eating showed a 16% eating disorder incidence versus 4% for those with lower emotional eating. Among girls with low denial and low emotional eating, those in the upper 17% of externalizing symptoms showed an eating disorder incidence of 11% versus 2% for those with lower externalizing symptoms. These results suggest that prevention programs should be targeted towards young women who deny the costs of pursuing the thin ideal, as well as those who are low in

denial but high on emotional eating, and those who are low in denial and emotional eating but who report high externalizing problems.

Although these CTA studies have elucidated interactions between risk factors, only one used a general community recruited sample (Stice et al., 2011) and none included boys, essential to identify sex-specific risk processes. Indeed, almost no prospective risk factor studies have been conducted with males, despite over 30% reporting at least occasional binge eating, purging or overeating (e.g., Field et al., 2014) and up to 3% meeting criteria for a binge eating or purging disorder (Allen et al., 2013a; Field et al., 2014). One recent study found that dieting and extreme weight control behaviors predicted later onset of binge eating and eating disorders for females but not males (Liechty & Lee, 2013), which highlights that risk pathways may differ by sex. Identifying pathways to male eating disorders is important if prevention initiatives are to accommodate young men at risk of eating pathology.

We have previously reported on risk factors for binge eating and purging eating disorders in the Western Australian Pregnancy Cohort (Raine) Study. In these analyses, female sex, parent-perceived childhood overweight, and weight and eating concerns emerged as the most potent predictors of early (14-year) and later (17/20-year) onset binge eating and purging disorders (Allen, Byrne, Forbes, & Oddy, 2009; Allen et al., 2014). However, analyses to date have not considered sex differences. Interactions between risk factors in the prediction of eating disorder onset are also unexplored.

The current report sought to identify interactions between risk factors in early-middle adolescence, and the specific cut-points on these factors, that could best predict onset of binge eating and purging disorders in later adolescence. Sex differences were also investigated. We used both CTA and cross-product terms in traditional logistic regression models to address this aim, to determine whether the former analytic approach is more sensitive and whether there is evidence that traditional cross-product terms miss non-linear relations. We focused on adolescence because most eating disorder symptoms appear to emerge during this period (Stice et al., 2013) and most prevention trials target adolescents (Stice & Shaw, 2004). Identifying the adolescent variables that best predict eating disorder onset, and specific risk cut-points for these variables, will facilitate selection of youth most in need of prevention work. Again, this is important because prevention programs are most effective when targeting high risk groups and, to date, even the most effective programs have produced only moderate effects (Stice & Shaw, 2004).

Given the small number of studies examining interactions between eating disorder risk factors, no specific predictions were made regarding the results. However, predictor variables were selected a priori based on findings from previous eating disorder studies with CTA (Jacobi et al., 2011; Stice, Rohde, Gau, & Shaw, 2012; Stice et al., 2011) and with the Raine Study (Allen et al., 2009, 2014). Thus, our predictors of interest included dietary restraint, weight and eating concerns, depressive symptoms, internalizing problems (capturing negative affect, anxiety, social problems and somatic complaints), externalizing problems (capturing inattention, rule-breaking behavior and anti-social/aggressive behavior) and body mass index (BMI), as well as participant sex. We were not in a position to assess thin-ideal internalization, perceived pressure to be thin or social support as these variables were not measured. We chose to include a specific measure of depressive symptoms as well as the broader internalizing scale, as previous studies have assessed negative affect in different ways (Jacobi et al., 2004; Stice, 2016) and we were interested in whether one measure would provide better predictive utility.