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Young adult mental health sequelae of eating and body image disturbances in adolescence

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Data Availability Statement

Ethics approvals for this study do not permit the data to be made publicly available, due to limitations of participant consent and concerns regarding potential re-identifiability. The current institutional body responsible for ethical approval is The Royal Children's Hospital Human Research Ethics Committee. Enquires about access to pre-existing cohort data used in this submission is possible through our institutional data access protocol (https://lifecourse.melbournechildrens.com/data-access/).

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Conflict of Interest

The authors have no conflict to declare

Abstract

Objective: There has been interest in the antecedents and mental health impacts of eating and body image disturbances in adolescence. Less is known about longer-term mental health impacts into young adulthood, as longitudinal studies with data spanning this developmental period are rare. We capitalize on mental health data collected across adolescence and young adulthood from a population-based cohort study that has been following >2000 Australian children and their families from infancy to young adulthood. **Method:** This sample comprised 1,568 participants who completed the *Eating Disorder Inventory* drive for thinness and bulimic behaviour (the severity of binge-purge patterns) subscale, and a modified version of the body dissatisfaction subscale in mid-adolescence (15-16 years), or the depression, anxiety, stress scales in young adulthood (19-20, 23-24, and 27-28 years). **Results:** After adjusting for baseline demographic and prior mental health factors (<13 years of age), all three indices of eating and body image disturbances in adolescence predicted each mental health outcome in young adulthood. Mental health risks associated with adolescent body dissatisfaction and bulimic behavior scores remained stable across young adulthood, with men having more pronounced problems associated with bulimic behavior scores than women. In contrast, mental health risks associated with adolescent drive for thinness scores diminished across this period similarly for men and women. **Conclusions:** Findings suggest that adolescent eating and body image disturbances may have long-term mental health impacts that extend into young adulthood. This underscores the need for early preventative intervention, and longer-term monitoring and support for body image and eating disturbances.

Keywords: eating disorders; body image; mental health; population-based cohort

Introduction

There has been widespread interest in the antecedents and mental health impacts of eating and body image disturbances in adolescence. Around 65% of young people are dissatisfied with their body (Dion et al., 2015), and between 10 to 30% of the general population engage in disordered eating behaviors, including binge eating, restrictive eating, and purging (Mitchison et al., 2013). Eating and body image disturbances often emerge during early adolescence and, if unaddressed, can persist well into later life and have the potential to progress to a clinically significant eating disorder (e.g., Brown et al., 2020; Neumark-Sztainer et al., 2006; Stice et al., 2013). The consequences of eating and body image disturbances can also be severe, and may include functional impairment, elevated mortality rates, and suicidality (Ágh et al., 2015; Arcelus et al., 2011). In many countries, the burden of disease costs associated with eating disorders, including subthreshold variants, are substantial and resemble estimates reported for other common psychiatric conditions (Deloitte Access Economics, 2012; Streatfeild et al., 2021).

Eating and body image disturbances are often comorbid with other common mental health problems across all age groups. Comorbidity rates between eating, anxiety, and mood disorders can be as high as 60% in young and middle adults (Swinbourne et al., 2012), and adults with a clinically significant eating disorder report substantially higher levels of general psychological distress compared to healthy controls (Bardone-Cone et al., 2010; Marchesi et al., 2014). Moreover, a strong body of research has identified robust associations between dimensional measures of eating and body image disturbances and mental health problems in adult clinical (Linardon et al., 2018) and community samples (da Luz et al., 2018), as well as in adolescent student samples (Mitchison et al., 2017).

A meta-analysis of 22 studies that examined the *prospective* relationship between eating pathology and depressive symptoms observed a small but statistically significant

pooled effect size (r = .13), suggesting that eating pathology may increase the risk for mood disturbances across adolescence (Puccio et al., 2016). Only one study has investigated these relationships from adolescence into young adulthood (Herpertz-Dahlmann et al., 2015). In this study, a subset of participants (n = 772, 54.5% girls) from a larger study assessing the health status of a cohort of German children and adolescents (N = 2863) were analyzed. The authors found eating pathology at baseline (M_{age} = 14.3 years, min = 11 years, max = 18 years) to predict higher average depressive symptoms at six-year follow-up (M_{age} = 21.0 years, min = 17.1 years, max = 27 years), with a small to moderate effect size that was comparable for both sexes (b = 0.45; 95 % CI: 0.19–0.70).

Although findings from this study provide important insights into the potential for longer-term mental health effects of eating pathology, assessments at only two time-points preclude a more nuanced understanding of the trajectory of long-term risk relationships; for example, whether risks remain stable, diminish, or worsen across the young adult years. Additionally, the mean age of participants at follow-up was 21.0 years (SD = 2.2), which leaves unanswered questions about longer term impacts across the 20s. Attrition was also substantial (49%), introducing bias towards higher socioeconomic status and older age Finally, no assessments were made of the more common problem of body image disturbances, including drive for thinness and body dissatisfaction.

While other prospective studies have been conducted (e.g., Presnell et al., 2009; Puccio et al., 2017; Stice et al., 2000; Vaughan & Halpern, 2010), finding consistent short-term (i.e., ranging from one to six year follow-up) prospective associations between eating pathology and subsequent mental health problems, most have focused exclusively on school-aged or adolescent girls, around the time of onset. Additionally, few studies have examined men, which is important as there is evidence to suggest that the timing and developmental sequelae of body image and eating problems may differ by sex (Slater & Tiggemann, 2011).

Furthermore, most research has been based on samples of convenience (e.g., Stice & Bearman, 2001), which limits generalisability to broader community settings. Assessment of mental health difficulties has also been limited, typically with a focus on depressive symptoms, leaving a range of unanswered questions about the longer-term impacts on anxiety and other stress-related outcomes.

The purpose of the present study is to examine the extent to which mid-adolescent eating and body image disturbances (15-16 years) predict mental health difficulties across young adulthood (19-20, 23-24 and 27-28 years). Specifically, the aims are threefold: (1) to estimate the strength of association between adolescent eating and body image disturbances and young adult mental health outcomes, including symptoms of depression, anxiety and stress; (2) to examine the extent to which risk-relationships remain stable, diminish, or intensify across the young adulthood years; and (3) to determine whether the longer-term mental health risks into young adulthood differ by sex.

Based on prior research, we hypothesized that higher levels of eating and body image disturbances in adolescence would predict elevated symptoms of depression, anxiety and stress throughout young adulthood. In the absence by both data and theory on outcomes in young adulthood, we took an exploratory approach to investigating both the nature of risk-relationships over young adulthood as well as the nature of sex differences. To investigate these, we capitalize on rare prospective data from one of Australia's longest running, population-based cohort studies, that has been following a cohort of over 2,000 Australian children and their families from infancy to young adulthood since 1983.

Methods

Participants and Procedure

Participants were drawn from the Australian Temperament Project (ATP), a 15-wave longitudinal study tracking the psychosocial development of young people from infancy to

adulthood. The baseline sample consisted of 2,443 infants aged between 4-8 months, recruited in 1983 from urban and rural areas and representative of the state of Victoria, Australia. Since then, families have been invited to participate via mail surveys approximately every 2 years until 19-20 years and every 4 years thereafter (Vassallo & Sanson, 2013). The ATP has sustained approximately 1% attrition per annum, which is comparable to other major cohort studies of its kind worldwide. Data collection waves were approved by Human Research Ethics Committees at the University of Melbourne, the Australian Institute of Family Studies and/or the Royal Children's Hospital, Melbourne. Participants were included in the current study if they provided relevant data in adolescence or young adulthood. For the current study, data for the primary analytic variables are drawn from four waves spanning adolescence (eating and body image disturbances; 1 wave: age-15-16 years) and young adulthood (mental health problems; 3 waves: age 19-20, 23-24, and 27-28 years). Participants were included in the current study if they provided relevant data in adolescence or young adulthood. This resulted in a sample size of 1,568 (805 female) for the current study, for which 72% of participants provided data both in adolescence and young adulthood.

Measures

Eating and Body Image Disturbances

Adolescents (15-16 years) completed the *drive for thinness* and *bulimic behavior* subscale from the Eating Disorder Inventory (EDI; Garner et al., 1983). The drive for thinness construct was assessed by 7-items (α=0.87) such as "*I am preoccupied with the desire to be thinner*", measuring behaviors such as restrictive dieting and fears of gaining weight. Bulimic behavior 6-items (α = 0.69) assessed the presence and severity of binge-eating and purging behaviors (hereafter referred to as "bulimic behaviours") using items such as "*I eat moderately in front of others and stuff myself when they're gone*".

A body dissatisfaction scale, assessing discontentment with overall shape and size of body regions, was specifically developed for the ATP study. It consisted of four items (α = 0.51), including "*I think I am too fat*", "*I feel satisfied with the shape of my body*" (reversed), "*I think I am not muscular enough*" and "*I think I am too skinny*". The decision to use this subscale rather than the original EDI body dissatisfaction subscale was based on substantial numbers of missing items in the previous wave and negative feedback from participants, which resulted in a high level of missing data, yielding a variable unsuitable for analysis (Prior et al., 2000).

Each item from the three scales was rated along a six-point scale (1 = Never, 6 = Always), as is recommended for normative samples where the prevalence of clinically significant disorders is low. For further details relating to the measurement characteristics of the items assessing eating and body image disturbances, see Le Grange et al. (2014).

Mental Health Problems

Young adult (ages 19-20, 23-24, and 27-28 years) mental health was assessed using the 21-item self-report Depression, Anxiety, and Stress Scale (DASS; Lovibond & Lovibond, 1995). Seven items form the depression, anxiety, and stress subscales, with each item rated along a 4-point scale, ranging from 0 (*never*) to 3 (*almost always*). Item scores are summed to produce a subscale score, with higher scores reflecting more severe mental health problems. Internal reliability was acceptable for all subscales at each young adult age: depression: 19-20 (α = 0.89), 23-24 (α = 0.90), and 27-28 (α = 0.91); anxiety: 19-20 (α = 0.77), 23-24 (α = 0.78), and 27-28 (α = 0.80); stress: 19-20 (α = 0.83), 23-24 (α = 0.83), and 27-28 (α = 0.83).

Potential Confounding Factors

Potential confounders were assessed according to the modified disjunctive cause criteria, identified as pre-exposure variables that are associated with the exposure and/or outcomes, or a proxy for a potential unmeasured confounder, but unlikely to act as an

instrument (associated with the outcome only via exposure; VanderWeele, 2019). These included parent family background characteristics of country of birth (either parent not born in Australia), low parental education (< year 12) and separation/divorce during the participant's childhood (ages 0-13 years). We also included participant sex, early puberty onset (menarche/voice break prior to 12 years old), and BMI at ages 12-13. Finally, to reduce the potential for reverse causality where possible (VanderWeele, 2019), elevated levels of depressive and anxiety symptoms at 13-14 years were adjusted for using the Short Mood and Feelings Questionnaire (Angold & Stephen, 1995) and the Revised Behavior Problem Checklist Short Form (RBPC; Quay & Peterson, 1987).

Statistical Analyses

All analyses were conducted in Stata 15 (StataCorp, 2017). Linear generalized estimating equations (GEEs) with an exchangeable working correlation were used to estimate associations between adolescent EDI subscales (15-16 years) and DASS subscales at young adult waves (19-20, 23-24, and 27-28 years). Models were fitted separately for each eating/body image disturbance and mental health variable relationship. For each model, analyses were estimated: (1) adjusting for outcome wave only, and (2) adjusting for all potential confounders. Fully adjusted models were then repeated by including: (3) an interaction between each eating/body image disturbance subscale and sex to examine whether associations varied between men and women, (4) an interaction between each eating/body image disturbance subscale and outcome measurement wave to examine whether associations varied across young adulthood, and (5) a 3-way interaction between eating/body image disturbance, sex, and outcome measurement wave to examine potential differential effects both across men and women, and across young adulthood.

Multiple imputation was used to handle missing data in the inferential analyses. Twenty complete datasets were imputed, based on a multivariate normal model (Lee &

Carlin, 2010). Binary variables were imputed as continuous variables and then back transformed with adaptive rounding following imputation (Bernaards et al., 2007). Estimates were obtained by pooling results across the 20 imputed datasets using Rubin's rules (Rubin, 1987). Prior to inferential analyses, mental health symptoms and disordered eating subscales were standardized (z-scores), such that effect sizes are interpreted as standard deviation change in mental health outcomes for every standard deviation change in eating and body image disturbances.

Results

Table 1 presents the descriptive statistics for study variables. As seen, adolescent girls reported notably higher levels of drive for thinness, bulimic behavior, and body dissatisfaction than adolescent boys. Levels of depression, anxiety, and stress across the young adulthood waves were similar for men and women.

Insert Table 1 about here

Table 2 presents the results of the linear GEE models where DASS subscale scores were regressed onto each of the EDI subscales. After adjusting for time and potential confounders, higher drive for thinness, bulimic behavior, and body dissatisfaction scores each predicted more severe depressive (range $\beta = 0.07 - 0.14$), anxiety (range $\beta = 0.09 - 0.15$), and stress levels (range $\beta = 0.06 - 0.15$), independent of the young adulthood assessment timepoint.

Insert Table 2 about here

For bulimic behavior only, effect sizes were larger in men than women for young adult depression (men $\beta = 0.25$, 95% CI = 0.13 - 0.37; women $\beta = 0.09$, 95% CI = 0.03 -

0.15), anxiety (men β = 0.33, 95% CI = 0.22 - 0.44; women β = 0.07, 95% CI = -0.00 - 0.14), and stress (men β = 0.33, 95% CI = 0.23 - 0.42; women β = 0.07, 95% CI = 0.00 - 0.14). No interaction by sex was observed for any other risk relationship.

The only evidence of interaction by wave of assessment in young adulthood was for the relationship between drive for thinness and depression. This relationship reduced in magnitude across each time point in young adulthood, from 19-20 years (β = 0.13, 95% CI = 0.06 - 0.19), and 23-24 years (β = 0.06, 95% CI = -0.01 - 0.13), to 27-28 years (β = 0.03, 95% CI = -0.04 - 0.10).

For completeness, we examined whether there were three-way interactions between EDI subscale scores, participant sex, and outcome assessment wave (visualized in Supplementary Material Figure S1). Three-way interactions emerged for bulimic behavior and body dissatisfaction on depressive symptoms, indicating that the strength of these associations at each wave was stronger in men than women (see Supplementary Figure 1).

Discussion

Using data from one of Australia's longest running studies of social and emotional development, we found that each indice of eating and body image disturbances were associated with long-term mental health sequelae in young adulthood. Young adult mental health risks associated with adolescent bulimic-behavior and body dissatisfaction remained stable across the 20s, with the longer-term mental health effects of adolescent bulimic-behavior being more pronounced in men than women. Effects of drive for thinness on mental health sequelae were also present but diminished (for depressive symptoms specifically) over time. Together, findings raise the possibility that adolescent eating and body disturbances may be an important developmental marker for long-term mental health difficulties, one that could potentially guide more targeted approaches to population mental health promotion in

the teens as well as clinical practice through improved screening (particularly for men) that could likewise enhance targeting of treatment.

Findings from this study extend earlier prospective studies (Puccio et al., 2016; Puccio et al., 2017; Vannucci & Ohannessian, 2018; Vaughan & Halpern, 2010) in three important ways. First, we show that adolescent eating and body image disturbances predict mental health problems much later in young adult development than has previously been reported (Herpertz-Dahlmann et al., 2015). Second, we show that several of these relationships are no less pronounced for men than women, indicating that lower levels of eating disturbances in men do not necessarily confer lower risk of later mental health problems. This highlights the importance of intervening with and supporting both boys and girls affected by eating and body image disturbances during adolescence. Third, we show that these risk-relationships, particularly for bulimic behavior and body dissatisfaction, remain largely stable across the young adulthood years (ages 21 to 28 years). Taken together, we show that eating and body image disturbances in adolescence may exacerbate psychological vulnerabilities that persist well into young adult life.

Further research is now needed to clarify whether long term developmental associations reported here are causal, and if so, identify mechanisms through which risk is transmitted. A range of causal mechanisms might be at play. From a biological perspective, disordered eating in adolescence may disrupt normative developmental process across puberty, a critical period that can have a long-standing influence on later mental health (Patton & Viner, 2007). Restrictive eating has been linked with growth retardation and pubertal delay, possibly via endocrine abnormalities in key growth axes (Gianotti et al., 2002; Misra & Klibanski, 2016; Travaglini et al., 1976) and neurotransmission pathways (e.g., 5HTT) (Bailer et al., 2004; Kaye, 2008). Disrupted growth patterns, and pubertal delay, may be among a number of biological mediated pathways that increase risk for on-going mental

health problems (De Onis & Branca, 2016; Tanner, 1952; Zhu & Chan, 2017). Greater understanding of such biological pathways would assist with targeting of preventive and health promotion interventions in adolescence as well as potential pharmacotherapy interventions if severity of clinical presentation warranted an extended response.

From a psychological perspective, eating and body image disturbances have long been thought to reflect attempts by young people to regulate and cope with negative emotional experiences (Haedt-Matt & Keel, 2011). When sustained, these problematic coping styles play a key role in later mental health problems (Pineles et al., 2011; Stevens, 2014) and also represent modifiable targets for both prevention and clinical intervention. From a social transition role perspective, engaging in unhealthy weight control behaviours in adolescence may also disrupt social maturation; for example, avoidance of or withdrawal from social situations that elicit concerns with eating, shape, and weight (Arcelus et al., 2012) may hamper transitions to emerging adulthood roles and responsibilities such as finding a partner, developing new friendship networks, and taking on the role as a parent. These developmental achievements are key to later mental health and wellbeing (Schulenberg et al., 2004). Further research on mechanisms of risk transmission through this phase of the life cycle may advance targeting of population and clinical interventions in adolescence and young adulthood.

Limitations

Despite several key strengths of this study, there are also limitations that need to be considered. Assessments of eating and body image disturbances were not conducted during middle childhood and pre-adolescence, a period within which these problems typically first emerge. This means that EDI scores in mid-adolescence likely represent a range of earlier aetiological pathways, which if modelled separately may have revealed different risk relationships with later mental health difficulties. Concurrent 15-16 year old mental health problems were also not assessed. However, mental health problems at ages 13-14 were

adjusted for using the developmentally appropriate SMFQ and RBCQ, ensuring that the observed mental health risks associated with adolescent EDI scores were not explained by pre-exposure mental health problems (depression/anxiety). Additionally, all variables were based on self-report. Although efficient,, evidence suggests that individuals may overestimate the nature and severity of symptoms through self-report assessment (Berg et al., 2011). Future research should investigate prospective relationships with interviewer-based assessments. Finally, while we adjusted for a range of baseline demographic and individual factors, as with all observational studies, the potential for confounding remains. This includes confounding related to prior help-seeking, treatment history, or the presence of a clinically significant eating disorder. Extension of investigations to other cohort studies with clinical diagnostic and treatment data would be valuable, as would randomized controlled trials of clinical treatments of adolescent eating disorder that maintain long term follow-up into young adulthood.

Implications and Conclusion

Taken together, findings suggest that eating and body image disturbances in adolescence may be important factors influencing the mental health in younger adulthood, potentially highlighting the importance of investing in prevention and early intervention programs across the teenage years. Replication in other longitudinal studies is now needed; however, if similar patterns are observed, one translational outcome of this work could be to promote greater awareness of the potential long-term effects of adolescent eating and body image disturbances in healthcare and education settings. A second translational outcome might be to ensure that adolescent population monitoring systems, commonly implemented in secondary schools, include dedicated indicators of disordered eating attitudes and behaviours which could be used by policy makers, healthcare and education professionals to target potentially at-risk young people for preventive and early intervention. A third implication of

this work could be to inform the development of new approaches to intervening on disordered eating attitudes and behaviours in adolescence, including the development of school based curricula (Kwag et al., 2021; Yager et al., 2013), which could be trialed in stronger study designed, and include follow-up of participants into the young adult years. A final clinical translation point could be to include systematic screening for prior adolescent eating problems when treating mental health problems in young adulthood, for example within university mental health services (Harrer et al., 2020).

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Table 1
Descriptive statistics for study variables

Variable	Boys/men (*n* = 763)			Girls/women (*n* = 805)			Full sample (*n* = 1568)		
	M	**95% CI**	**% missing**	***M***	**95% CI**	**% missing**	***M***	**95% CI**	**% missing**
Eating and Body Image Disturbances									
Drive for thinness (15-16 years)	0.78	(0.65, 0.92)	17%	3.65	(3.28, 4.02)	17%	2.25	(2.04, 2.47)	17%
Bulimia (15-16 years)	0.72	(0.60, 0.84)	17%	1.17	(1.00, 1.35)	17%	0.95	(0.84, 1.06)	17%
Body dissatisfaction (15-16 years)	1.13	(1.00, 1.26)	17%	2.36	(2.19, 2.54)	17%	1.76	(1.65, 1.88)	17%
Mental health problems									
Depression (19-20 years)	3.76	(3.41, 4.10)	34%	3.84	(3.52, 4.16)	20%	3.80	(3.57, 4.04)	27%
Depression (23-24 years)	3.23	(2.87, 3.59)	50%	3.37	(3.07, 3.67)	24%	3.32	(3.08, 3.55)	37%
Depression (27-28 years)	3.23	(2.86, 3.60)	45%	3.03	(2.75, 3.30)	25%	3.11	(2.89, 3.33)	35%
Anxiety (19-20 years)	2.54	(2.30, 2.78)	34%	2.81	(2.56, 3.07)	20%	2.69	(2.52, 2.87)	27%
Anxiety (23-24 years)	2.09	(1.83, 2.35)	50%	2.40	(2.17, 2.63)	24%	2.28	(2.11, 2.45)	37%
Anxiety (27-28 years)	1.96	(1.73, 2.19)	45%	2.07	(1.86, 2.28)	25%	2.03	(1.87, 2.18)	35%
Stress (19-20 years)	4.54	(4.23, 4.85)	34%	5.40	(5.09, 5.70)	20%	5.02	(4.80, 5.24)	27%
Stress (23-24 years)	4.57	(4.21, 4.93)	50%	5.25	(4.96, 5.54)	24%	4.98	(4.76, 5.21)	37%
Stress (27-28 years)	4.71	(4.38, 5.05)	45%	4.91	(4.64, 5.19)	25%	4.83	(4.62, 5.04)	35%
	N	**%** **95% CI**	**% missing**	***N***	**%** **95% CI**	**% missing**	***N***	**%** **95% CI**	**% missing**
Parent									
Not born in Australia	209	29% (26, 32%)	5%	213	27% (24, 31%)	3%	422	28% (26, 30%)	4%
< year 12 education	199	26% (23, 29%)	0%	220	27% (24, 31%)	0%	419	27% (25, 29%)	0%
Separated/divorce	111	15% (13, 18%)	2%	129	17% (14, 19%)	4%	240	16% (14, 18%)	3%
Participant									
Early onset puberty	11	2% (1, 3%)	20%	123	18% (16, 22%)	17%	134	10% (9, 12%)	18%
Adolescent mental health	89	14% (12, 17%)	17%	173	26% (23, 30%)	18%	262	20% (18, 23%)	18%
	M	**95% CI**	**% missing**	***M***	**95% CI**	**% missing**	***M***	**95% CI**	**% missing**
BMI (age 12-13 years)	19.25	(18.95, 19.55)	46%	19.89	(19.55, 20.23)	44%	19.58	(19.35, 19.81)	45%

Note: adolescent mental health problems were defined as scoring either ≥ 11 on the SMFQ or a > 1 on the RBPC.

Table 2
Associations between eating and body image disturbances in adolescence (15-16 years) and changes in mental health symptoms across three waves (19-20, 23-24, 27-28 years) in young adulthood (n = 1,568)

	Unadjusted			Adjusted			Interactions		
							Predictor × Gender	Predictor × Wave	Predictor × Gender × Wave
	β	95% CI	*p*	*β*	95% CI	*p*	*p*	*p*	*p*
Predictor									
	Depressive symptoms								
Drive for thinness	0.10	(0.05, 0.15)	<0.001	0.07	(0.02, 0.13)	0.011	0.409	0.028	0.885
Bulimic behavior	0.17	(0.11, 0.23)	<0.001	0.14	(0.08, 0.20)	<0.001	0.024	0.944	0.097
Body dissatisfaction	0.16	(0.11, 0.21)	<0.001	0.14	(0.09, 0.19)	<0.001	0.194	0.549	0.740
	Anxiety symptoms								
Drive for thinness	0.11	(0.06, 0.16)	<0.001	0.09	(0.03, 0.15)	0.003	0.645	0.319	0.434
Bulimic behavior	0.18	(0.12, 0.24)	<0.001	0.15	(0.09, 0.21)	<0.001	<0.001	0.406	0.018
Body dissatisfaction	0.13	(0.08, 0.18)	<0.001	0.11	(0.05, 0.16)	<0.001	0.563	0.424	0.248
	Stress symptoms								
Drive for thinness	0.11	(0.05, 0.16)	<0.001	0.06	(0.01, 0.12)	0.028	0.556	0.064	0.153
Bulimic behavior	0.18	(0.12, 0.23)	<0.001	0.15	(0.09, 0.20)	<0.001	<0.001	0.436	0.009
Body dissatisfaction	0.13	(0.08, 0.18)	<0.001	0.10	(0.05, 0.15)	<0.001	0.099	0.167	0.031

Covariates in adjusted analyses included country of birth, low parental education (< year 12) and separation/divorce during the participant's childhood (ages 0-13 years), sex, early puberty onset (menarche/voice break prior to 12 years old), BMI at ages 12-13 years, and elevated levels of mental health problems at 13-14 years.

Reviewer 1

Comment 1: This Australian longitudinal study assessed if eating and body image disturbances (15-16 years) predict mental health difficulties across young adulthood (19-20, 23-24 and 27-28 years). The sample included 1,637 participants (50% female) of the initial 2,443 sample who completed some items of the Eating Disorder Inventory (drive for thinness, bulimic behavior and a modified version of the body dissatisfaction scale) at 15-16 years or the depression, anxiety, stress scales at 21, 24 and 28 years). The authors found an association between eating and body image disturbances in adolescents and general mental health problem in young adulthood. They concluded that their finding supports the need to monitor and support the mental health of young people presenting with eating and body image disturbances in adolescence. The main strengths of the study are its longitudinal design and the inclusion of a large community sample. Moreover, the Introduction includes an updated selection of the previous studies on this topic. The main limitation is the use of self-report measures assessing both body image and general psychopathology that might have overestimated the psychopathology. Therefore, it is not clear if these findings are clinically significant. Moreover, as in all longitudinal studies, some confounders may have not been considered.

> **Response 1:** We thank the reviewer for these comments. As noted, data have been collected by self-report; however, for both exposure and outcomes, self-reports have been done using well validated measures (EDI and DASS). So while there remains some risk of over/under estimation, the use of well validated measures mitigates this to a considerable extent. Furthermore, these measures have been used widely, which both speaks to their reliability and provides the capacity for replication. We agree too that residual unmeasured confounding remains a challenge in observational studies. We note all these points in our revised manuscript and in our responses below.

Comment 2: The study design description requires more accuracy and detail. In particular, the authors should specify how many time points were included in the analysis and how many participants completed both eating and body image disturbance items and mental health difficulties items (i.e., how many data could be considered paired data). A table could help to clarify this point.

> **Response 2:** We have now provided more detail related to the study design and sample size throughout. Under the "Participants and Procedure" section, we now clarify which time points were included in the analysis, the total number of participants included, and the percentage of participants who provided paired data across each time point. Information pertaining to available data at each time-point analyzed are also provided in the revised Table 1.
>
> *Page 7*
>
> *"For the current study, data for the primary analytic variables are drawn from four waves spanning adolescence (eating and body image disturbances; 1 wave: age-15-16 years) and young adulthood (mental health problems; 3 waves: age 19-20, 23-24, and 27-28 years). Participants were included in the current study if they provided relevant data in adolescence or young adulthood. This resulted in a sample size of 1,568 (805 females) for the current study, for which 72% of participants provided data both in adolescence and young adulthood."*

Comment 3: Moreover, authors should consider, as confounding variables, the absence of any information about the number of participants who developed an eating disorder of clinical severity or treated for eating disorders or are attending treatment for the eating disorder. The absence of this information limits the conclusions about the key role of prevention.

> **Response 3:** We agree that these variables would be important to consider as potential confounds. However, clinical diagnoses were not assessed as part of this population-based longitudinal study. In this analysis we have focused on early (non-clinical) signs and symptoms of eating and body image disturbances and show that these predict later mental health problems. We have included the absence of clinical indicators as an important limitation to address in future research.
>
> *Page 14*
>
> *"...while we adjusted for a range of baseline demographic and individual factors, as with all observational studies, the potential for confounding remains. This includes confounding related to prior help-seeking, treatment history, or the presence of a clinically significant eating disorder. Extension of investigations to other cohort studies with clinical diagnostic and treatment data would be valuable, as would randomized controlled trials of clinical treatments of adolescent eating disorder that maintain long term follow-up into young adulthood."*

Comment 4: The biological and psychosocial mechanisms proposed by the authors to explain the association between body image disturbance in adolescents and general psychopathology in young adulthood are very speculative and not supported by data. Maybe they should be removed by the discussion

Response 4: We have had extensive discussions about this suggestion within our team and would prefer, if acceptable, to retain a modified, shortened discussion of potential biological, psychological, and social mechanisms to stimulate thinking about possible future lines of enquiry. We have modified the text accordingly and hope this enables the section to be retained with a clearer sense of purpose.

Page 12-13

"Further research is now needed to clarify whether long term developmental associations reported here are causal, and if so, identify mechanisms through which risk is transmitted. A range of causal mechanisms might be at play. From a biological perspective, disordered eating in adolescence may disrupt normative developmental process across puberty, a critical period that can have a long-standing influence on later mental health (Patton & Viner, 2007). Restrictive eating has been linked with growth retardation and pubertal delay, possibly via endocrine abnormalities in key growth axes (Gianotti et al., 2002; Misra & Klibanski, 2016; Travaglini et al., 1976) and neurotransmission pathways (e.g., 5HTT) (Bailer et al., 2004; Kaye, 2008). Disrupted growth patterns, and pubertal delay, may be among a number of biological mediated pathways that increase risk for on-going mental health problems (De Onis & Branca, 2016; Tanner, 1952; Zhu & Chan, 2017). Greater understanding of such biological pathways would assist with targeting of preventive and health promotion interventions in adolescence as well as potential pharmacotherapy interventions if severity of clinical presentation warranted an extended response. From a psychological perspective, eating and body image disturbances have long been thought to reflect attempts by young people to regulate and cope with negative emotional experiences (Haedt-Matt & Keel, 2011). When sustained, these problematic coping styles play a key role in later mental health problems (Pineles et al., 2011; Stevens, 2014) and also represent modifiable targets for both prevention and clinical intervention. From a social transition role perspective, engaging in unhealthy weight control behaviours in adolescence may also disrupt social maturation; for example, avoidance of or withdrawal from social situations that elicit concerns with eating, shape, and weight (Arcelus et al., 2012) may hamper transitions to emerging adulthood roles and responsibilities such as finding a partner, developing new friendship networks, and taking on the role as a parent These developmental achievements are key to later mental health and wellbeing (Schulenberg et al., 2004). Further research on mechanisms of risk transmission through this phase of the life cycle may advance targeting of population and clinical interventions in adolescence and young adulthood."

Comment 5: Given the limitations of the study, the authors should be more cautious in interpreting their results. I think that there is a need to move toward a more solid study design (e.g., RCT with direct interviews) to assess with more accuracy if body image disturbances in adolescents and mental health outcomes in young adulthood.

Response 5: We agree that causal inference from observational studies needs to be stated cautiously and have reviewed (and revised where needed) the text throughout to ensure we have done so. We have also incorporated comments about the potential future use of randomized controlled trials as a means of strengthening confidence in causal inference into the Implications/Conclusions section of the manuscript:

Page 14-15

"Taken together, findings suggest that eating and body image disturbances in adolescence may be important factors influencing the mental health in younger adulthood, potentially highlighting the importance of investing in prevention and early intervention programs across the teenage years. Replication in other longitudinal studies is now needed; however, if similar patterns are observed, one translational outcome of this work could be to promote greater awareness of the potential long-term effects of adolescent eating and body image disturbances in healthcare and education settings. A second translational outcome might be to ensure that adolescent population monitoring systems, commonly implemented in secondary schools, include dedicated indicators of disordered eating attitudes and behaviours which could be used by policy makers, healthcare and education professionals to target potentially at-risk young people for preventive and early intervention. A third implication of this work could be to inform the development of new approaches to intervening on disordered eating attitudes and behaviours in adolescence, including the development of school based curricula (Yager et al., 2013), which could be trialed in stronger study designed (RCT with direct interviews), and include follow-up of participants into the young adult years. A final clinical translation point could be to include systematic screening for prior adolescent eating problems when treating mental health problems in young adulthood, for example within university mental health services (Harrer et al., 2020)."

Reviewer 2

Comment 1: This study provides novel insight into the associations between body image and eating disturbance in early adolescence and mental health in young adulthood at three time points in the 20s. The manuscript is

well written and the study design is strong. There are several points in the manuscript where the analytic methods and data interpretation of multivariable models could be more precise to more clearly explain what was done and what the models are predicting. See specific comments inserted throughout the attached PDF of the manuscript.

Response 1: We thank the reviewer for these comments and respond to each specific query below.

Comment 2: Including underweight and overweight as confounders raises a question of over controlling as either may be consequences of disordered eating/disordered weight control behaviors and overweight in particular may be associated with weight-related stigma/bullying/harassment/discrimination, which in turn may increase the risk of depression and anxiety. How were these plausible pathways considered in the analysis approach and findings interpretations? It would be helpful to see some discussion of the thinking about how and where weight status might fit into the hypothesized causal model (page 8, line 17).

Response 2: Complex relationships are likely to exist between eating disturbances, weight, and mental health outcomes. Relevant to this analysis, BMI has been consistently associated with later mental health outcomes (doi:10.1001/archgenpsychiatry.2010.2); it is also a core feature of eating and body image disturbances. To test this in our data, we ran a series of sensitivity analyses (not reported) where we excluded BMI as a confound to see whether the same pattern of results emerge. In these analyses, we found a near identical pattern of results. Given that our study was not designed to investigate complex pathways involving BMI at distinct adolescent stages, we have raised this as an area for future research. Furthermore, based on additional suggestions from Reviewer 3, we have changed our analytic strategy and now use a continuous measure of pre-exposure BMI (12-13 years) to adjust for potential confounding by BMI.

Comment 3: Would be helpful to clarify "or" here: Were participants classified as underweight if they were underweight at either 12-13 or 15-16 or both? Same question for overweight. What standard (with citation) was used to classify underweight and overweight? (Page 8, line 18).

Response 3: See response 2 above. These classifications have now been removed from the manuscript. Instead, continuous BMI scores at ages 12-13 were added as a pre-exposure confound.

Comment 4: Since DASS at ages 13-14 y/o is controlled for, models are predicting CHANGE in DASS from ages 13-14 y/o to some subsequent age (and not predicting DASS score at the subsequent age); clarify that these models are predicting CHANGE in DASS and clarify what that subsequent age at follow-up where DASS is measured (Page 8, Line 20).

Response 4: We note that our initial description of adolescent mental health measures was unclear. Mental health symptoms in early adolescence (13-14 years; pre-exposure) were measured using the Short Mood and Feelings Questionnaire (SMFQ) and the Revised Behaviour Problem Checklist (RBPC). The DASS didn't exist at the time of administration, and even if it had, the SMFQ and RBPC would still have been used because the DASS is primarily designed for use with adults. We include the SMFQ and the RBPC to control for pre-exposure confounding; specifically, our aim was to examine the associations between EDI subscales and young adult mental health problems net of pre-exposure mental health problems. We have now clarified this point in the Statistical Analyses section.

Page 9

"Finally, to reduce the potential for reverse causality where possible (VanderWeele, 2019), elevated levels of depressive and anxiety symptoms at 13-14 years were controlled for using the Short Mood and Feelings Questionnaire (Angold & Stephen, 1995) and the Revised Behavior Problem Checklist Short Form (RBPC; Quay & Peterson, 1987).

Comment 5: It would be helpful to state explicitly that since DASS at ages 13-14 y/o is controlled for, models are predicting CHANGE in DASS from ages 13-14 y/o to some subsequent age (and not predicting DASS score at the subsequent age). Also clarify if separate models are predicting outcomes at each of the follow-up waves (19-20 y/o, 23-24 y/o, and 27-28 y/o) so that effect estimates for predictors could vary with each wave or if models were run in such a way to assume that the association between predictors and outcomes would be the same regardless of wave. It would be helpful to clarify these points more explicitly (Page 8, line 24).

Response 5: Please see our response to the point above clarifying the description of the variable indicating prior mental health problems. Additionally, we did not run separate models to examine the associations between the EDI and DASS at each wave. Instead, we included the interaction term (EDI × time-point) to investigate whether the strength of the EDI-DASS associations vary as a function of measurement wave. We have now clarified this more explicitly in the Statistical Analyses section.

Page 9

"All analyses were conducted in Stata 15 (StataCorp, 2017). Linear generalized estimating equations (GEEs) with an exchangeable working correlation were used to estimate associations between adolescent EDI subscales (15-16 years) and DASS subscales at young adult waves (19-20, 23-24, and 27-28 years). Models were fitted separately for each eating/body image disturbance and mental health variable relationship. For each model, analyses were estimated: (1) adjusting for outcome wave only, and (2) adjusting for all potential confounders. Fully adjusted models were then repeated by including: (3) an interaction between each eating/body image disturbance subscale and sex to examine whether associations varied between males and females, (4) an interaction between each eating/body image disturbance subscale and outcome measurement wave to examine whether associations varied across young adulthood, and (5) a 3-way interaction between eating/body image disturbance, sex, and outcome measurement wave to examine potential differential effects both across men and women, and across young adulthood."

Comment 6: Was there reason to think there would be sufficient statistical power to test 3-way interactions? (Page 9, line 6).

Response 6: Consistent with recommendations that power calculations only be undertaken for planning purposes at the beginning of a cohort study (Zhang et al 2019), we did not conduct a priori power analysis for the 3-way interactions examined in this specific analysis. Nevertheless, in the updated analytic models, some 3-way interactions were identified (suggesting we were adequately powered). We additionally updated Figure 1 (Supplementary Materials) to help readers visualize these 3-way interactions.

Reference: Zhang, Y., Hedo, R., Rivera, A., Rull, R., Richardson, S., & Tu, X. M. (2019). Post hoc power analysis: is it an informative and meaningful analysis?. General Psychiatry, 32(4).

Comment 7: This sentence that begins with "From a psychosocial perspective, engaging in...." does not seem to connect the dots as well as the previous sentence from a psychological perspective surmising why eating and body image disturbance may lead to longer term mental health problems. Can more be offered to connect the dots on why engaging in unhealthy weight control behaviors may disrupt "natural transitions to adulthood roles"? (Page 12, line 14).

Response: We have attempted to strengthen this section by re-working the text in the following way:

Page 13

"From a social transition role perspective, engaging in unhealthy weight control behaviours in adolescence may also disrupt social maturation; for example, avoidance of or withdrawal from social situations that elicit concerns with eating, shape, and weight (Arcelus et al., 2012) may hamper transitions to emerging adulthood roles and responsibilities such as finding a partner, developing new friendship networks, and taking on the role as a parent These developmental achievements are key to later mental health and wellbeing (Schulenberg et al., 2004). Further research on mechanisms of risk transmission through this phase of the life cycle may advance targeting of population and clinical interventions in adolescence and young adulthood"

Comment 8. It would be helpful to clarify here in the table or footnote at what age underweight and overweight status were determined and according to what standard for these thresholds (Table 1).

Response 8: As per our response to comment 2, we have now used a continuous measure of prior BMI rather than the two binary variables. This has now been specified in Table 1.

Comment 9: It would be helpful to make the table title much more informative about the sample and developmental periods covered, longitudinal modeling from what time point to what future time point, the outcomes (need to be labeled in the column headings as outcomes), etc., and clarify that these are three separate sets of models. Since DASS at ages 13-14 yo is controlled for, models are predicting CHANGE in DASS from ages 13-14 yo to some subsequent age (and not predicting DASS score at the subsequent age); clarify that these models are predicting CHANGE in DASS in table title and clarify what that subsequent age at follow-up where DASS is measured. It would be helpful to also give the N in the table title (Table 2)

Response 9: In response, we have now adjusted the title of Table 2 to accommodate these suggestions. We have also provided the sample size in the Title.

"Table 2: Associations between eating and body image disturbances in adolescence (15-16 years) and changes in mental health symptoms across three waves (19-20, 23-24, 27-28 years) in young adulthood (n = 1,568)"

Comment 10: Should this be "and/or" rather than "or"?.

Response 10: As per our response to comment 8, this binary variable has been removed and replaced with a continuous BMI score.

Comment 11: Would be helpful if the figure title was more self-explanatory and gave more information about what the waves represent (e.g., ages of participants when data were collected over X years of follow up).

Response 11: We have now adjusted Figure 1 to accommodate these suggestions.

Supplementary Figure 1. Depression: 3-way interactions between EDI subscale score (ages 15-16), gender, and outcome measurement wave (19-20, 23-24, and 27-28 years)

Reviewer 3

This prospective study examined 1,637 male and female adolescents at ages 15-16 who completed questionnaires assessing drive for thinness, bulimic behavior and body dissatisfaction in mid-adolescence. Depression, anxiety and stress measures were completed at ages 13-14, 21, 24 and 28 years. All three eating/body related scales in adolescence predicted each mental health outcome in adulthood. Mental health risks associated with adolescent bulimic behavior and body dissatisfaction remained stable across young adulthood, with males having more pronounced problems associated with bulimic behaviors than females. Mental health risks associated with drive for thinness decreased for both males and females. There is a lot to like about this study. It is well written and the long-term outcome data and inclusion of both boys and girls are significant strengths. However, there are areas that need clarification in the Methods. Furthermore, the Discussion section could be bolstered. Suggestions are as follows:

Comment 1: The authors did not include hypotheses. Based on the extensive literature, hypotheses can be made.

Response 1: Hypotheses have now been included.

Page 6

"Based on prior research, we hypothesized that higher levels of drive for thinness, bulimic behaviour and body dissatisfaction in adolescence would predict more elevated symptoms of depression, anxiety and stress throughout young adulthood (Aim 1). In the absence by both data and theory on outcomes in young adulthood, we took an exploratory approach to investigating both the nature of risk-relationships over young adulthood (Aim 2) as well as the nature of sex differences (Aim 3)"

Comment 2: For all of the questionnaire subscales, it would be useful to include internal reliability (Cronbach's alphas).

Response 2: Cronbach's alpha for each of the scales has been provided. Please see this information under the "measures" section – Page 7.

Comment 3: In general, the analyses appear robust. However, covariates included "underweight and overweight". What about healthy weight? Given the robust link between body weight and both the independent and dependent variables in the study, it seems warranted to include BMI as a continuous covariate.

Response 3: We thank Reviewer 3 for this suggestion and have now included BMI as a continuous covariate. Please note that the results remained near identical after this modification. Please see the updated results section.

Comment 4: Boys appear to have lower levels on the eating/body image scales than girls, yet the predictive models are robust for boys. Clinically, providers should be aware of this, as it may be very important for screening and recognizing that lower levels on measures may confer the same (or higher) risk as for girls with higher levels on these scales.

Response 4: We have included a brief discussion of this finding in the first paragraph of the Discussion.

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"Second, we show that several of these relationships are no less pronounced for males than females, indicating that lower levels of eating disturbances in males do not necessarily confer lower risk of later mental health problems. This highlights the importance of intervening with and supporting both males and females affected by eating and body image disturbances during adolescence."

Comment 5: The diminishment of the relationship between drive for thinness and depressive symptoms should also be further addressed. Is it that, for some youth (perhaps those who have overweight or obesity, which was substantial proportion of the sample – see the next point) drive for thinness is just a response to body image dissatisfaction that is primarily part of adolescence? Even if not, this is a finding that should be explored deeper.

Response 5: In response, we have now added a brief, tentative interpretation of this finding based on the reviewer's suggestion

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"Effects of drive for thinness on mental health sequelae were also present but diminished (for depressive symptoms specifically) over time, potentially indicating that the features associated with drive for thinness may be a more normative part of adolescent development (particularly among overweight/obese individuals) that does not bear long-term risks to dysphoric moods."

Comment 6: The sample, according to Table 1 (which is presumably baseline data), indicates that 37% of participants had overweight or obesity. This appears to be much higher than the current rate in Australia and, given that at least some data were collected in 1983 when rates were lower, especially high. This should be discussed, particularly given the points made above

Response 6: As per our response to comment 3, BMI has now been included as a continuous measure in our models to partial out effects of body mass variation, not overweight/obese classifications, on the relationship between eating problems in adolescence and mental health problems in young adulthood. Although BMI is not the focus of this analysis, we do acknowledge that a higher-than-expected proportion of our sample can be classified as overweight/obese; however, any confounding effect of this variation prior to estimating the relationship between EDI and DASS has been removed by adjustment.

Comment 7: That youth were not assessed when signs of eating related and body image disturbance first emerge, which has been documented during middle childhood and pre-adolescence, should also be noted as a limitation and future direction

Response 7: This has now been included as a limitation and future direction.

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"Assessments of eating and body image disturbances were not conducted during middle childhood and pre-adolescence, a period within which these problems typically first emerge. This means that EDI scores in mid-adolescence likely represent a range of earlier aetiological pathways, which if modelled separately may have revealed different risk relationships with later mental health difficulties."

Comment 8: Another limitation that should be further highlighted is that it appears as though mental health risks were not assessed at 15-16. Using data from age 13-14 is somewhat useful, but it would have been optimal to covary variables collected at the same time.

Response 8: We agree with this suggestion and have now added it as a limitation to this study.

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"A second limitation was that the DASS was not administered the same time participants completed the EDI subscales, preventing us from controlling for DASS scores during adolescence. However, mental health problems at ages 13-14 were controlled for using the developmentally appropriate SMFQ and RBCQ, ensuring that the observed mental health risks associated with adolescent EDI scores were not explained by pre-exposure mental health problems (depression/anxiety)."

Comment 9: To make space for adding the above suggestions, the second full paragraph of this section (p. 11, lines 8-19) could be removed or reduced substantially.

Response 9: After considerable discussion with our team, we would like to retain a shorter version of this paragraph rather than removing it completely. We believe that a paragraph demonstrating how our findings offer new information over prior prospective studies was an important addition. We do note that we are well within the 4,500 maximum word count for IJED after including the additional suggestions raised by each of the reviewers.

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"Findings from this study extend earlier prospective studies (Puccio et al., 2016; Puccio et al., 2017; Vannucci & Ohannessian, 2018; Vaughan & Halpern, 2010) in three important ways. First, we show that adolescent eating and body image disturbances predict mental health problems much later in young adult development than has previously been reported (Herpertz-Dahlmann et al., 2015). Second, we show that several of these relationships are no less pronounced for males than females, indicating that lower levels of eating disturbances in males do not necessarily confer a lower risk of later mental health problems. This highlights the importance of intervening with and supporting both males and females affected by eating and body image disturbances during adolescence. Third, we show that these risk-relationships, particularly for bulimic behavior and body dissatisfaction, remain largely stable across the young adulthood years (ages 21 to 28 years). Taken together, we show that eating and body image

disturbances in adolescence may exacerbate psychological vulnerabilities that persist well into young adult life."