

Hughes Elizabeth (Orcid ID: 0000-0002-4377-5610)
Le Grange Daniel (Orcid ID: 0000-0001-7293-9496)

Title

Eating Disorder Symptoms across the Weight Spectrum in Australian Adolescents

Running title

Eating disorders and weight

Authors

Elizabeth K. Hughes, PhD^{1, 2, 3}

Jessica A. Kerr, PhD^{1, 2}

George C. Patton, MD^{1, 2, 3}

Susan M. Sawyer, MD^{1, 2, 3}

Melissa Wake, MD^{1, 2, 5}

Daniel Le Grange, PhD^{6, 7}

Peter Azzopardi, PhD^{1, 4}

Affiliations

1. The University of Melbourne, Parkville, VIC, Australia
2. Murdoch Children's Research Institute, Parkville, VIC, Australia
3. Royal Children's Hospital, Parkville, VIC, Australia
4. Burnet Institute, Melbourne, VIC, Australia
5. University of Auckland, Auckland, New Zealand
6. University of California San Francisco, CA, USA
7. The University of Chicago, Chicago, IL, USA (Emeritus)

Correspondence

Elizabeth K. Hughes, PhD, Department of Paediatrics, The University of Melbourne, 50
Flemington Road, Parkville VIC 3052, Australia; Phone: +61 3 9345 4738; Email:

Libby.Hughes@rch.org.au

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: [10.1002/eat.23118](https://doi.org/10.1002/eat.23118)

Word counts

Abstract: 238

Main text: 4,860

Acknowledgements

We thank the participants and supporters of Growing Up in Australia: The Longitudinal Study of Australian Children.

Growing Up in Australia: The Longitudinal Study of Australian Children (LSAC) is supported by the Australian Government Department of Social Services. MCRI is supported by the Victorian Government's Operational Infrastructure Program. Dr Hughes is supported by a grant from the Baker Foundation. Professor Patton is supported by a NHMRC Senior Principal Research Fellowship (#1019887). Professor Wake is supported by a NHMRC Principal Research Fellowship (#1160906). Dr Azzopardi is supported by a NHMRC Early Career Fellowship (#1145228). This article uses unit record data from the Longitudinal Study of Australian Children (LSAC). LSAC is conducted in partnership between the Department of Social Services, the Australian Institute of Family Studies, and the Australian Bureau of Statistics. The findings and views reported in this paper are solely those of the authors.

Abstract

Objective: Despite known associations between eating disorder symptoms and obesity, little is known about symptoms of eating disorders across the weight spectrum. This study therefore aimed to estimate the population prevalence of eating disorder symptoms in relation to weight status in adolescents. **Method:** The sample comprised 3,270 adolescents (14-15 years; 52% boys) drawn from Wave 6 of the Longitudinal Study of Australian Children. Symptoms of anorexia nervosa (AN) and bulimia nervosa (BN) were assessed using self-report on the Branched Eating Disorder Test. This measure identifies clinically significant symptoms in the past 3 months according to the DSM-5. Using study-derived cross-sectional population weights, the prevalence of each symptom was estimated for the total population and by sex and weight status. **Results:** The estimated population prevalence was high (14.3%-25.7%) for body image symptoms such as fear of weight gain and overvaluation of body weight, but lower (0.5%-3.7%) for behavioural symptoms such as binge eating and compensatory behaviours. Symptoms were more prevalent among adolescents with overweight or obesity. Although most symptoms tended to have higher prevalence among girls than boys, boys with obesity had higher prevalence of binge eating and excessive exercise than girls with obesity. The overall estimated population prevalence for AN and BN was 0.20% and 0.10%, respectively. **Conclusions:** The study highlights a need for clinicians to be cognisant of disordered eating behaviours regardless of weight status, and has implications for both eating disorder and obesity prevention and intervention.

Keywords: eating disorders; adolescents; anorexia nervosa; bulimia nervosa; overweight; obesity; prevalence

Eating disorders make a significant contribution to the global burden of disease (Erskine, Whiteford, & Pike, 2016) and are associated with high social and economic costs (Deloitte Access Economics, 2012). Adolescence is the peak period for onset of anorexia nervosa (AN) and bulimia nervosa (BN), with AN having its highest incidence at 15-19 years of age and BN at 15-24 years of age (Smink, van Hoeken, & Hoek, 2012). While several studies have attempted to estimate the prevalence of disordered eating among adolescents, most use small samples and symptom measures which do not allow for assessment of specific diagnostic criteria (e.g., Eating Attitudes Test (Garner & Garfinkel, 1979), Eating Disorder Inventory (Garner, Olmsted, & Polivy, 1983), SCOFF (Morgan, Reid, & Lacey, 1999)). In addition, few population-based studies have reported eating disorder symptoms across the weight spectrum in adolescents, despite the increased prevalence of obesity and known associations between body weight and disordered eating (Darby et al., 2009). Understanding the prevalence of eating disorder symptoms across the weight spectrum could help to identify opportunities for prevention and intervention within previously neglected groups.

Across studies that have examined the prevalence of eating disorders in adolescents, estimates vary considerably by methodology (e.g., by sample selection, sample size, assessment mode and instrument). A few large studies have been conducted which may provide more reliable population estimates, although these were conducted some time ago. In one of the largest population studies to date, the Composite International Diagnostic Interview was administered face-to-face with 10,123 adolescents aged 13-18 years in the USA in 2001-2004 (Swanson, Crow, Le Grange, Swendsen, & Merikangas, 2011). Lifetime prevalence was reported to be 0.3% for AN, 0.9% for BN and 1.6% for binge eating disorder

(BED). A further 0.8% and 2.5% met partial criteria for AN and BED, respectively. In an Australian study, a written questionnaire, the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Belgin, 2008), was administered to 1,597 14-year-olds born in 1989-1991 (Allen, Byrne, Forbes, & Oddy, 2009). This study found that 2.8% adolescents met full criteria for an eating disorder (0.06% AN, 0.56% BN; 0.44% BED) and 3.2% met partial criteria (0.25% AN, 0.81% BN, 0.88% BED).

Beyond overall population prevalence, there has also been growing interest in the relationship between eating disorders and obesity, in part due to the significant increase in overweight and obesity during the late twentieth century (Norton, Dollman, Martin, & Harten, 2006), coupled with greater focus on weight loss promotion and interventions (Cleland, Gross, Koss, Daynard, & Muoio, 2002; Oude Luttikhuis et al., 2009; Summerbell et al., 2003). There is concern that this focus may lead to preoccupation with weight, exacerbation of body image concerns and perpetuation of weight biases, all of which may contribute to eating disorder symptoms especially in people with higher body weights or existing body dissatisfaction (Ximena Ramos, 2015). In one of the only population-based studies to examine disordered eating across the weight spectrum, the third wave of the USA National Longitudinal Study of Adolescent to Adult Health conducted in 2001 to 2002 (n = 14,322), symptoms such as fasting, self-induced vomiting, and binge eating were found to be more common in young adults with overweight or obesity (18-24 years) than in young adults who were underweight or normal weight (Nagata, Garber, Tabler, Murray, & Bibbins-Domingo, 2018). Studies of adults and university students report similar findings (Duncan, Ziobrowski, & Nicol, 2017; Kass et al., 2017; Lipson & Sonnevile, 2017). Such large-scale

studies broaden our understanding of eating disorder symptoms across the weight spectrum, but the focus on adults and older adolescents limits extrapolation to earlier adolescence when the onset of eating disorders is at its peak. Although other studies of younger adolescents have found similar patterns of results with regard to weight status (e.g., Fan et al., 2010; Loth, Wall, Larson, & Neumark-Sztainer, 2015; O'Dea & Amy, 2011), these have not been population-based or have used measures that do not align with diagnostic criteria.

The interactions between obesity and eating disorders are complex. For example, persistent high weight during childhood has been shown to predict disordered eating attitudes and behaviours in adolescence (Le Grange et al., 2014). Conversely, eating disorder symptoms in adolescence have been shown to predict later weight gain and obesity (Loth, Watts, van den Berg, & Neumark-Sztainer, 2015; Neumark-Sztainer, Wall, Story, & Standish, 2012; Stice, Presnell, Shaw, & Rohde, 2005). Furthermore, it has been reported that although the prevalence of eating disorder symptoms among adolescents who were not overweight decreased between 1999 and 2010, the prevalence remained stable among adolescents with overweight or obesity (Loth, Wall, et al., 2015). This highlights the importance of reporting eating disorder symptoms at different weight categories during adolescence in contemporary population-based studies.

Using data from *Growing Up in Australia: the Longitudinal Study of Australian Children*, the current study aimed to estimate the prevalence of AN and BN symptoms in 14-15 year old boys and girls who were entering the peak age of onset for AN and BN. The study also aimed to estimate the prevalence of these symptoms across sex and weight categories (i.e., underweight, normal weight, overweight and obese).

Method

Participants and Procedure

The sample was drawn from Wave 6 of the population-representative Longitudinal Study of Australian Children (LSAC) conducted in 2014 when the Kinder (K) Cohort was aged 14 to 15 years. Details of the study design and sampling procedure are described elsewhere (Soloff, Lawrence, & Johnstone, 2005). In brief, the study used a two-stage clustered sample design based on Australian postcodes stratified by state of residence and urban versus rural, and random selection using the Medicare database. The study was approved by the Australian Institute of Family Studies ethics committee and written informed consent was obtained from the participants' parent or guardian. For the K cohort, 4,983 children were recruited at age 4 to 5 years (59% response rate) with 3,537 (71%) retained at Wave 6 (i.e. the current sample). The Birth (B) cohort is younger, having been recruited at 0-1 years of age, and is not included in the current study as they were not administered the eating disorders measure during Wave 6.

Measures

A revised version of the Branched Eating Disorders Test (BET; Selzer, Hamill, Bowes, & Patton, 1996) was used to assess eating disorder symptoms over the past 3 months. The BET consists of 9 stem items branching out to a maximum of 31 item. The items map closely onto symptoms of AN and BN as defined in the Diagnostic and Statistical Manual of Mental

Disorders (DSM). Minor revisions were made to the original BET (which had consisted of 10 stem items and a maximum of 27 items) to ensure consistency with the current DSM-5 AN and BN criteria, and to clarify wording. Specifically, the two stem items inquiring about laxative and diuretic use were collapsed into a single stem item (i.e., “*Over the LAST 4 WEEKS have you taken any tablets, medicines or drugs in order to control your weight?*”) with endorsement branching into questions regarding which substances were used (i.e., laxative, diuretics, appetite suppressants, other drugs), the frequency, duration, and amount. The excessive exercise questions were reworded from “*exercised vigorously...(i.e., any exercise involving heavy breathing, puffing or panting)*” to “*exercised hard (i.e., heavy breathing)*” and an additional branched item assessed time spent exercising hard. The original BET was validated in a community sample of adolescent girls and demonstrated high sensitivity and specificity for identifying eating disorder cases (Selzer et al., 1996). It has subsequently been used in several large studies of adolescents including the Health of Young Victorians Study (n ≈ 1,000; Mathers, Canterford, Wake, Hesketh, & Olds, 2007), ‘HowRU’ Adolescent Health and Wellbeing Survey (n ≈ 10,000; Thomas et al., 2018) and Victorian Adolescent Health Cohort Study (n ≈ 2,000; Patton, Coffey, & Sawyer, 2003). Table 1 shows the criteria used to identify DSM-5 symptoms of AN and BN using the BET.

Weight and height were assessed by trained researchers during 90-minute home visits (Australian Institute of Family Studies, 2018). Weight was measured in light clothing to the nearest 0.10 kg using Tanita electronic scales. Before being weighed, participants were asked to remove their shoes and any heavy clothing and to take any heavy items out of their pockets. Height was measured to the nearest 0.1 cm using a stadiometer. Before being

measured for height, the adolescent was asked to remove shoes and any hair ornaments. Height was measured twice; if the two measurements differed by ≥ 0.5 cm, a third measurement was taken. The final recorded height was the average of the two closest measurements. BMI was calculated (kg/m^2) and converted to z-scores using the Center for Disease Control and Prevention Growth Charts (2000). The sample was divided into four weight categories (underweight, normal, overweight, obese) based on cut-points recommended by Cole (2000; 2007) which provide age- and sex-specific equivalents to adult BMI cut-points of $18.5 \text{ kg}/\text{m}^2$ for underweight, $25 \text{ kg}/\text{m}^2$ for overweight and $30 \text{ kg}/\text{m}^2$ for obesity.

Socioeconomic status was assessed using the neighborhood-level Socioeconomic Indexes for Areas (SEIFA) disadvantage score (Australian Bureau of Statistics, 2011). The SEIFA score is derived from Australian Bureau of Statistics census data and uses participants' residential postcode to broadly summarize neighborhood social and economic conditions. This measure is standardized to have a mean of 1000 and SD of 100, with low scores indicating the greater disadvantage.

During Wave 1 the child's parent reported their own and their child's country of birth. In addition, during Wave 6 the study child indicated whether a language other than English was spoken at home.

Statistical Analysis

Participants were required to have height and weight data to be included in the analyses. The distribution of BMI z-scores was examined to rule out erroneous data. Weight

status groups were compared on demographics using p-for-trend analyses. The frequency of each of the DSM-5 AN and BN symptoms as assessed by the BET was calculated for the sample as a whole and by sex. The estimated overall population prevalence for each symptom was then calculated based on a population size of 232,251 (male population size: 121,568; female population size: 110,683). For population prevalence estimates, analyses used cross-sectional population weights. These weights adjust the Wave 6 LSAC sample to be representative of the population-representative sample who took part in Wave 1 (Australian Institute of Family Studies, 2015; Norton & Monahan, 2015). By taking differential non-response patterns into account, these weights are intended to produce population estimates.

The prevalence of each AN and BN symptom was next estimated by weight status and sex with percentages indicating the prevalence within each weight status subgroup (e.g., % of underweight adolescent who have AN Symptom 1) and estimated population prevalence (e.g., % of the population that is both underweight and has AN Symptom 1). In addition, the population prevalence of AN and BN were estimated by examining how many adolescents met both symptoms of AN as outlined in Table 1 and were underweight, and how many adolescents met all three symptoms for BN as outlined in Table 1 and were not underweight.

Prevalence by weight status was estimated for the whole population and within weight subgroups. The former estimates the proportion of adolescents who are of a specified weight and have that symptom (e.g., percentage of Australian adolescents who are both underweight and have AN Symptom 1), giving an indication of the relative distribution across the whole population. The latter estimates what proportion of adolescents of a specified weight status have that symptoms (e.g., the percentage of underweight Australian adolescents who have

AN Symptom 1), giving an indication of the prevalence of symptoms within weight categories.

Results

Sample

After exclusion of missing or erroneous weight or height data, the final analytic sample comprised 3,270 adolescents with a mean age of 14.4 years (SD = 0.5). The sample characteristics are shown in Table 2. Around half the sample was male ($n = 1,691$; 52%) and most spoke English at home ($n = 2,954$; 90%). Few participants were born outside Australia ($n = 133$; 4%), but many had a mother ($n = 1,161$; 36%) or a father ($n = 1,912$; 58%) who was born outside Australia. Of the total sample, 202 (6.2%) were underweight, 2,194 (67.1%) were normal weight, 640 (19.6%) were overweight, and 234 (7.2%) were obese. Although there were no sex or age differences by weight status, higher weight was associated with lower SES ($p < .001$).

Overall Prevalence

Table 3 shows the estimated population prevalence of AN and BN symptoms in the past 3 months based on the total sample and by sex. For AN symptoms, the estimated population prevalence was 14.3% for fear of weight gain or the presence of behaviours interfering with weight gain (AN Symptom 1), and 25.7% for disturbance in the experience of body weight or overvaluation of body weight (AN Symptom 2). Behaviours interfering with weight gain included: self-inducing vomiting at least weekly; taking tablets, medicines

or drugs at least weekly; fasting (12+ hours) at least 4 days per week; excessive exercise (2+ hours) at least 6 days per week. Estimated prevalence of AN Symptoms 1 and 2 were lower for boys (7.6%, 16.0%) than girls (21.7%, 36.3%). Overall, the estimated population prevalence of having both AN Symptoms 1 and 2 was 9.5% (3.4% boys; 16.1% girls). The presence of both symptoms in adolescents who were underweight gave an estimated population prevalence for AN of 0.20% (0% boys; 0.42% girls).

For BN symptoms, the estimated population prevalence was 0.5% for regular binge eating (BN Symptom 1), 17.0% for overvaluation of weight for sense of self (BN Symptom 2) and 3.7% for regular engagement in compensatory behaviours (BN Symptom 3). Estimated prevalence of BN Symptoms 1 and 2 were lower for boys (0.3%, 10.8%) than girls (0.7%, 23.8%), while the prevalence of BN Symptom 3 was similar for boys (3.9%) and girls (3.6%). The presence of all three BN symptoms in adolescents who were not underweight resulted in an estimated population prevalence for BN of 0.10% (0% boys; 0.21% girls).

Prevalence by Weight Status

Table 3 also shows the estimated population prevalence of AN and BN symptoms in the past 3 months across the weight categories and by sex. Adolescents with overweight or obesity had the highest occurrence of AN Symptom 1, with an estimated 24.5% of adolescents with overweight and 22.5% of adolescents with obesity having fear of weight gain or behaviours interfering with weight gain. This was even higher for girls with overweight or obesity at 35.7% and 30.0%, respectively. AN Symptom 2 had the highest occurrence among adolescents who were underweight with 47.8% estimated to have a

disturbance in the experience of body weight or overvaluation of body weight. This was mainly attributable to more frequent overestimation of body size, with 41% of adolescents who were underweight rating themselves “about the right weight” or larger. Among adolescents with normal weight, 11.2% had fear of weight gain or the presence of behaviours interfering with weight gain (AN Symptom 1) and 24.6% had disturbance in the experience of body weight or overvaluation of body weight (AN Symptom 2).

Adolescents with overweight or obesity had the highest occurrence of BN symptoms. The estimated prevalence of regular binge eating (BN Symptom 1) was 1.2% for adolescents with overweight and 1.7% for adolescents with obesity. The estimated prevalence of overvaluation of weight for sense of self (BN Symptom 2) was 21.3% for adolescents with overweight and 22.4% for adolescents with obesity. The estimated prevalence of regular engagement in compensatory behaviours (BN Symptom 3) was 7.0% for adolescents with overweight and 4.4% for adolescents with obesity. Notably, unlike most other symptoms, compensatory behaviours tended to be equally or more prevalent among boys. This was attributable to more boys engaging in excessive exercise. Among adolescents with normal weight, the estimated prevalence of regular binge eating (BN Symptom 1) was 0.3%, while the estimated prevalence of overvaluation of weight for sense of self (BN Symptom 2) was 15.8%. The estimated prevalence of regular engagement in compensatory behaviours (BN Symptom 3) among adolescents who were underweight was 2.9%. The estimated population prevalence of BN (i.e., all three BN symptoms combined) was highest for adolescent girls with overweight at 0.7%.

Discussion

Eating disorder symptoms are common among 14- to 15-year-old Australians.

Although body image related symptoms tend to be the most prevalent (e.g., fear of weight gain, overvaluation of weight), behavioural symptoms are also relatively common (e.g., compensatory behaviours such as vomiting and excessive exercise) particularly among adolescents with overweight and obesity. These results are especially concerning given the increased prevalence of overweight and obesity and indicate a higher population burden of eating disorders that may go unrecognised. The findings suggest a need for greater prevention and intervention efforts in childhood and adolescence, and highlight the need for clinicians to be cognisant of disordered eating behaviours regardless of weight status.

The estimated prevalence of AN in this study (0.2% of the population and 0.4% of girls) was similar to that reported in previous population-based studies conducted around a decade earlier using face-to-face and questionnaire measures that allowed for assessment of specific diagnostic criteria (Allen et al., 2009; Swanson et al., 2011) and other studies using the BET (Patton, Selzer, Coffey, Carlin, & Wolfe, 1999; Selzer et al., 1996). Of note, the two DSM-5 criteria for AN assessed by the BET in this study were each remarkably common, especially when stratified by weight status. For example, it was estimated that 14% of all adolescents and 36% of girls with overweight experienced a fear of weight gain or engaged in behaviours interfering with weight gain (e.g., fasting, self-induced vomiting, and excessive exercise) at a clinically significant frequency. The second criterion was even more common, with 26% of all adolescents overestimating their body size or overvaluing body weight or shape for their self-worth. Of interest, this symptom was highest for girls who were

underweight, at 63%. This was mostly due to girls not identifying their body weight as being underweight, but instead reporting it to be ‘about right’ or larger. This finding may reflect internalisation of the thin ideal whereby a person adopts the belief promoted in Western society that underweight bodies are the most desirable (Thompson & Stice, 2001). The pervasiveness of the thin ideal is likely a large contributor to the high prevalence of fear of weight gain, unhealthy weight control behaviours and overvaluation of weight and shape observed in this study. Indeed, the experience of these symptoms is so common it has been referred to as “normative discontent” (Rodin, Silberstein, & Striegel-Moore, 1984). Although having one of these symptoms is common and does not equate to a full syndrome eating disorder, they can pose risk for depression, binge eating, weight gain and persisting disordered eating (Neumark-Sztainer et al., 2012; Sinton & Birch, 2006; Sonnevile et al., 2015; Stice, Hayward, Cameron, Killen, & Taylor, 2000).

The overall estimated prevalence of BN in this study (0.1%) was similar to other studies using the BET (Patton et al., 1999; Selzer et al., 1996) but somewhat lower than that reported in other population studies (Allen et al., 2009; Swanson et al., 2011). This may be due to BN having a later peak age of onset (Smink et al., 2012). Nonetheless, BN symptoms were remarkably prevalent. Clinically significant binge eating was estimated at 0.5% of all adolescents, rising to 2.4% among boys with obesity. This behaviour was defined as eating large amounts of food (i.e., at least the equivalent of 8 pieces of bread and half a litre of ice-cream and 5 biscuits) while experiencing a loss of control (i.e., finding it very difficult or impossible to stop eating), and for this to have occurred at least weekly during the last 3 months. The reported prevalence may actually be an underestimate, given that the examples

(e.g. 8 pieces of bread) may have been difficult for some participants to generalise to other types of food they consume. Questionnaires used in this type of research incorporate various descriptors of binge eating which also makes comparisons especially difficult. For example, the EDE-Q refers to “what other people would regard as an unusually large amount of food” (Fairburn & Belgin, 2008), while others do not use a frequency threshold and instead include any occurrence of binge eating (e.g., Loth, Wall, et al., 2015). The more stringent criteria used in this study make the findings all the more striking. The second BN symptom, overvaluation of weight and shape for self-worth was particularly prevalent, with 17% of all adolescents and 33% of girls with obesity endorsing this symptom. Of importance, overvaluation of weight has been shown to predict the onset of binge eating in girls who are overweight, and to be associated with greater depressive symptoms (Sinton & Birch, 2006; Sonnevile et al., 2015).

The final BN symptom assessed was regular use of compensatory behaviours. The estimated prevalence of this symptom was 4% of the population, with the highest prevalence estimated to be among girls and boys with overweight (both 7%). While some studies have reported higher prevalence, these studies tend not to apply DSM-5 criteria to identify clinically significant symptomatology. For example, Nagata and colleagues (2018) reported that 22.7% of girls with overweight engaged in unhealthy weight control behaviours. However, this included any occurrence of the following behaviours during the past 7 days: fasting, skipping meals, self-induced vomiting, or use of weight loss pills, diuretics, or laxatives. In contrast, for the current study, this BN symptom was defined as self-induced vomiting at least once a week, not eating for more than 12 hours for at least 4 days a week,

hard exercise at least 2 hours a day for at least 6 days a week, or taking medications to lose weight at least weekly. Although any occurrence of unhealthy weight loss behaviours may warrant attention, the symptoms as defined herein are more aligned with the clinically significant BN symptoms defined in the DSM-5, giving a more accurate basis for estimates of population prevalence.

This study highlights the high prevalence of eating disorder symptoms among Australian adolescents aged 14 to 15 years across the weight spectrum, and aligns with previous large international studies of adolescents conducted around a decade earlier. The study has several strengths, most prominently the use of a large, representative sample of adolescents, and objective measurement of height and weight. Prevalence was estimated for the overall population and within weight categories, as well as for weight and eating disorder symptoms combined. This allows more flexible and meaningful comparison across studies when considering the burden of eating disorder symptoms in the adolescent population. The narrow age range of the sample is also a strength as it allowed prevalence to be estimated at a more specific developmental period relevant to the development of AN and BN than has been the case in many other previous studies which have included a broader age range. Importantly, the use of an eating disorder measure which assessed specific DSM-5 diagnostic criteria stands in contrast to most other prevalence studies which have attempted to identify likely eating disorder cases by applying a cut-off score to continuous symptom measures, or having a lower threshold for intensity and frequency of disordered eating behaviour. In doing so, such methods typically result in much higher prevalence estimates (Torstveit, Aagedal-

Mortensen, & Stea, 2015; Vega Alonso, Rasillo Rodriguez, Lozano Alonso, Rodriguez Carretero, & Martin, 2005).

Despite this, the measure used in the current study also has limitations. First, the BET is a self-report computer-administered questionnaire which may not have the same level of rigour as a standardised clinical interview. However, the BET has been shown to have high sensitivity and specificity for identifying eating disorder cases in a non-clinical sample (Selzer et al., 1996). An additional limitation was that the total prevalence of eating disorders inclusive of all diagnostic groups was not able to be estimated as the BET did not assess DSM-5 eating disorders other than AN and BN (i.e., BED, avoidant/restrictive food intake disorder (ARFID), atypical AN). Young people with these other disorders often have significant physical and psychological morbidity (Norris et al., 2014; Sawyer, Whitelaw, Le Grange, Yeo, & Hughes, 2016). As such this study will underestimate the overall burden of eating disorders in Australian adolescents. The measurement of weight status (i.e., BMI) is also limited as it does not account for muscle mass and bone density and thus does not give a particularly accurate representation of adiposity.

These limitations aside, the study makes an important contribution to our understanding of clinically significant symptoms of AN and BN across the weight spectrum and highlights the need to be vigilant regarding eating disorder symptoms. Of importance, when clinical judgement is over-reliant on physical appearance, there is a risk of bias toward underweight appearance being associated with restrictive eating and purging, and overweight appearance with overeating and a lack of exercise. Similarly, the need for some attention to weight in the context of overall health may detract from identifying preoccupation with weight that

warrants clinical attention, especially in people who are overweight and obese and may be expected to have heightened weight concerns. Further, although in this study eating disorder symptoms tended to be more prevalent among girls, boys with obesity tended to have higher prevalence of binge eating and excessive exercise than their female counterparts. Clinicians' biases regarding who is vulnerable to eating disorder symptoms combined with the current diagnostic criteria (e.g., underweight criterion for AN) may lead to under-diagnosis and delayed treatment (Sim, Lebow, & Billings, 2013; Sonnevile & Lipson, 2018). This study reinforces that clinicians need to be aware of such biases and the limitations of current diagnostic criteria, and ensure they consider and enquire about eating disorder symptoms regardless of weight and sex.

Also of relevance to the current study are obesity-focused interventions and policies. In an effort to reduce the health risks associated with obesity, many universal and targeted obesity interventions and public health campaigns have been developed for both adults and children. For some vulnerable young people, the increased frequency of weight loss promotion and anti-obesity messaging in today's culture, whether targeted at them or not, may foster or exacerbate unhealthy attitudes and behaviours. This may be especially so when these messages are weight-related rather than health focused, or are developmentally inappropriate. While some weight control efforts might be perceived to be appropriate for adolescents with overweight or obesity, the extreme behaviours examined in the current study pose significant risks for their health. Furthermore, although well designed and implemented weight management interventions for children and adolescents have not been shown to be harmful, individual negative effects are often poorly assessed and rarely reported (Carter &

Bulik, 2008). The high prevalence of eating disorder symptoms demonstrated in this study reinforces the need for awareness of the potential risks associated with anti-obesity messaging, and for careful ongoing monitoring for negative impacts to be a critical component of weight management interventions.

In sum, this study provides important contemporary data on the prevalence of clinically significant symptoms of AN and BN in the Australian adolescent population that can be used to assess public healthcare needs and track change in prevalence over time. Furthermore, the study highlights the importance of examining eating disorder symptom prevalence in relation to weight status and sex, and for clinicians to be vigilant of making assumptions about disordered eating based on appearance. Extrapolation of the findings to a broader spectrum of eating disorders, including BED and ARFID, will form an important next step for research in this area.

References

- Allen, K. L., Byrne, S. M., Forbes, D., & Oddy, W. H. (2009). Risk factors for full- and partial-syndrome early adolescent eating disorders: a population-based pregnancy cohort study. *Journal of the American Academy of Child and Adolescent Psychiatry*, 48(8), 800-809. doi: 10.1097/CHI.0b013e3181a8136d
- Australian Bureau of Statistics. (2011). Socio-Economic Indexes for Areas (SEIFA). Technical paper 2033.0.55.001. Canberra, Australia: Commonwealth of Australia.
- Australian Institute of Family Studies. (2015). Longitudinal Study of Australian Children Data User Guide - November 2015. Melbourne: Australian Institute of Family Studies.
- Australian Institute of Family Studies. (2018). Instruments - Data user guide - Growing Up in Australia: The Longitudinal Study of Australian Children (LSAC). <http://www.growingupinaustralia.gov.au/data/docs/userguide/3-instruments.html>
- Carter, F. A., & Bulik, C. M. (2008). Childhood obesity prevention programs: How do they affect eating pathology and other psychological measures? *Psychosom Med*, 70(3), 363-371. doi: 10.1097/PSY.0b013e318164f911
- Centers for Disease Control and Prevention. (2000). Clinical Growth Charts. from www.cdc.gov
- Cleland, R. L., Gross, W. C., Koss, L. D., Daynard, M., & Muoio, K. M. (2002). Weight-loss advertising: An analysis of recent trends. Rockville, MD: Fair Trade Commission.

- Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal*, 320(7244), 1240.
- Cole, T. J., Flegal, K. M., Nicholls, D., & Jackson, A. A. (2007). Body mass index cut offs to define thinness in children and adolescents: international survey. *British Medical Journal*, 335(7612), 194.
- Darby, A., Hay, P., Mond, J., Quirk, F., Buttner, P., & Kennedy, L. (2009). The rising prevalence of comorbid obesity and eating disorder behaviors from 1995 to 2005. *International Journal of Eating Disorders*, 42(2), 104-108. doi: 10.1002/eat.20601
- Deloitte Access Economics. (2012). Paying the Price: economic and social impact of eating disorders report: The Butterfly Foundation.
- Duncan, A. E., Ziobrowski, H. N., & Nicol, G. (2017). The prevalence of past 12-month and lifetime DSM-IV eating disorders by BMI category in US men and women. *European Eating Disorders Review*, 25(3), 165-171. doi: 10.1002/erv.2503
- Erskine, H. E., Whiteford, H. A., & Pike, K. M. (2016). The global burden of eating disorders. *Current Opinion in Psychiatry*, 29(6), 346-353. doi: 10.1097/YCO.0000000000000276
- Fairburn, C. G., & Belgin, S. (2008). Eating Disorder Examination Questionnaire (EDE-Q 6.0). UK: University of Oxford.
- Fan, Y., Li, Y., Liu, A., Hu, X., Ma, G., & Xu, G. (2010). Associations between body mass index, weight control concerns and behaviors, and eating disorder symptoms among non-clinical Chinese adolescents. *BMC Public Health*, 10, 314.

- Garner, D. M., & Garfinkel, P. E. (1979). The Eating Attitudes Test: An index of the symptoms of anorexia nervosa. *Psychological Medicine*, 9(2), 273-279.
- Garner, D. M., Olmsted, M., & Polivy, J. (1983). *Eating Disorder Inventory manual*. Odessa, FL: Psychological Assessment Resources.
- Kass, A. E., Jones, M., Kolko, R. P., Altman, M., Fitzsimmons-Craft, E. E., Eichen, D. M., . . . Wilfley, D. E. (2017). Universal prevention efforts should address eating disorder pathology across the weight spectrum: Implications for screening and intervention on college campuses. *Eating Behaviors*, 25, 74-80. doi: 10.1016/j.eatbeh.2016.03.019
- Le Grange, D., O'Connor, M., Hughes, E. K., Macdonald, J., Little, K., & Olsson, C. A. (2014). Developmental antecedents of abnormal eating attitudes and behaviours in adolescence. *International Journal of Eating Disorders*, 47(7), 812-824. doi: 10.1002/eat.22331
- Lipson, S. K., & Sonnevile, K. R. (2017). Eating disorder symptoms among undergraduate and graduate students at 12 U.S. colleges and universities. *Eating Behaviors*, 24, 81-88. doi: 10.1016/j.eatbeh.2016.12.003
- Loth, K., Wall, M., Larson, N., & Neumark-Sztainer, D. (2015). Disordered eating and psychological well-being in overweight and nonoverweight adolescents: secular trends from 1999 to 2010. *International Journal of Eating Disorders*, 48(3), 323-327.
- Loth, K. A., Watts, A. W., van den Berg, P., & Neumark-Sztainer, D. (2015). Does body satisfaction help or harm overweight teens? A 10-year longitudinal study of the relationship between body satisfaction and body mass index. *Journal of Adolescent Health*, 57(5), 559-561. doi: 10.1016/j.jadohealth.2015.07.008

- Mathers, M., Canterford, L., Wake, M., Hesketh, K., & Olds, T. (2007). Heath of Young Victorians Study (HOYVS) 2005 Report. Melbourne: Royal Children's Hospital.
- Morgan, J. F., Reid, F., & Lacey, J. H. (1999). The SCOFF questionnaire: Assessment of a new screening tool for eating disorders. *British Medical Journal of Australia*, 319, 1467-1468.
- Nagata, J. M., Garber, A. K., Tabler, J. L., Murray, S. B., & Bibbins-Domingo, K. (2018). Prevalence and correlates of disordered eating behaviors among young adults with overweight or obesity. *Journal of General Internal Medicine*, 33(8), 1337-1343. doi: 10.1007/s11606-018-4465-z
- Neumark-Sztainer, D., Wall, M., Story, M., & Standish, A. R. (2012). Dieting and unhealthy weight control behaviors during adolescence: Associations with 10-year changes in body mass index. *Journal of Adolescent Health*, 50(1), 80-86. doi: 10.1016/j.jadohealth.2011.05.010
- Norris, M. L., Robinson, A., Obeid, N., Harrison, M., Spettigue, W., & Henderson, K. (2014). Exploring avoidant/restrictive food intake disorder in eating disordered patients: A descriptive study. *International Journal of Eating Disorders*, 47(5), 495-499.
- Norton, A., & Monahan, K. (2015). *Growing Up in Australia: The Longitudinal Study of Australian Children (LSAC). Technical paper No.15, Wave 6 Weighting and Non-Response*. Canberra, Australia: Australian Bureau of Statistics.

- Norton, K., Dollman, J., Martin, M., & Harten, N. (2006). Descriptive epidemiology of childhood overweight and obesity in Australia: 1901-2003. *Int J Pediatr Obes*, 1(4), 232-238.
- O'Dea, J. A., & Amy, N. K. (2011). Perceived and desired weight, weight related eating and exercising behaviours, and advice received from parents among thin, overweight, obese or normal weight Australian children and adolescents. *The International Journal of Behavioral Nutrition and Physical Activity*, 8, 68. doi: 10.1186/1479-5868-8-68
- Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V. A., O'Malley, C., Stolk, R. P., & Summerbell, C. D. (2009). Interventions for treating obesity in children. *Cochrane Database of Systematic Reviews*(1). doi: 10.1002/14651858.CD001872.pub2
- Patton, G. C., Coffey, C., & Sawyer, S. M. (2003). The outcome of adolescent eating disorders: findings from the Victorian Adolescent Health Cohort Study. *European Child & Adolescent Psychiatry*, 12, 125.
- Patton, G. C., Selzer, R., Coffey, C., Carlin, J. B., & Wolfe, R. (1999). Onset of adolescent eating disorders: Population based cohort study over 3 years. *British Medical Journal*, 318(7186), 765-768.
- Rodin, J., Silberstein, L., & Striegel-Moore, R. (1984). Women and weight: A normative discontent. *Nebraska Symposium on Motivation*, 32, 267-307.
- Sawyer, S. M., Whitelaw, M., Le Grange, D., Yeo, M., & Hughes, E. K. (2016). Physical and psychological morbidity in adolescents with atypical anorexia nervosa. *Pediatrics*, 137(4), e20154080. doi: 10.1542/peds.2015-4080

- Selzer, R., Hamill, C., Bowes, G., & Patton, G. (1996). The Branched Eating Disorders Test: Validity in a nonclinical population. *International Journal of Eating Disorders*, 20(1), 57-64.
- Sim, L. A., Lebow, J., & Billings, M. (2013). Eating disorders in adolescents with a history of obesity. *Pediatrics*, 132(4), e1026-e1030. doi: 10.1542/peds.2012-3940
- Sinton, M. M., & Birch, L. L. (2006). Individual and sociocultural influences on pre-adolescent girls' appearance schemas and body dissatisfaction. *Journal of Youth and Adolescence*, 35(2), 157-167. doi: 10.1007/s10964-005-9007-4
- Smink, F. R. E., van Hoeken, D., & Hoek, H. W. (2012). Epidemiology of eating disorders: Incidence, prevalence and mortality rates. *Current Psychiatry Reports*, 14(4), 406-414. doi: 10.1007/s11920-012-0282-y
- Soloff, C., Lawrence, D., & Johnstone, R. (2005). *Sample design, LSAC Technical Paper no. 1*. Melbourne: Australian Institute of Family Studies.
- Sonneville, K. R., Grilo, C. M., Richmond, T. K., Thurston, I. B., Jernigan, M., Gianini, L., & Field, A. E. (2015). Prospective association between overvaluation of weight and binge eating among overweight adolescent girls. *Journal of Adolescent Health*, 56(1), 25-29. doi: 10.1016/j.jadohealth.2014.08.017
- Sonneville, K. R., & Lipson, S. K. (2018). Disparities in eating disorder diagnosis and treatment according to weight status, race/ethnicity, socioeconomic background, and sex among college students. *International Journal of Eating Disorders*, 51(6), 518-526. doi: 10.1002/eat.22846

- Stice, E., Hayward, C., Cameron, R. P., Killen, J. D., & Taylor, C. B. (2000). Body-image and eating disturbances predict onset of depression among female adolescents: a longitudinal study. *Journal of Abnormal Psychology, 109*(3), 438-444.
- Stice, E., Presnell, K., Shaw, H., & Rohde, P. (2005). Psychological and behavioral risk factors for obesity onset in adolescent girls: A prospective study. *Journal of Consulting and Clinical Psychology, 73*(2), 195-202. doi: 10.1037/0022-006X.73.2.195
- Summerbell, C. D., Ashton, V., Campbell, K. J., Edmunds, L., Kelly, S., & Waters, E. (2003). Interventions for treating obesity in children. *Cochrane Database of Systematic Reviews*(3). doi: 10.1002/14651858.CD001872
- Swanson, S. A., Crow, S. J., Le Grange, D., Swendsen, J., & Merikangas, K. R. (2011). Prevalence and correlates of eating disorders in adolescents: Results from the national comorbidity survey replication adolescent supplement. *Archives of General Psychiatry, 68*(7), 714-723. doi: 10.1001/archgenpsychiatry.2011.22
- Thomas, R. L., Kelly, A. B., Chan, G. C. K., Hides, L. M., Quinn, C. A., Kavanagh, D. J., & Williams, J. W. (2018). An examination of gender differences in the association of adolescent substance use with eating and weight loss attitudes. *Substance Use & Misuse, 53*(13), 2125-2131. doi: 10.1080/10826084.2018.1455703
- Thompson, J. K., & Stice, E. (2001). Thin-ideal internalization: Mounting evidence for a new risk factor for body-image disturbance and eating pathology. *Current Directions in Psychological Science, 10*(5), 181-183. doi: 10.1111/1467-8721.00144

Torstveit, M. K., Agedal-Mortensen, K., & Stea, T. H. (2015). More than half of high school students report disordered eating: a cross sectional study among Norwegian boys and girls. *PLoS ONE*, 10(3), e0122681.

Vega Alonso, A. T., Rasillo Rodriguez, M. A., Lozano Alonso, J. E., Rodriguez Carretero, G., & Martin, M. F. (2005). Eating disorders. Prevalence and risk profile among secondary school students. *Social Psychiatry and Psychiatric Epidemiology*, 40(12), 980-987.

Ximena Ramos, S. (2015). The ineffectiveness and unintended consequences of the public health war on obesity. *Canadian Journal of Public Health*, 106(2), e79-e81.

Availability of Data

The datasets analysed during the current study are available in the Australian Data Archive repository, <https://dataverse.ada.edu.au/dataverse/lsac>

Table 1

Criteria for Symptom Identification Using the Branched Eating Disorders Test

Symptom	Criteria
Anorexia Nervosa Symptoms	
1. Fear of gaining weight, or behaviours that interfere with weight gain	Reported at least ONE of the following behaviours, lasting at least 3 months: Self-inducing vomiting to control weight at least weekly; taking tablets, medicines or drugs to control weight at least weekly; fasting to control weight at least 4 days per week; excessive exercise (2+ hours) to control weight at least 6 days per week. OR Reported being “very” or “extremely” concerned about gaining weight.
2. Disturbance in experience of body weight, or overvaluation of weight	Weight rated as “very important” to how they feel about themselves. OR If underweight: Rated themselves as “about the right weight”, “somewhat overweight” or “very overweight” If normal weight: Rated themselves as “somewhat overweight” or “very overweight” If overweight: Rated themselves as “very overweight” If obese: Could not be rated
Bulimia Nervosa Symptoms	
1. Regular binge eating	Reported experiencing a loss of control over eating or overeating at least weekly for the last 3 months AND Reported that it is “very difficult” or “impossible” to stop eating after starting to eat in this way AND That the amount of food eaten in a 2-hour period is equivalent to “8 pieces of bread and half a litre of ice-cream and 5 biscuits” OR “12 pieces of bread and 1 litre of ice-cream and 10 biscuits” OR “1 loaf of bread and 2 litres of ice-cream and 1 packet of biscuits”.
2. Overvaluation of weight	Rated their weight as “very important” to how they feel about themselves.

3. **Regular engagement in compensatory behaviours** Reported at least ONE of the following, lasting at least 3 months: Self-inducing vomiting to control weight at least weekly; taking tablets, medicines or drugs to control weight at least weekly; fasting to control weight at least 4 days per week; excessive exercise (2+ hours) to control weight at least 6 days per week.
-

Table 2

Characteristics of the Sample by Weight Status

	Total		Weight Status				Significance ^d
	N=3270		Underweight n=202	Normal weight n=2194	Overweight n=640	Obese n=234	
	M (SD)	Range	M (SD)	M (SD)	M (SD)	M (SD)	
Boys (n, %)	1691 (52%)	-	106 (52%)	1135 (52%)	316 (49%)	134 (57%)	p=.63
Age, years	14.4 (0.5)	14-15	14.4 (0.5)	14.4 (0.5)	14.4 (0.5)	14.4 (0.5)	p=.37
BMI z-score ^a	0.4 (1.0)	-6.1-2.9	-1.8 (0.7)	0.1 (0.6)	1.4 (0.2)	2.1 (0.2)	p<.001
SEIFA disadvantage score ^b	1014.7 (72.8)	722-1186	1015.2 (75.4)	1018.2 (72.0)	1013.4 (72.7)	985.3 (71.2)	p<.001

Notes.

^a Based on CDC Growth Charts; ^b Low score indicates most disadvantaged. ^d p-for-trend analysis, except sex which was tested using ordinal regression.

Table 3

Estimated Prevalence of Eating Disorder Symptoms in Population and by Weight Status

Total			Weight Status Subgroups								
			Estimated Population Prevalence ^c				Estimated Prevalence within Subgroup ^d				
Sample n N=3,270 ^a Estimated Population Prevalence ^b			Under- weight	Normal weight	Overweight	Obese	Under- weight	Normal weight	Overweight	Obese	
Anorexia Nervosa Symptoms											
1.	Fear of gaining weight, or behaviours that interfere with weight gain	454	14.31%	0.20%	7.28%	4.92%	1.91%	3.17%	11.19%	24.47%	22.47%
	Boys	121	7.58%	0.00%	3.40%	2.63%	1.55%	0.00%	5.22%	13.52%	16.75%
	Girls	333	21.69%	0.42%	11.55%	7.43%	2.30%	6.56%	17.73%	35.72%	30.02%
2.	Disturbance in experience of body weight, or overvaluation of weight	839	25.65%	3.03%	16.01%	4.72%	1.9%	47.80%	24.60%	23.46%	22.39%
	Boys	269	15.95%	2.11%	9.95%	2.58%	1.31%	33.75%	15.30%	13.25%	14.16%
	Girls	570	36.30%	4.03%	22.66%	7.06%	2.55%	62.85%	34.79%	33.95%	33.28%
Symptoms 1 and 2		303	9.46%	0.20%	5.34%	2.85%	1.07%	3.17%	8.21%	14.20%	12.56%
	Boys	55	3.41%	0.00%	1.84%	1.00%	0.57%	0.00%	2.84%	5.13%	6.18%
	Girls	248	16.10%	0.42%	9.18%	4.89%	1.61%	6.56%	14.09%	23.53%	21.00%
Bulimia Nervosa Symptoms											
1.	Binge eating	18	0.54%	0.00%	0.16%	0.24%	0.14%	0.00%	0.25%	1.18%	1.66%

	Total		Weight Status Subgroups							
	Sample n N=3,270 ^a	Estimated Population Prevalence ^b	Estimated Population Prevalence ^c				Estimated Prevalence within Subgroup ^d			
			Under- weight	Normal weight	Overweight	Obese	Under- weight	Normal weight	Overweight	Obese
Boys	5	0.38%	0.00%	0.04%	0.11%	0.22%	0.00%	0.06%	0.58%	2.41%
Girls	13	0.72%	0.00%	0.30%	0.37%	0.05%	0.00%	0.46%	1.79%	0.67%
2. Overvaluation of weight	560	17.02%	0.54%	10.30%	4.28%	1.90%	8.57%	15.82%	21.31%	22.39%
Boys	185	10.84%	0.31%	6.71%	2.51%	1.31%	4.91%	10.32%	12.91%	14.16%
Girls	375	23.80%	0.80%	14.23%	6.22%	2.55%	12.50%	21.84%	29.93%	33.28%
3. Engagement in compensatory behaviours	114	3.72%	0.06%	1.89%	1.40%	0.37%	0.94%	2.90%	6.98%	4.40%
Boys	64	3.88%	0.00%	2.01%	1.32%	0.55%	0.00%	3.09%	6.79%	5.98%
Girls	50	3.55%	0.12%	1.75%	1.49%	0.18%	1.95%	2.69%	7.18%	2.30%
Symptoms 1, 2 and 3	3	0.10%	0.00%	0.03%	0.07%	0.00%	0.00%	0.04%	0.37%	0.00%
Boys	0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Girls	3	0.21%	0.00%	0.06%	0.15%	0.00%	0.00%	0.09%	0.74%	0.00%

^aTotal boys in sample: 1691; Total girls in sample 1579

^bBased on a population size of 232,251 (male population size: 121,568; female population size: 110,683).

^cFor example, 0.20% of the population is underweight and has Anorexia Nervosa Symptom 1

^dFor example, 3.17% underweight adolescents have Anorexia Nervosa Symptom 1