European Child & Adolescent Psychiatry (2019) 28:1507–1516
https://doi.org/10.1007/s00787-019-01314-8

ORIGINAL CONTRIBUTION

Body dissatisfaction and weight control behaviour in children with ADHD: a population-based study

Matthew Bisset[1,2] · **Nicole Rinehart**[1] · **Emma Sciberras**[1,2,3]

Received: 21 October 2018 / Accepted: 9 March 2019 / Published online: 19 March 2019

Abstract

Although attention-deficit/hyperactivity disorder (ADHD) is associated with eating disorders (EDs), it is unclear when ED risk emerges in children with ADHD. We compared differences in body dissatisfaction and weight control behaviour in children with/without ADHD aged 12–13 years concurrently, and when aged 8–9 and 10–11 years, to determine when risk emerges. We also examined differences by ADHD medication status at each age. This study uses waves 1–5 from the Longitudinal Study of Australian Children ($n = 2323$–2972). ADHD (7.7%) was defined at age 12–13 years by both parent- and teacher-reported SDQ Hyperactivity–Inattention scores ≥ 90th percentile, parent-reported ADHD diagnosis and/or ADHD medication treatment. Children reported body dissatisfaction and weight control behaviour at 8–9, 10–11 and 12–13 years. Children with ADHD had greater odds of body dissatisfaction at ages 8–9 and 12–13 years. Comorbidities drove this relationship at 8–9 but not at 12–13 years [adjusted odds ratio (AOR): 1.6; 95 % CI 1.1–2.4; $p = 0.01$]. At 12–13 years, children with ADHD had greater odds of both trying to lose and gain weight, regardless of BMI status. Comorbidities drove the risk of trying to lose weight in ADHD but not of trying to gain weight (AOR 2.3; 95% CI 1.1–4.6; $p = 0.03$), which is likely accounted for by ADHD medication treatment. ADHD moderately increases body dissatisfaction risk in children aged 8–9 and 12–13 years. Clinicians should monitor this and weight control behaviour throughout mid-late childhood, particularly in children with comorbid conditions and those taking ADHD medication, to reduce the likelihood of later ED onset.

Keywords Attention-deficit/hyperactivity disorder · Eating disorder · Body dissatisfaction · Weight control · Children

Abbreviations

AOR	Adjusted odds ratio
CI	Confidence interval
ED	Eating disorder
LSAC	Longitudinal Study of Australian Children
OR	Odds ratio
SDQ	Strengths and Difficulties Questionnaire

Introduction

Emerging research suggests that attention-deficit/hyperactivity disorder (ADHD) increases risk of developing an eating disorder (ED) [1–7]. Early identification and intervention facilitate better outcomes for EDs [8, 9] and failure to identify at-risk individuals early is a common barrier impeding effective ED treatment [10]. Presently, the age at which ED symptoms emerge in children with ADHD and the impact of ADHD medication are unknown. Body dissatisfaction and engagement in weight control behaviour have been identified as primary risk factors for ED development [11] so this study examined the prevalence and age of onset of these risk factors in a population-based sample of children with ADHD.

Body dissatisfaction (subjective negative evaluation of an individual's own physical body [12]) is one of the strongest risk and maintenance factors for EDs [11, 13, 14]. Elevated rates of body dissatisfaction have been found in adolescents with ADHD [1, 6, 15–17] and longitudinal research reports that childhood ADHD symptoms predict later body dissatisfaction and ED behaviour [6, 16–18]. Additionally,

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00787-019-01314-8) contains supplementary material, which is available to authorized users.

✉ Matthew Bisset
m.bisset@deakin.edu.au

[1] School of Psychology, Faculty of Health, Deakin Child Study Centre, Deakin University, 221 Burwood Hwy, Burwood, VIC 3125, Australia

[2] Murdoch Children's Research Institute, Parkville, Australia

[3] Department of Paediatrics, The University of Melbourne, Parkville, Australia

body dissatisfaction has moderated the relationship between ADHD symptoms and disordered eating in an overweight/obese sample of children with ADHD [19]. As such, body mass (particularly adiposity) might be the underlying mechanism for the association between body dissatisfaction and ADHD, as body mass has been identified as a causal risk factor for body dissatisfaction [11] and elevated rates of adiposity have been found in children with ADHD [20].

Little research has examined whether attempts to control weight differ between children with and without ADHD. One study found that males and females with ADHD aged 12–20 years ($n=3530$) were more likely to use weight control strategies (dieting, vomiting) than children without a chronic illness, and that girls (but not boys) were more likely to use laxatives, diuretics or emetics [15]. A more recent study suggested that 9- to 12-year-old boys (but not girls) with ADHD ($n=12{,}304$) were more likely to fear weight gain and engage in restrictive eating; however, data were obtained via parent report and may not accurately reflect the *intent* of the children [21]. Another study indicated that girls with ADHD aged 11–18 years ($n=228$) reported a greater desire to lose weight and to engage in pathological eating (including dieting) than controls; however, this study excluded males and the ADHD group had a higher body mass index (BMI), which may have contributed to findings [16]. Understanding whether both boys and girls with ADHD engage differently in weight control behaviour (either to lose or gain weight) than children without ADHD may provide a deeper understanding of the relationship between ED development and ADHD.

The impact of ADHD medication on body dissatisfaction and weight control behaviour is also unclear. This is important to consider because common side-effects of ADHD medications such as methylphenidate, dexamphetamine and atomoxetine include appetite suppression, resulting in restricted food consumption and weight loss [22]. Conversely, ADHD medication treatment increased risk of binge-eating threefold (without increased BMI) in a clinical sample of young people with ADHD ($n=252$), suggesting that binge-eating more likely occurs after the medication's appetite-suppressing effects wear off [23]. Another two studies suggested that a history of ADHD medication treatment had no significant impact on body dissatisfaction or ED symptoms (including compensatory weight control behaviours) in young people with ADHD [16, 17]. However, these studies included samples across wide age ranges, so whether results differ at specific ages is unknown.

Most studies have examined ADHD samples across wide age ranges, preventing the ability to determine the age at which ED symptoms such as body dissatisfaction or weight control behaviour emerge [15–17, 21, 24, 25]. Previous research has often neglected potential confounding factors (sex, BMI, SES, comorbidities); thus, it is unknown whether these factors or ADHD specifically confers risk for EDs [5]. Research has also focused on clinical samples [23, 24, 26, 27], revealing little about children not accessing clinical services—which, in Australia, is almost half (47%) of youth with ADHD [28].

This study aimed to examine differences in body dissatisfaction and weight control behaviour for children classified with/without ADHD aged 12–13 years across three time points: at 12–13 years (concurrent), and when these children were aged 8–9 and 10–11 years (retrospective), to determine when risk appears. It was hypothesised that:

1. Higher rates of body dissatisfaction would be found in the ADHD group compared to controls by age 12–13 years; and
2. Higher rates of engagement in weight control behaviour would be found in the ADHD group compared to controls by age 12–13 years.

An additional exploratory aim was to examine differences between children with ADHD based on ADHD medication status.

Methods

Study design

The Longitudinal Study of Australian Children (LSAC) commenced in 2004 and is a population-based study following the development of a nationally representative Australian sample of children and families [29]. The current study utilised four waves of data for the Kindergarten cohort when children were aged 4–5 years (wave 1, $n=4983$; sociodemographic variables only), 8–9 years (wave 3, $n=4331$; 87% retention from wave 1), 10–11 years (wave 4, $n=4196$; 84% retention) and 12–13 years (wave 5, $n=3956$; 80% retention). The Australian Institute of Family Studies (AIFS) ethics committee approved this study. Informed consent was obtained from all participants prior to inclusion in the study.

Participants

Participants were recruited via the Medicare Australia (publicly funded national health insurance) database in two stages: 311 postcodes were randomly selected; then, children were randomly selected from within those postcodes. Stratification ensured that the distribution of children selected was comparable to that of each state/territory in Australia, as well as within capital city and ex-metropolitan areas [30].

Participants were included in the current study if they had complete data available for ADHD and at least one outcome measure at age 12–13 years. This age was chosen to

ensure the greatest chance of capturing an ADHD sample in accordance with DSM-5 criteria [31]. Children not classified as having ADHD at 12–13 years but classified as having ADHD at an earlier age were excluded ($n = 144$). Overall, 2972 children (60% of original sample) were included, comprising 230 children with ADHD and 2742 controls (see Supplementary Table 1 regarding differences between included/excluded children).

Measures

ADHD identification

ADHD was assessed at age 12–13 years using three measures: children were classified as having ADHD if they had: (1) parent- and teacher-reported inattention/hyperactivity symptoms in the clinical range; or (2) a parent-reported ADHD diagnosis (primarily diagnosed by paediatricians in Australia [32]); or (3) been reported by parents to be taking ADHD medication.

The parent- and teacher-reported 5-item Hyperactivity–Inattention score ($\alpha = 0.81$) from the Strengths and Difficulties Questionnaire (SDQ) [33] was used to classify clinical symptoms. Children scoring ≥90th percentile on this scale (≥6) by both parent and teacher report were placed into the ADHD group based on previous studies validating this approach [33–35].

Additionally, parents were asked "Does your child have attention-deficit disorder or attention-deficit/hyperactivity disorder?" If parents responded "yes", the child was classified as having ADHD as per previous research [34, 35].

Finally, to assess for ADHD medication use at each age, parents were asked "Is your child currently taking medication for ADD or ADHD?" If a parent responded "yes", they were then asked to specify the type of medication. The child was then classified as having ADHD and being treated with ADHD medication at that age.

Overall, 230 children (7.7%) were classified as having ADHD at 12–13 years, similar to recent Australian community prevalence estimates [28].

Body dissatisfaction and weight control behaviour

Body dissatisfaction was measured at all ages using the Pictorial Body Image Instrument [36], which examines dissatisfaction with body size. Children were presented with seven drawings depicting children of their same sex, ranging in size and numbered from one (very thin) to seven (obese). Children were asked to choose which picture most looked like them (perceived body image score, range 1–7) and which picture showed how they wanted to look (desired body image score, range 1–7). Any discrepancy between perceived and desired body image scores indicated whether a child was experiencing body dissatisfaction (range −6 to 6, where negative/positive values specify desire to be larger/thinner) [37]. Children with no difference between perceived and desired body image were considered to not experience body dissatisfaction. Absolute body dissatisfaction scores were also derived, as per previous research in ADHD [16, 19] and the general population [38, 39] (range 0–6, where higher scores represent more dissatisfaction).

To measure weight control behaviour, children were asked "What are you trying to do about your weight now?" and to specify if they were trying to *lose* weight (yes/no) or *gain* weight (yes/no).

Sample characteristics

Primary caregivers reported on socio-demographic variables (language spoken, single-parent family, maternal high school completion) when children were aged 4–5 years. Child BMI was obtained at all ages via direct measurement of the child's height and weight. Trained researchers measured weight in light clothing to the nearest 50 g using glass bathroom scales. Height was measured twice, without shoes, to the nearest 0.1 cm using a portable rigid stadiometer. The average of both height measurements was used in analyses, where both differed by more than 0.5 cm; a third measurement was taken and the average of the two closest was used. BMI was calculated as weight (kg) divided by the square of height (m). Raw BMI scores were transformed into z-scores using the 2000 US Centres for Disease Control growth reference data [40]. Parent BMI was derived at each age from self-reported height and weight. Clinical internalising and conduct problems [≥90th percentile (≥7)] were measured at all ages via parent report on the Emotional Problems ($\alpha = 0.66$) and Conduct Problems scales ($\alpha = 0.63$) of the SDQ. Sleep problems were assessed by asking parents "How much is your child's sleeping pattern or habits a problem for you?" Responses were dichotomised into 'no problem at all/small problem' versus 'moderate/large problem' [41–43].

Analyses

Analyses were performed using Stata version 14.2 [44]. Survey methods were used to weight main analyses (but not ADHD sub-group analyses examining differences by medication status, ADHD diagnosis or ADHD symptoms) to account for the unequal probability of participant selection, non-response and sample attrition, and the multi-stage, clustered sampling design [30].

Sample characteristics were compared between groups at each age via *t* tests (continuous variables) and logistic regression (categorical variables). Unadjusted and adjusted logistic regression was used to compare body dissatisfaction (aim 1) and weight control behaviour (aim 2) between

children with/without ADHD, and to examine differences in outcome variables between children with ADHD based on ADHD medication (aim 3). Unadjusted and adjusted linear regression was used to examine mean differences in body dissatisfaction scores between ADHD and control groups at each age (aim 1). Analyses were first adjusted to control for child sex, child and parent BMI and maternal high school completion and then re-run to also control for clinical internalising, conduct and sleep problems.

Results

Sample characteristics

Compared with controls, the ADHD group had more boys, children with clinical internalising, conduct and sleep problems, single-parent families and mothers who had not completed high school, and fewer mothers who spoke a language other than English (Table 1; all $p < 0.05$). Child age, BMI z-scores or weight status did not differ between groups at any age; however, there was a non-significant trend for more children with ADHD to meet criteria for obesity at age 12–13 years ($p = 0.08$). Parents in the ADHD group had a higher mean BMI than control parents at ages 8–9 and 12–13 years (all $p < 0.05$), but this trend was non-significant at 10–11 years ($p = 0.08$). Children treated with ADHD medication at each age were reported to be treated with methylphenidate, dexamphetamine or atomoxetine. All children being treated with ADHD medication had a parent-reported ADHD diagnosis. Parent- or teacher-reported SDQ Hyperactivity–Inattention scores did not differ between children with a parent-reported ADHD diagnosis or SDQ-identified ADHD at any age (all $p < 0.05$).

Data for body dissatisfaction and weight control behaviour variables were available for 2323–2760 children at 8–9 years (78.2–92.8%); 2583–2884 children at 10–11 years (86.9–97.0%); and 2720–2969 children at 12–13 years (91.5–99.9%; Table 2).

Body dissatisfaction in children with and without ADHD

Children with ADHD had greater odds of body dissatisfaction than controls at ages 8–9 (OR 1.5, $p = 0.05$) and 12–13 years (OR 1.7, $p = 0.006$), after adjusting for child sex, child and parent BMI and maternal education (Table 2). Results attenuated when adjusting for comorbidities at 8–9 years (OR 1.4, $p = 0.09$), but held for increased odds of children with ADHD wanting to be thinner at this age (OR 1.6, $p = 0.02$) and held for increased odds of body dissatisfaction at 12–13 years (OR 1.6, $p = 0.01$). In the fully adjusted models, higher BMI z-scores were also independently associated with greater odds of wanting to be thinner at 8–9 years (OR 2.4; $p < 0.001$) and body dissatisfaction at 12–13 years (OR 2.1; $p < 0.001$). Female sex was also independently associated with greater odds of wanting to be thinner at 8–9 years (OR 1.3; $p = 0.01$) and greater odds of body dissatisfaction at 12–13 years (OR 1.4; $p < 0.001$), whilst higher parent-reported sleep problems were independently associated with greater odds of body dissatisfaction at 12–13 years (OR 1.5; $p = 0.03$). Body dissatisfaction prevalence did not differ between ADHD and control groups at age 10–11 years (all $p > 0.05$).

Children with ADHD had higher mean absolute body dissatisfaction scores than controls at each age (Table 3; all $p < 0.05$); however, results attenuated at 12–13 years when adjusting for comorbidities in the fully adjusted model ($p = 0.06$). The amount of variance explained by the factors of interest was only small in the fully adjusted models at ages 8–9 ($R^2 = 0.07$), 10–11 ($R^2 = 0.16$) and 12–13 years ($R^2 = 0.16$).

Weight control behaviour in children with and without ADHD

Children with ADHD at 12–13 years had greater odds of trying to lose weight than controls after adjusting for child and parent BMI, child sex and maternal high school completion (OR 1.6, $p = 0.03$; Table 2), but findings attenuated after adjusting for comorbidities (OR 1.3, $p = 0.25$). Higher BMI z-scores (OR 3.9, $p < 0.001$), female sex (OR 1.6, $p < 0.001$) and more parent-reported sleep problems (OR 1.5, $p = 0.05$) were independently associated with greater odds of trying to lose weight at 12–13 years in the fully adjusted model.

Children with ADHD had greater odds of trying to gain weight than controls at 10–11 (OR 1.9, $p = 0.04$) and 12–13 years (OR 2.2, $p = 0.04$) after controlling for child and parent BMI, child sex and maternal high school completion. Results attenuated when adjusting for comorbidities at 10–11 years (OR 1.5, $p = 0.32$) but held at 12–13 years (OR 2.3, $p = 0.03$; Table 2). More parent-reported sleep problems were also independently associated with greater odds of trying to gain weight at 12–13 years in the fully adjusted model (OR 2.3, $p = 0.05$), whilst higher BMI z-scores (OR 0.3, $p < 0.001$) and female sex (OR 0.5, $p = 0.002$) were independently associated with reduced odds of trying to gain weight at this age.

The proportion of children reporting both body dissatisfaction and trying to lose weight did not differ significantly between children with ADHD and controls at 10–11 years (ADHD: 23.4%, 95% CI 18.2–29.2; Controls: 26.2%; 95%

Table 1 Sample characteristics

Child and family characteristics	12–13 years			Baseline: 8–9 years			10–11 years		
	ADHD ($n=230$)	Control ($n=2742$)	*P* value	ADHD ($n=230$)	Control ($n=2742$)	*p* value	ADHD ($n=230$)	Control ($n=2742$)	*p* value
Child									
Male, %	80.9	46.3	**< 0.001**						
Age in years [mean (SD)]	12.9 (0.3)	12.9 (0.3)	0.49	8.8 (0.2)	8.8 (0.2)	0.24	10.8 (0.3)	10.8 (0.3)	0.32
BMI z-score [mean (SD)]	0.31 (1.1)	0.34 (1.0)	0.67	0.29 (0.99)	0.38 (0.98)	0.27	0.31 (1.0)	0.35 (1.0)	0.59
Underweight, %	8.3	6.5	0.24	5.2	5.3	0.82	4.8	5.6	0.59
Normal weight, %	63.0	67.3	0.14	71.7	69.1	0.38	66.5	65.1	0.37
Overweight, %	19.1	18.3	0.92	14.3	17.2	0.32	17.4	18.7	0.59
Obese weight, %	8.7	6.4	0.08	4.3	5.4	0.78	4.3	5.9	0.74
Comorbid disorders									
Clinical internalising problems, %	44.3	15.4	**< 0.001**	25.9	10.5	**< 0.001**	38.3	15.6	**< 0.001**
Clinical conduct problems, %	52.2	8.9	**< 0.001**	47.2	11.3	**< 0.001**	51.4	13.1	**< 0.001**
Sleep problems, %	19.1	5.1	**< 0.001**	14.5	3.8	**< 0.001**	18.4	5.1	**< 0.001**
ADHD medication, %	30.0	0	**< 0.001**	19.6	0	**< 0.001**	24.8	0	**< 0.001**
Methylphenidate, %	25.2	0	**< 0.001**	13.0	0	**< 0.001**	18.7	0	**< 0.001**
Dexamphetamine, %	3.9	0	**< 0.001**	3.0	0	**< 0.001**	4.3	0	**< 0.001**
Atomoxetine, %	0.9	0	**< 0.001**	0	0	–	1.7	0	**< 0.001**
Primary caregiver									
BMI [mean (SD)]	27.9 (6.4)	26.9 (6.1)	**0.02**	26.6 (5.8)	25.8 (5.2)	**0.04**	27.1	26.4	0.08
Mother speaks language other than English[a], %	4.4	12.9	**< 0.001**						
Single-parent family[a], %	19.7	11.8	**0.002**						
Mother did not complete high school[a], %	50.4	35.5	**< 0.001**						

[a]Reported when children aged 4–5 years

CI 24.5–27.9) or at 12–13 years (ADHD: 25.8%, 95% CI 20.5–31.9; Controls: 25.7%, 95% CI 24.1–27.4). A significantly higher proportion of children with ADHD reported both body dissatisfaction and trying to gain weight than controls at ages 10–11 years (ADHD: 6.4%, 95% CI 3.8–10.6; Controls: 3.2%, 95% CI 2.6–3.9) and 12–13 years (ADHD: 6.9%, 95% CI 4.3–11.1; Controls: 2.9%, 95% CI 2.3–3.6).

Table 2 Odds of body dissatisfaction and weight control behaviour between ADHD and control groups

Child age	ADHD %	Control %	OR (95% CI)	*p* value	Adjusted[a] OR (95% CI)	*p* value	Adjusted[b] OR (95% CI)	*p* value
8–9 years[c]								
Body dissatisfaction	67.1	55.0	1.7 (1.2-2.3)	**0.003**	1.5 (1.0-2.2)	**0.05**	1.4 (0.9-2.1)	0.09
Wants to be thinner	49.6	42.5	1.3 (0.9-1.8)	0.09	1.6 (1.0-2.3)	**0.03**	1.6 (1.1-2.4)	**0.02**
Wants to be larger	17.5	12.5	1.5 (0.9-2.4)	0.09	0.9 (0.6-1.7)	0.96	0.9 (0.5-1.4)	0.55
10-11 years[d]								
Body dissatisfaction	52.5	46.5	1.3 (0.9-1.8)	0.15	1.3 (0.9-1.9)	0.13	1.2 (0.9-1.8)	0.28
Wants to be thinner	42.9	38.7	1.2 (0.8-1.7)	0.32	1.3 (0.9-2.0)	0.19	1.4 (0.9-2.1)	0.16
Wants to be larger	9.6	7.7	1.3 (0.7-2.2)	0.43	1.1 (0.5-2.1)	0.85	0.8 (0.4-1.6)	0.44
Weight control strategy								
Lose weight	39.7	35.9	1.2 (0.8-1.7)	0.37	1.2 (0.8-1.9)	0.29	1.1 (0.7-1.7)	0.65
Gain weight	13.2	5.4	2.6 (1.5-4.6)	**0.001**	1.9 (1.1-3.7)	**0.04**	1.5 (0.7-3.1)	0.32
12–13 years[e]								
Body dissatisfaction	53.3	44.3	1.4 (1.1-1.9)	**0.02**	1.7 (1.2-2.4)	**0.006**	1.6 (1.1-2.4)	**0.01**
Wants to be thinner	41.6	37.8	1.2 (0.9-1.6)	0.29	1.4 (0.9-2.2)	0.08	1.4 (0.9-2.2)	0.11
Wants to be larger	11.7	6.5	1.9 (1.2-3.1)	**0.009**	1.8 (1.0-3.2)	**0.05**	1.8 (0.9-3.4)	0.07
Weight control strategy								
Lose weight	44.6	36.4	1.4 (1.0-1.9)	**0.04**	1.6 (1.1-2.5)	**0.03**	1.3 (0.8-2.1)	0.25
Gain weight	10.5	4.6	2.4 (1.4-4.2)	**0.001**	2.2 (1.1-4.4)	**0.04**	2.3 (1.1-4.6)	**0.03**

OR Odds ratio; *CI* confidence interval

[a]Analyses adjusted to control for child and parent BMI, child sex and maternal high school completion

[b]Adjusted model re-run to also control for parent-reported internalising, conduct and sleep problems

[c]N ranges from 2323 to 2760

[d]N ranges from 2583 to 2884

[e]N ranges from 2720 to 2969

Table 3 Unadjusted and adjusted mean differences in absolute body dissatisfaction scores between ADHD and control groups

Child age	ADHD *M* (SD)	Control *M* (SD)	Unadjusted		Adjusted[a]		Adjusted[b]		Adjusted R^2
			MD (95% CI)	*p* value	MD (95% CI)	*p* value	MD (95% CI)	*p* value	
8–9 years[c]	1.04 (1.04)	0.70 (0.81)	0.33 (0.18, 0.49)	**< 0.001**	0.26 (0.09, 0.43)	**0.002**	0.24 (0.07, 0.41)	**0.006**	0.07
10–11 years[d]	0.67 (0.85)	0.56 (0.72)	0.17 (0.02, 0.32)	**0.03**	0.17 (0.03, 0.32)	**0.02**	0.17 (0.01, 0.33)	**0.03**	0.16
12–13 years[e]	0.69 (0.90)	0.53 (0.72)	0.18 (0.01, 0.35)	**0.04**	0.19 (0.03, 0.36)	**0.02**	0.16 (-0.01, 0.33)	0.06	0.16

MD mean difference, *CI* confidence interval; R^2 *R*-squared for fully adjusted model

[a]Analyses adjusted to control for child and parent BMI, child sex and maternal high school completion

[b]Adjusted model re-run to also control for parent-reported internalising, conduct and sleep problems

[c]N ranges from 2323 to 2760

[d]N ranges from 2583 to 2884

[e]N ranges from 2720 to 2969

Body dissatisfaction and weight control behaviour in children with ADHD by ADHD medication status

Body dissatisfaction prevalence did not differ for children with ADHD based on ADHD medication treatment at any age (all $p > 0.05$; Table 4). Medicated children with ADHD had greater odds of trying to gain weight at ages 10–11 (OR 2.8, $p = 0.04$) and 12–13 years (OR 2.8, $p = 0.03$) in the fully adjusted model.

Few differences were observed based on how ADHD was identified for this study (e.g., parent-reported diagnosis or SDQ symptoms; see Supplementary Table 2). Children with a parent-reported ADHD diagnosis had reduced odds of body dissatisfaction (OR 0.5, $p = 0.04$) and wanting to be thinner (OR 0.5, $p = 0.05$) at age 8–9 years and

Table 4 Odds of body dissatisfaction and weight control behaviour between children with ADHD, by medication status[a]

Child age	ADHD + med %	ADHD no med %	OR (95% CI)	*p* value	Adjusted[b] OR (95% CI)	*p* value	Adjusted[c] OR (95% CI)	*p* value
8–9 years, *n*	45	185						
Body dissatisfaction	56.8	67.8	0.6 (0.3–1.2)	0.17	0.6 (0.3–1.2)	0.16	0.6 (0.3–1.5)	0.29
Wants to be thinner	36.4	50.6	0.6 (0.3–1.1)	0.09	0.6 (0.3–1.4)	0.23	0.6 (0.3–1.6)	0.32
Wants to be larger	20.5	17.2	1.2 (0.5–2.8)	0.62	0.9 (0.3–2.4)	0.76	1.0 (0.3–3.2)	0.99
10–11 years, n	57	173						
Body dissatisfaction	46.4	47.2	0.9 (0.5–1.8)	0.92	1.4 (0.7–2.7)	0.36	1.3 (0.7–2.6)	0.44
Wants to be thinner	32.1	38.7	0.8 (0.4–1.4)	0.39	1.2 (0.6–2.5)	0.63	1.2 (0.6–2.6)	0.60
Wants to be larger	14.3	8.6	1.8 (0.7–4.5)	0.23	1.6 (0.6–4.2)	0.36	1.4 (0.5–3.8)	0.56
Weight control strategy								
Lose weight	29.1	38.0	0.7 (0.3–1.3)	0.23	1.1 (0.5–2.4)	0.77	0.9 (0.4–2.1)	0.81
Gain weight	21.8	7.9	3.2 (1.4–7.6)	**0.007**	2.4 (1.0–6.3)	**0.05**	2.8 (1.0–7.6)	**0.04**
12–13 years, *n*	69	161						
Body dissatisfaction	42.0	53.4	0.6 (0.4–1.1)	0.12	0.7 (0.4–1.3)	0.27	0.7 (0.4–1.3)	0.28
Wants to be thinner	26.1	41.6	0.5 (0.3–0.9)	**0.03**	0.6 (0.3–1.4)	0.25	0.7 (0.3–1.5)	0.30
Wants to be larger	15.9	11.8	1.4 (0.6–3.2)	0.39	0.9 (0.4–2.4)	0.89	0.9 (0.3–2.3)	0.83
Weight control strategy								
Lose weight	30.9	41.6	0.6 (0.3–1.1)	0.13	0.8 (0.4–1.5)	0.44	0.6 (0.3–1.3)	0.20
Gain weight	17.6	7.5	2.7 (1.1–6.3)	**0.03**	2.6 (1.0–6.4)	**0.04**	2.8 (1.1–7.1)	**0.03**

OR odds ratio, *CI* confidence interval

[a]Survey methods were not used to weight sub-group analyses

[b]Analyses adjusted to control for child and parent BMI, child sex and maternal high school completion

[c]Adjusted model re-run to also control for parent-reported internalising, conduct and sleep problems

greater odds of trying to gain weight (OR 3.8, $p = 0.009$) at 12–13 years in the fully adjusted models. Results for children with a parent-reported ADHD diagnosis did not differ by ADHD medication status (all $p > 0.05$; see Supplementary Table 3).

Discussion

This study longitudinally examined differences in the prevalence of body dissatisfaction and weight control behaviour in children with and without ADHD in a population-based sample at three distinct ages leading into adolescence. Whilst there was evidence of elevated risk in children with ADHD from age 8–9 years, this risk appeared to be small and was accounted for by comorbid internalising, conduct and/or sleep problems in many instances. Children with ADHD had more than 1.5 times greater odds of body dissatisfaction at 8–9 and 12–13 years and of trying to lose weight at 12–13 years, regardless of BMI status. Children with ADHD also had approximately two times greater odds of trying to gain weight at ages 10–11 and 12–13 years. Generally, relationships did not differ for children with ADHD by medication status, though medicated children had almost three times greater odds of trying to gain weight at ages 10–11 and 12–13 years.

The finding that children with ADHD experience elevated rates of body dissatisfaction reflects previous research [1, 6, 15–17] and extends it by showing evidence for this risk emerging at 8–9 years and again at 12–13 years. Risk was independent of comorbidities at 12–13 years, similar to previous research [6].

Whilst more children with ADHD reported body dissatisfaction than controls at 10–11 years, the difference was not statistically significant at this age. This might suggest that mid-childhood and the onset of adolescence are important periods developmentally for this risk emerging in ADHD. Further, a number of factors may have contributed to the developmental trajectory observed in this sample, such as different patterns observed between groups in relation to changes in weight status over time, changes in the prevalence of internalising, conduct and sleep comorbidities between groups over time, or the effects of ADHD medication over time (e.g., ceasing medication or being on medication for a longer duration). As the aim of the present study is purely to understand differences in the prevalence of body dissatisfaction and weight control behaviour between children with

and without ADHD, the next step would be to better understand the mechanisms for these differences. Future research should examine such factors to gain a more comprehensive understanding of the causal mechanisms for the associations observed in the present study.

Whilst previous research suggests that youth with ADHD are more likely to engage in weight control strategies [15, 16, 21], the present research extends this by indicating that increased risk of engagement in strategies to try to *lose* weight emerges at the onset of adolescence (by age 12–13 years), regardless of child sex, child and parent BMI or maternal education. However, results attenuated when adjusting for internalising, conduct and sleep problems, suggesting that the elevated prevalence of these comorbidities may be driving observed relationships instead of ADHD.

Our finding that children with ADHD also had greater odds of trying to *gain* weight from 10 to 11 years is new. Whilst existing research suggests a greater likelihood of engaging in behaviours that may contribute to weight gain, such as overeating and binge-eating [23, 27, 45, 46], to our knowledge, no other studies have examined the self-reported *intent* to gain weight in children with ADHD.

The increased odds of trying to gain weight may largely be attributed to ADHD medication use. There was evidence that medicated children with ADHD were more likely to try to gain weight at ages 10–11 and 12–13 years. This finding is not surprising and may not be unhealthy, given the known impact of ADHD medication on appetite suppression and weight loss [22], as these children may simply be attempting to restore weight lost since commencing ADHD medication treatment. Future research could examine whether engaging in strategies to gain/restore weight in conjunction with greater risk for body dissatisfaction contributes to later ED onset, as Benard and colleagues reported a single case study where a young male with childhood ADHD developed an ED after ceasing ADHD medication treatment [47].

Importantly, ADHD status was not the only factor associated with risk for body dissatisfaction and engagement in weight control behaviour in this sample. BMI z-scores, child sex and parent-reported sleep problems were also independently associated with outcomes at age 12–13 years. Children had greater odds of body dissatisfaction and trying to lose weight, and reduced odds of trying to gain weight at this age, if they were females or had higher BMI z-scores, reflecting previous studies [6, 15, 19]. Further, risk of body dissatisfaction and trying to lose or gain weight was increased for children with more parent-reported sleep problems. Previous research has associated sleep problems with BMI [20], so it may be this association that also contributes to risk of body dissatisfaction and/or engagement in weight control behaviour. Future research should examine whether risk for body dissatisfaction and/or engagement in weight control behaviour differs for particular subgroups of children with ADHD, such as females, those with a higher BMI and/or sleep problems, as well as examining the temporal order of these associated factors.

The present study included a broad range of children with ADHD, accounting for both sexes and those not accessing clinical services. Parents and teachers assessed ADHD symptoms and children reported outcomes. Research staff measured child BMI, reducing measurement error. Longitudinal data were captured at specific ages, allowing for more accurate examination of symptom development. Numerous potentially confounding factors were accounted for and differences examined by ADHD medication treatment, which have been important limitations of previous research [5].

This study also had limitations. Due to the number of analyses conducted, the rate of making a Type 1 error might be elevated. However, we decided not to make alpha corrections, as doing so is associated with reduced study power and increased likelihood of making a Type 2 error [48], which we considered to be more costly due to the lack of research examining associations between body dissatisfaction and weight control behaviour in children with ADHD. Brief measures were used for the factors of interest. The SDQ captures symptoms but does not assess impairment or replace clinical ADHD assessment. Whilst child self-report is important, this method has associated challenges—particularly for ED-related symptoms [49]. Future research should incorporate supplemental information from parents and/or clinical observation. Although children reported reasons for employing weight control strategies (to lose/gain weight), the specific strategies used are unknown and, importantly, may not necessarily be unhealthy. Understanding the strategies that children use and determining whether they are healthy or not may help to further clarify the association between ADHD and EDs and better assist with intervention. Whilst ADHD medication treatment was accounted for in this study, no information was obtained regarding other treatments. ADHD medication dosage and compliance were unaccounted for and objective measures were not used (e.g., review of medical records) to confirm parent-reported medication use or ADHD diagnosis. The authors note, however, that whilst primarily obtaining data via parent- and child-report reduces objectivity (and is a common methodological limitation of epidemiological research [50]), this method closely reflects symptom assessment in clinical practice. Finally, the study was not able to account for the duration of ADHD medication treatment due to there being too few children persisting or remitting medication treatment over time. Future research should examine any potential impact of medication treatment duration to better understand this relationship.

Conclusions

Children with ADHD appear to be at moderately greater risk of body dissatisfaction at ages 8–9 and 12–13 years and of trying to lose weight at 12–13 years, regardless of BMI status, compared with children without ADHD. Whilst ADHD also appeared to increase odds of trying to gain weight from age 10–11 years, attempts to gain weight may not carry the same risk for ED development as attempts to lose weight. Increased risk for body dissatisfaction and weight control behaviour—whilst small—appeared to be more pronounced for children with ADHD and comorbidities; so, it may be important to assess risk in these children during mid-childhood and the transition into adolescence, to facilitate early intervention and reduce the likelihood of ED development. Such assessment might be achieved in clinical practice using brief items (such as those used in the present study); however, outcomes associated with risk detected via these measures are still to be determined. Future research should confirm outcomes associated with body dissatisfaction and weight control behaviour for children with ADHD.

Acknowledgements Mr Bisset's position is funded by a Deakin University Postgraduate Research Scholarship (2017–2018). Associate Professor Sciberras' position is funded by a National Health and Medical Research Council (NHMRC) Early Career Fellowship in Population Health 1037159 (2012–2015) and an NHMRC Career Development Fellowship 1110688 (2016–2019). We thank all families participating in the LSAC study. This paper uses unit record data from Growing Up in Australia, the Longitudinal Study of Australian Children. The study is conducted in partnership between the Department of Social Services (DSS), the Australian Institute of Family Studies (AIFS) and the Australian Bureau of Statistics (ABS). The findings and views reported in this paper are those of the authors and should not be attributed to DSS, AIFS or the ABS.

Compliance with ethical standards

Conflict of Interest: The authors have no financial relationships or conflicts of interest relevant to this article to disclose.

Ethical standards This study was approved by The Australian Institute of Family Studies (AIFS) ethics committee. Informed consent was obtained from all individual participants prior to inclusion in the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

References

1. Curtin C, Pagoto SL, Mick E (2013) The association between ADHD and eating disorders/pathology in adolescents: a systematic review. Open J Epidemiol 3:193–202. https://doi.org/10.4236/ojepi.2013.34028
2. Bleck J, DeBate R, Levin BL, Baldwin J (2016) Underlying mechanisms and trajectory of comorbid ADHD and eating disorders: proposing an innovative systems framework for informing research. Int J Ment Health Addict 14:449–458. https://doi.org/10.1007/s11469-015-9593-7
3. Nazar BP, Bernardes C, Peachey G et al (2016) The risk of eating disorders comorbid with attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. Int J Eat Disord 49:1045–1057. https://doi.org/10.1002/eat.22643
4. Levin RL, Rawana JS (2016) Attention-deficit/hyperactivity disorder and eating disorders across the lifespan: a systematic review of the literature. Clin Psychol Rev 50:22–36. https://doi.org/10.1016/j.cpr.2016.09.010
5. Kaisari P, Dourish CT, Higgs S (2017) Attention deficit hyperactivity disorder (ADHD) and disordered eating behaviour: a systematic review and a framework for future research. Clin Psychol Rev 53:109–121. https://doi.org/10.1016/j.cpr.2017.03.002
6. Yilmaz Z, Javaras KN, Baker JH et al (2017) Association between childhood to adolescent attention deficit/hyperactivity disorder symptom trajectories and late adolescent disordered eating. J Adolesc Heal 61:140–146. https://doi.org/10.1016/j.jadohealth.2017.04.001
7. Güngör S, Celiloğlu ÖS, Raif SG et al (2016) Malnutrition and obesity in children with ADHD. J Atten Disord 20:647–652. https://doi.org/10.1177/1087054713478465
8. Chamay-Weber C, Narring F, Michaud PA (2005) Partial eating disorders among adolescents: a review. J Adolesc Heal 37:417–427
9. Vall E, Wade TD (2015) Predictors of treatment outcome in individuals with eating disorders: a systematic review and meta-analysis. Int J Eat Disord 48:946–971
10. Kazdin AE, Fitzsimmons-Craft EE, Wilfley DE (2017) Addressing critical gaps in the treatment of eating disorders. Int J Eat Disord 50:170–189
11. Stice E (2002) Risk and maintenance factors for eating pathology: a meta-analytic review. Psychol Bull 128:825–848
12. Stice E, Shaw HE (2002) Role of body dissatisfaction in the onset and maintenance of eating pathology: a synthesis of research findings. J Psychosom Res 53:985–993
13. Polivy J, Herman CP (2002) Causes of eating disorders. Annu Rev Psychol 53:187–213
14. Davison KK, Markey CN, Birch LL (2003) A longitudinal examination of patterns in girls' weight concerns and body dissatisfaction from ages 5–9 years. Int J Eat Disord 33:320–332
15. Neumark-Sztainer D, Story M, Resnick MD et al (1995) Body dissatisfaction and unhealthy weight-control practices among adolescents with and without chronic illness: a population-based study. Arch Pediatr Adolesc Med 149:1330–1335. https://doi.org/10.1001/archpedi.1995.02170250036005
16. Mikami AY, Hinshaw SP, Lee KA, Chang J (2008) Eating pathology among adolescent girls with attention-deficit/hyperactivity disorder. J Abnorm Psychol 117:225–235. https://doi.org/10.1037/0021-843X.117.1.225
17. Mikami AY, Hinshaw SP, Arnold LE et al (2010) Bulimia nervosa symptoms in the multimodal treatment study of children with ADHD. Int J Eat Disord 43:248–259. https://doi.org/10.1002/eat.20692
18. Bleck J, DeBate RD (2013) Exploring the co-morbidity of attention-deficit/hyperactivity disorder with eating disorders and disordered eating behaviors in a nationally representative community-based sample. Eat Behav 14:390–393
19. Gowey MA, Stromberg SE, Lim CS, Janicke DM (2017) The moderating role of body dissatisfaction in the relationship between ADHD symptoms and disordered eating in pediatric overweight and obesity. Child Heal Care 46:15–33

20. Cortese S, Vincenzi B (2012) Obesity and ADHD: clinical and neurobiological implications. Curr Top Behav Neurosci 9:199–218. https://doi.org/10.1007/7854_2011_154
21. Råstam M, Täljemark J, Tajnia A et al (2013) Eating problems and overlap with ADHD and autism spectrum disorders in a nationwide twin study of 9- and 12-year-old children. Sci World J 2013:315429. https://doi.org/10.1155/2013/315429
22. Davis C, Fattore L, Kaplan AS et al (2012) The suppression of appetite and food consumption by methylphenidate: the moderating effects of gender and weight status in healthy adults. Int J Neuropsychopharmacol 15:181–187
23. Reinblatt SP, Leoutsakos JMS, Mahone EM et al (2015) Association between binge eating and attention-deficit/hyperactivity disorder in two pediatric community mental health clinics. Int J Eat Disord 48:505–511. https://doi.org/10.1002/eat.22342
24. Biederman J, Ball SW, Monuteaux MC et al (2007) Are girls with ADHD at risk for eating disorders? Results from a controlled, 5-year prospective study. J Dev Behav Pediatr 28:302–307. https://doi.org/10.1097/DBP.0b013e3180327917
25. Yoshimasu K, Barbaresi WJ, Colligan RC et al (2012) Childhood ADHD is strongly associated with a broad range of psychiatric disorders during adolescence: a population-based birth cohort study. J Child Psychol Psychiatry 53:1036–1043. https://doi.org/10.1111/j.1469-7610.2012.02567.x
26. Cortese S, Isnard P, Frelut ML et al (2007) Association between symptoms of attention-deficit/hyperactivity disorder and bulimic behaviors in a clinical sample of severely obese adolescents. Int J Obes 31:340–346. https://doi.org/10.1038/sj.ijo.0803400
27. Kim EJ, Kwon HJ, Ha M et al (2014) Relationship among attention-deficit hyperactivity disorder, dietary behaviours and obesity. Child Care Health Dev 40:698–705. https://doi.org/10.1111/cch.12129
28. Lawrence D, Johnson S, Hafekost J et al (2015) The mental health of children and adolescents: report on the second Australian child and adolescent survey of mental health and wellbeing. ACT, Canberra
29. Gray M, Sanson A (2005) Growing up in Australia: the Longitudinal Study of Australian Children. Fam Matters 72:4–9
30. Soloff C, Lawrence D, Johnstone R (2005) LSAC technical paper no. 1: sample design. Aust Aust Inst Fam Stud, Melbourne
31. American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders, 5th edn. American Psychiatric Publishing, Arlington
32. Concannon P, Tang Y (2005) Management of attention deficit hyperactivity disorder: a parental perspective. J Paediatr Child Health 41:625–630
33. Goodman R (2001) Psychometric properties of the strengths and difficulties questionnaire. J Am Acad Child Adolesc Psychiatry 40:1337–1345. https://doi.org/10.1097/00004583-200111000-00015
34. Sciberras E, Ukoumunne OC, Efron D (2011) Predictors of parent-reported attention-deficit/hyperactivity disorder in children aged 6–7 years: a national longitudinal study. J Abnorm Child Psychol 39:1025–1034
35. Sciberras E, Lucas N, Efron D et al (2013) Health care costs associated with parent-reported ADHD: a longitudinal Australian population–based study. J Atten Disord 21:1063–1072
36. Collins ME (1991) Body figure perceptions and preferences among preadolescent children. Int J Eat Disord 10:199–208
37. Daraganova G (2017) Body image of pre-adolescents. In: Garvis S, Pendergast D (eds) Health and wellbeing in childhood, 2nd ed. Cambridge University Press, Cambridge, pp 177–194
38. Stock S, Miranda C, Evans S et al (2007) Healthy buddies: a novel, peer-led health promotion program for the prevention of obesity and eating disorders in children in elementary school. Pediatrics 120:e1059–e1068
39. Franklin J, Denyer G, Steinbeck KS et al (2006) Obesity and risk of low self-esteem: a statewide survey of Australian children. Pediatrics 118:2481–2487
40. Ogden CL, Kuczmarski RJ, Flegal KM et al (2002) Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version. Pediatrics 109:45–60. https://doi.org/10.1542/peds.109.1.45
41. Sung V, Hiscock H, Sciberras E, Efron D (2008) Sleep problems in children with attention-deficit/hyperactivity disorder: prevalence and the effect on the child and family. Arch Pediatr Adolesc Med 162:336–342
42. Quach J, Hiscock H, Canterford L, Wake M (2009) Outcomes of child sleep problems over the school-transition period: Australian population longitudinal study. Pediatrics 123:1287–1292
43. Lycett K, Mensah FK, Hiscock H, Sciberras E (2014) A prospective study of sleep problems in children with ADHD. Sleep Med 15:1354–1361
44. StataCorp (2015) Stata statistical software: release 14. StataCorp LP, College Station
45. Reinblatt SP, Mahone EM, Tanofsky-Kraff M et al (2015) Pediatric loss of control eating syndrome: association with attention-deficit/hyperactivity disorder and impulsivity. Int J Eat Disord 48:580–588
46. Sonneville KR, Calzo JP, Horton NJ et al (2015) Childhood hyperactivity/inattention and eating disturbances predict binge eating in adolescence. Psychol Med 45:2511–2520. https://doi.org/10.1017/S0033291715000148
47. Benard V, Cottencin O, Guardia D et al (2015) The impact of discontinuing methylphenidate on weight and eating behavior. Int J Eat Disord 48:345–348
48. Ranstam J (2016) Multiple *p* values and Bonferroni correction. Osteoarthr Cartil 24:763–764. https://doi.org/10.1016/j.joca.2016.01.008
49. Barmine M, Schvey NA, Ress R, Tanofsky-Kraff M (2017) Assessment of Children and Adolescents: Special Considerations. In: Wade T (ed) Encyclopedia of Feeding and Eating Disorders. Springer, Singapore, pp 18–24
50. Gordon-Lipkin E, Marvin AR, Law JK, Lipkin PH (2018) Anxiety and mood disorder in children with autism spectrum disorder and ADHD. Pediatrics 141:e20171377