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Weight Status and Weight-control Exercise in Adolescents: A Longitudinal Population-based study

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Abstract

Objective: Exercise is a transdiagnostic clinical feature of eating disorders, but consensus is lacking as to what constitutes, and gives rise to, excessive exercise motivated by weight control. Using a longitudinal cohort study, we aimed to describe population-level prevalence rates of varying levels of weight-control exercise and examine gender and weight status (overweight or obesity; OVOB) as cross-sectional determinants of weight-control exercise in 14–15-year-old adolescents. We then evaluated the association of OVOB at 10-11 years with weight-control exercise at 14-15 years.

Methods: The sample comprised 6,329 adolescents from the Longitudinal Study of Australian Children (LSAC). Weight and height were measured in early adolescence (aged 10-11) and in mid-adolescence (aged 14-15). Participants reported weight-control exercise using the Branched Eating Disorders Test at 14-15 years.

Results: In mid-adolescence, the estimated population prevalence for any weight-control exercise was 49% (55% in females). For girls, moderate levels of exercise were most prevalent, and low levels for boys. For all levels except for the very lowest, boys with (vs. without) OVOB history (10-11 years) had about twice the odds of endorsing every level of weight-control exercise. Patterns among girls were similar, though lower in magnitude (~1.5 times).

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Conclusions: For both girls and boys, across most exercise levels, rates of weight-control exercise were greatest for those with OVOB; for the highest exercise level, effects were strongest for boys with OVOB. To accurately identify at-risk adolescents, our results provide preliminary support for a fluid definition of excessive weight-control exercise, dependent on gender and weight status.

Keywords

weight-control exercise; eating disorders; overweight; obesity; adolescents; excessive exercise

1. Introduction

Eating disorders make a substantial contribution to global disease burden (1) and bear increased rates of mortality, as well as high societal and treatment costs (2). Exercise is a prominent transdiagnostic feature of eating disorders, reported in up to 80% of those with anorexia nervosa (3), 73% of those with atypical anorexia nervosa (4), and 40% of those with bulimia nervosa (5). While the association between exercise and eating pathology has been of interest to researchers for decades, “excessive exercise” remains inconsistently defined across the broader field of eating disorders (6). Consequently, varying definitions influence our determination of for whom and when exercise behavior is problematic and, in turn, the prevalence of such behavior. For example, our recent analysis of data from the population-based Longitudinal Study of Australian Children (LSAC) determined that for both boys and girls, the highest rates of compensatory behaviors (including exercise motivated by weight control) were reported among adolescents with overweight, compared to normal body weight (7). In that study, we defined excessive weight-control exercise as ≥ 6 days/week, ≥ 2 hours/day. However, in some circumstances lower amounts (e.g., 4-5 days/week, ≥ 2 hours/day) could be maladaptive, and it is therefore important to document prevalence rates of various levels of exercise, other than only the very highest. More nuanced definitions of exercise duration and frequency may yield different predictors and outcomes of exercise relative to gender and/or weight status.

Beyond quantifying the frequency or duration of exercise behavior as excessive (8), data support the idea that motivation for exercise may better identify whether the behavior is problematic (9-12). In particular, *weight-control* exercise may be problematic for some adolescents, with a recent systematic review finding reasonably consistent associations between early concern with weight/shape and later engagement in exercise in the context of eating pathology (13). Among adolescents, excessive weight-control behavior, including exercise, is a risk factor for eating disorder outcomes five years later (14) and in adult samples, compulsive exercise in the context of eating disorders (i.e., compulsively engaging in exercise as a means to reduce or avoid negative affective states or feared negative consequences, e.g., weight gain) consistently relates to more severe psychopathology, suicidality, and a more protracted and chronic course of illness (8,15-17).

Prior weight status may play a pivotal role in the onset of eating disorder symptoms (18), including behaviors like weight-control exercise (14). Further, although it seems that current overweight may increase risk for compensatory behavior that includes high duration

and frequency weight-control exercise (7), a lower threshold definition of weight-control exercise (e.g., ≥ 4 days/week, ≥ 2 hours vs. ≥ 6 days/week, ≥ 2 hours) is more inclusive (i.e., yielding higher rates) and therefore has the potential to reveal more about risk for weight-control exercise relative to gender and weight history. Exploring different definitions of weight-control exercise may help to delineate groups of individuals at greater risk for this behavior. For example, a threshold for excessive weight-control exercise may need to be defined differently for boys vs. girls.

Using data from LSAC, which specifically queries weight-control exercise and not total exercise performed, the current study had an overarching aim to consider population-representative rates of this behavior in a broader manner than has been done in the past. Within this overarching aim, we had three objectives. First, we wished to estimate the prevalence rates of various levels of weight-control exercise among adolescents aged 14-15 years (i.e., rates at varying combinations of exercise frequency and duration around the peak age of onset for restrictive eating disorders) (19-21) (Aim 1). As no work has examined rates of different levels of weight-control exercise, our hypotheses for this aim were exploratory. Second, we examined if adolescent boys and/or girls with current overweight or obesity (OVOB) endorsed higher rates of weight-control exercise, across all levels (Aim 2). While no research has examined these associations across variable levels of exercise, we expected our results to align with our prior work employing one stringent definition of excessive weight-control exercise (i.e., ≥ 6 days/week, ≥ 2 hours/day) in one of the two 14-15 year LSAC cohorts (7). That is, we hypothesized that the proportion of adolescents endorsing weight-control exercise would be higher amongst those with (vs. without) OVOB. Of note, our prior work included weight-control exercise within a broader category of ‘compensatory behavior.’ In the current study, we aimed to delineate the population-level prevalence of weight-control exercise behavior itself; given that compensatory behavior was elevated among boys with OVOB compared to female counterparts in our prior work, we expected to find this same pattern of results in the current study. Finally, stratified by gender, we longitudinally examined the association of weight history in early adolescence (i.e., OVOB at age 10-11) with different levels of weight-control exercise at age 14-15 (Aim 3). We expected that associations would mirror our cross-sectional findings, with OVOB in early adolescence associated with greater proportions of weight-control exercise later in adolescence.

2. Materials and Methods

2.1 Participants and Procedure

The sample was drawn from the B (Birth) and K (Kinder) cohorts of LSAC (Soloff et al., 2005) and included participants from the 14-15-year-old follow-up wave in 2014 (K cohort, Wave 6) or in 2018 (B cohort, Wave 8). Combined, the analytic sample (Figure 1) comprised 6,130 participants aged 14-15 years (mean age 14.9, 48.2% female). Details of the study design and sampling procedure are described fully elsewhere (Soloff et al., 2005). Briefly, in 2004, infants 0-1 years (B cohort) and children 4-5 years (K cohort) were sampled from Australia’s universal Medicare database using a two-stage clustered sample design based on Australian postcodes stratified by residence state, and by urban versus rural areas. LSAC

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 4-5 years (59% response rate), followed biennially, with 3,537 (71%) retained at Wave 6 in 2014 (part of the current sample). For the B cohort, 5,107 infants were originally recruited (57% response rate), followed biennially, with 3,127 (61%) retained at Wave 8 in 2018 (part of the current sample).

2.2 Measures

Branched Eating Disorder Test (BET; (22)).—At age 14-15 years, participants completed the revised BET that assessed weight-control exercise over the past 4 weeks. The BET consists of 9 stems branching to a maximum of 31 items; exercise specifically for weight control is assessed in the 9th stem. Participants self-report in a computer survey: "Did you exercise hard (i.e., heavy breathing) in order to control your weight over the LAST 4 WEEKS?" If one responds 'yes,' they are prompted to answer questions that assess frequency (e.g., about one day a week), duration (e.g., about an hour a day), and length of time (e.g., between 4 weeks and 3 months) (Appendix A). In its original validation, the BET demonstrated high agreement with the Eating Disorders Examination in a community sample of Australian adolescent girls (22).

We delineated weight-control exercise levels based on BET response options, and by cut points that guided meaningful exploration. For Aims 1 and 2, we used three mutually exclusive categories to organize frequency according to 0 to < 4, 4-5, or 6-7 days/week (Tables 2a and 2b). Also, for Aims 1 and 2, we used four mutually exclusive categories to organize duration according to 0 to < 1, 1 to < 2, 2 to < 4, or ≥ 4 hours/day. For Aim 3, we used a more parsimonious approach due to the number of participants per cell and the relative stability of the model (Table 3). Specifically, we collapsed frequency into two categories, 0 to < 4 or 4-7 days/week. For duration, we used three categories, 0 to < 1, 1 to < 2, or ≥ 2 hours/day.

Weight and height.—At ages 10-11 and 14-15 years, weight and height were measured by research staff during home visits. BMI was calculated (kg/m^2) and converted to Z-scores using the Centers for Disease Control and Prevention's (2000) growth charts. Weight status at age 10-11 years was selected as a robust indicator of prior weight history across all of childhood; unlike clinical cohorts, in community and population cohorts (including LSAC's B-cohort) BMI trajectories are quite stable across childhood (e.g., years 2-3 to 10-11 years and beyond to adolescence) (23,24). The sample was divided into two weight categories (underweight/normal weight or OVOB) based on recommended youth cut-points (25,26).

Puberty.—At age 14-15 years, participants completed the Pubertal Development Scale (PDS; (27)). Questions depended on sex and included items such as: "Would you say that your growth in height (growth spurt) has not started (1), barely started (2), definitely started (3), seems complete (4)". The percentage of participants in each stage of puberty (pre to early, early to mid, mid to late, late to complete) are included in Table 1.

Socioeconomic position (SEP; Blakemore et al., 2009).—SEP is a composite measure of parent-reported (age participant age 14-15 years) household income, current/most recent occupation, and highest educational qualification of each parent. In single-parent households an unweighted average was calculated over the 3 values, or over 5 values for dual-parent households. Values were standardized to mean = 0 (average SEP) and *SD* = 1 (Table 1).

2.3 Analytic plan

Participants were required to have answered the BET question "have you exercised to control your weight, in the last 4 weeks" and to have height and weight data to be included in the analytic sample (Figure 1). We present population prevalence estimates using study-derived cross-sectional population weights at participant age 14-15. These weights take differential non-response patterns into account and are intended to adjust the current sample to produce population-based estimates representative of the population-derived sample who participated in Wave 1 of LSAC (Australian Institute of Family Studies, 2015). For Aim 1, we present estimated population-representative proportions (based on population size 470,311) for each level of weight-control exercise regardless of weight status at age 14-15 (Table 2a). For Aim 2, we present these proportions separately for boys and girls (based on population sizes 242,129 and 228,182, respectively), with and without OVOB (Table 2b). For Aim 3, we conducted a series of logistic regression analyses to determine if having non-OVOB history (reference group) vs. having OVOB history (at age 10-11 prior to puberty) was associated with different odds of endorsing levels of weight-control exercise. Because most participants were likely pre-pubertal at the time of exposure measurement (age 10-11 years), we did not adjust (as a confounder) or stratify (as an effect modifier) for puberty in this Aim, as this could introduce bias into the effect estimates. Aim 3 analyses were stratified by gender and we present odds ratios (OR), 95% confidence intervals (CI) and *p*-values in Table 3.

3. Results

Table 1 shows the characteristics of participants who responded to the BET weight-control exercise question (n = 6,329). The sample was evenly split between boys and girls, with the majority (60%) in mid to late puberty, with half reporting weight-control exercise. The mean SEP was 0.01 z-score (*SD* 1.0, range −5.6 to 2.7) indicating that the SEP of participants in this analysis was average and equivalent to the SEP of all families at LSAC Wave 1, for which this score has been standardized. Of this sample, n = 6,127 (97%) had weight status data available (Figure 1); roughly a third had current OVOB status. The population-level prevalence of adolescents endorsing any level of weight-control exercise (i.e., responding "yes" to BET exercise question) was 49%; of those, 55% were female, translating to 27% of the total adolescent population being girls and participating in weight-control exercise at age 14-15 (22% for boys).

Compared to the analytic sample with complete data (Figure 1, n = 6,127), participants with missing height and weight, and/or those who missed the weight-control exercise BET question had lower SEP z-score (mean −0.2, *SD* 1.0; range −3.6 to 2.1) and were slightly

more likely to be girls (57% of adolescents with missing data were female). The weight status of participants with missing data was similar (29% OVOB) to the analytic sample (27% OVOB).

3.1 Aim 1: Overall weight-control exercise prevalence rates (Table 2a)

Regardless of exercise duration per day, most adolescents (84%) exercised for weight-control purposes fewer than 4 days/week, with 11% exercising 4-5 days/week, and 7% exercising 6-7 days/week. Regardless of days/week, most adolescents exercised for weight control less than 1 hour/day (61%), with 23% exercising 1 to < 2 hours/day, and 15% exercising 2 to < 4 hours/day. Weight-control exercise for ≥ 4 hours on any number of days/week was endorsed by 3% of the population, with 4% endorsing the BET criterion (6-7 days/week, ≥ 2 hours/day) for excessive weight-control exercise (7).

3.2 Aim 2: Association between current OVOB status and weight-control exercise

When comparing the population of boys to the population of girls (Table 2b**, bottom panel**), a greater proportion of boys (64% vs. girls 56%) endorsed the lowest level of weight-control exercise (0 to < 4 days, <1 hour) and the very highest level (≥ 4 days, 6-7 hours) of weight-control exercise (2% vs. girls 1%). In turn, girls (13%) more commonly endorsed moderate weight-control exercise levels (e.g., 4-5 days, any number of hours) compared to boys (9%).

When considering adolescents with OVOB (Table 2b**, middle panel**) 6% of boys with OVOB met BET criterion for “excessive” weight-control exercise (6-7 days, ≥ 2 hours), compared to 4% of girls with OVOB. Within adolescents without OVOB, rates for boys and girls were lower, and the same (3%). For the next highest level of weight-control exercise (4-5 days, ≥ 2 hours), the rate was 6% within both the population of boys and the population of girls with OVOB, and 3-4% among adolescents without OVOB.

Reducing the threshold for defining “excessive” from 6-7 days to also including 4-5 days (i.e., 4-7 days) and retaining the duration at ≥ 2 hour/day, the rate within the population of boys with OVOB is 12%, which is slightly higher than the rate among girls with OVOB (10%), and higher than rates among boys and girls without OVOB (6-7%).

3.3 Aim 3. Longitudinal association between OVOB history and current weight-control exercise

As shown in Table 3, for all weight-control exercise levels except for the very lowest, boys with OVOB history at age 10-11 had about twice the odds of endorsing every level of weight-control exercise than did boys without OVOB (reference). Patterns among girls were similar, though lower in magnitude. Except for the very lowest weight-control exercise level, girls with a history of OVOB at 10-11 years were 1.3 to 1.5 times more likely to endorse every other level of weight-control exercise aged 14-15 years, than were girls without OVOB (reference).

Patterns were reversed for the lowest level of weight-control exercise (0 to < 4 days, < 1 hour). Boys with OVOB history had 70% lower odds of endorsing this behaviour than boys

in the reference group without OVOB (OR 0.3, 95% CI 0.3-0.4), and girls with (vs. without) OVOB history had 40% lower odds (OR 0.6, 95% CI 0.5-0.7). Stated differently, compared to those with a history of OVOB, adolescents without a history of OVOB had higher odds of exercising for weight control purposes at this low level.

4. Discussion

At a population level, the majority of adolescents, particularly girls, endorsed low or moderate levels of weight-control exercise (e.g., 0 to < 4 days, for < 1 hour). For the higher more intense exercise levels, prevalence rates and chances of exercising for the purposes of weight control at this level were greater within the population of adolescents with current or prior OVOB, than within the population of adolescents without current or prior OVOB for both genders. For example, although the proportions of boys and girls with current OVOB endorsing the most excessive level of weight-control exercise (6-7 days, ≥ 4 hours) was 1-2%, holding duration constant at 2 to < 4 hours/day, 11-12% of the boys and girls without OVOB endorsed weight-control exercise, compared to 17-21% among girls and boys with OVOB, respectively. Similarly, when weight-control exercise is both high frequency (4-7 days) *and* high duration (≥ 1 hour), longitudinal analysis showed that compared to those without an earlier history of OVOB, both boys and girls with an OVOB history in early adolescence were at higher risk for engagement in this behavior at age 14-15 years, with the odds increased among boys (1.8 vs. girls 1.3). At a population and/or clinical level these increased odds would result in a considerable number of adolescents at-risk for potential excessive weight-control exercise behavior.

4.1 Definitions of “excessive” exercise

As mentioned previously, the LSAC study specifically evaluates weight-control exercise; high levels of this behavior can be differentiated from high levels of non-weight control exercise (e.g., in athletic contexts) for their potential excessive and problematic nature. Accordingly, we have extended the work of Hughes et al. (2019) to report on population-level prevalence of weight-control exercise and have more comprehensively examined possible categorizations of “excessive” weight-control exercise based on the BET measurement tool. Using the original BET definition of excessive weight-control exercise (6-7 days, ≥ 2 hours) resulted in 5% of boys and 3% of girls meeting these criteria. When we examine this definition across current weight status, 6% of boys with OVOB and 4% of girls with OVOB meet these criteria (vs. 3% prevalence in boys and girls without OVOB). Considering alternative and more inclusive definitions of excessive weight-control exercise, from both cross-sectional and longitudinal analyses, boys demonstrate lower rates of weight-control exercise than girls. However, boys with current or prior OVOB demonstrate increased risk for the most excessive forms of weight-control exercise; exercise that is comparable to, and perhaps exceeds that for girls, and their peers without OVOB. The original BET definition of “excessive” may thus apply well for determining specific risk for extreme weight-control exercise behavior among boys, with a particular eye to weight status.

The original BET definition may not be effective in characterizing risk among girls. Although the same proportion (3%) of girls and boys without OVOB met the original

"excessive" criterion, girls show increased reports of moderate duration weight-control exercise (i.e., 1 to < 2 hours/day, across all frequencies), and surpass boys in the amount of weight-control exercise they perform 4-5 days/week, for any duration. It is therefore possible that maintaining a 'high bar' for defining "excessive" regarding the specific combination of high frequency *and* high duration may not fully capture the amount of time that girls devote to weight-control exercise in each week.

Therefore, as well as gender, it is important to consider cumulative exercise. An adolescent exercising for weight control purposes 5 days for 3 hours (i.e., 15 hours/week) would surpass the weekly amount of an adolescent exercising 6 days for 2 hours (i.e., 12 hours/week). In other words, by excluding the category of 4-5 days (at various durations) when determining whether weight-control exercise is excessive, we may miss variability in how this behavior presents if weight-control exercise occurs on fewer days, but still cumulatively results in a high number of hours. For example, holding duration the same (2 to <4 hours) but manipulating frequency, the maximum of a moderate frequency category (4-5 days, 2 to <4 hours) is 20 hours, which surpasses the minimum (12 hours) for a high frequency category (6-7 days, 2 to <4 hours). Therefore, we must consider both categories as potentially excessive, simply by definition of total number of hours. Context is also important. Excess amounts of exercise should be considered alongside the expense of other activities (e.g., social, academic, sleep) (28).

Consequently, when determining whether exercise behavior is excessive within a clinical context, it may be beneficial to be more inclusive in our calculations to assess the average *total hours per week,* and the degree to which a priority placed on weight-control exercise may be impairing developmentally normative engagement in a broad range of activities. 2020 World Health Organization (WHO) guidelines call for children and adolescents to accumulate at least an average of 60 minutes of moderate to vigorous physical activity per day. Use of the word 'average' is intended to highlight that the 60 minutes need not be on every day (29). Therefore, an adolescent exercising more than 4-5 days per week, ≥ 2 hours per day *or* 6-7 days per week, 1 to <2 hour (or more) per day, surpasses the WHO exercise recommendation. Based on this, 13-14% of girls and boys with current OVOB (9% girls vs. 8% boys without OVOB), respectively, meet this more inclusive calculation of potentially "excessive" weight-control exercise (i.e., they surpass WHO recommendations). Similar to other types of behavioral recall (e.g., dietary), self-report data of *perceived* exercise behavior may be correlated with *actual* exercise behavior, but is known to be mismatched, with the literature generally demonstrating over-reporting by adolescents in self-report compared to objective measures (30,31). For the purposes of the current study, the perceived amount of weight-control exercise reported by adolescents - given its motivation that suggests subsequent risk for eating pathology - may be as clinically meaningful as an objectively accurate account. In particular, some evidence suggests that one's psychological relationship to exercise (e.g., the degree to which one reports an obligation to engage in weight-control exercise) is more informative than the actual *amount* of exercise in predicting eating disorder pathology (9,11,12,32,33). Future research is warranted to probe this hypothesis relative to weight status, including the degree to which over-report of exercise may reflect social desirability or a demand characteristic in one's response.

Of note, weight-control exercise can be normative within a given social structure and potentially adaptive for those with weight-related health concerns; we do not wish to over-pathologize adaptive exercise patterns. However, because adolescents with OVOB engage in a higher frequency and/or duration of weight-control exercise (relative to other activities) than non-OVOB peers, we evaluate our findings with an eye toward relative risk for the onset and maintenance of weight-control exercise as an eating disorder-related behavior.

Weight-control exercise is not inherently maladaptive. Considering whether the weight-control exercise amount is excessive is best determined in context, where motivation for this behavior may vary relative to body image ideals, and the function of the exercise (e.g., how driven it is, intended to alleviate negative affect, or to compensate for calories consumed). Weight-control exercise may also be necessary in particular contexts (e.g., to allow an individual to proceed with surgery; to avoid metabolic syndrome). However, unhealthy weight management strategies among adolescents may contribute to outcomes related to eating disorders five years later (14), and exercise for weight/shape reasons has been consistently associated with greater eating pathology (13,34). Our findings provide preliminary support for evaluating the *total amount of weight-control exercise* (across 4-7 days, ≥ 2 hours/day) to more accurately identify adolescents for whom this behavior may be excessive, and possibly maladaptive. In the future, to determine the threshold by which a given total duration of weight-control exercise is maladaptive depends upon at least two important methodological points: (1) the manner in which these data are collected across samples would ideally be consistent, i.e., weight-control exercise is specified across both frequency and duration; and (2) future lines of inquiry should begin to test associations between this consistently-measured amount of weight-control exercise across both diverse samples, and broader functional outcomes (e.g., quality of life; eating-disorder pathology). Lastly, high frequency and duration weight-control exercise may be a compensatory behavior that occurs frequently among boys (particularly those with current or prior OVOB) and denotes a need for improved screening practices.

4.2 Strengths and limitations

The large representative sample of adolescents allowed us to make population-representative prevalence estimates. Moreover, the selected age range pinpoints a developmental period around the typical onset of restrictive eating disorders (19,21,35). We therefore provide important information about antecedents to typical eating disorder onset that may guide community-level screening and prevention efforts. However, although the BET is a validated measure, with a range of weight-control exercise frequency and duration options, it is a self-report, computer-administered questionnaire and as such may be prone to social desirability and may not assess behavior with comparable nuance to a clinical interview, or reflect the accuracy of accelerometer data. This measure also does not include assessment of non-weight control activity; therefore, the proportion of weight-control activity relative to total activity could not be evaluated in the current data, and should be considered in future studies of this nature. Some recent work suggests that among adults with binge-spectrum eating disorders, study participants were able to identify motivations for exercise that were both positive (e.g., to spend time with family; to manage depression) and negative (e.g., solely for weight control; to compensate for eating); interestingly, they often reported several reasons

for exercise at each episode (e.g., weight control *and* to walk the dog) (36). Although these findings were from within an adult sample with clinical eating disorders, they underscore the importance of future research evaluating a broader variety of both positive and negative motivations for exercise to determine when, and for whom, weight-control exercise might become maladaptive. Last, within the BET, we acknowledge that some participants may not have attended to the reason for exercise being defined as "for weight control" in their response which may have contributed to over-reporting.

4.3 Conclusions

Varying definitions of weight-control exercise behavior influence our determination of for whom and when exercise behavior is excessive and, in turn, the prevalence of such behavior. If employing a more inclusive definition of excessive weight-control exercise, our findings underscore the potential for more effective identification of adolescents who engage in problematic weight-control exercise. A more fluid definition of excessive weight-control exercise may contribute to more accurate identification of those who need intervention or who may be at greater risk for other problems, including eating disorders. We also note that it may be particularly important to consider how current and prior OVOB status differentially increase risk for frequency and duration of this behavior, across both male and female adolescents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Funding and Conflicts of Interest:

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Data Availability:

The data analyzed for the current study are available in the Australian Data Archive repository, https://dataverse.ada.edu.au/dataverse/lsac.

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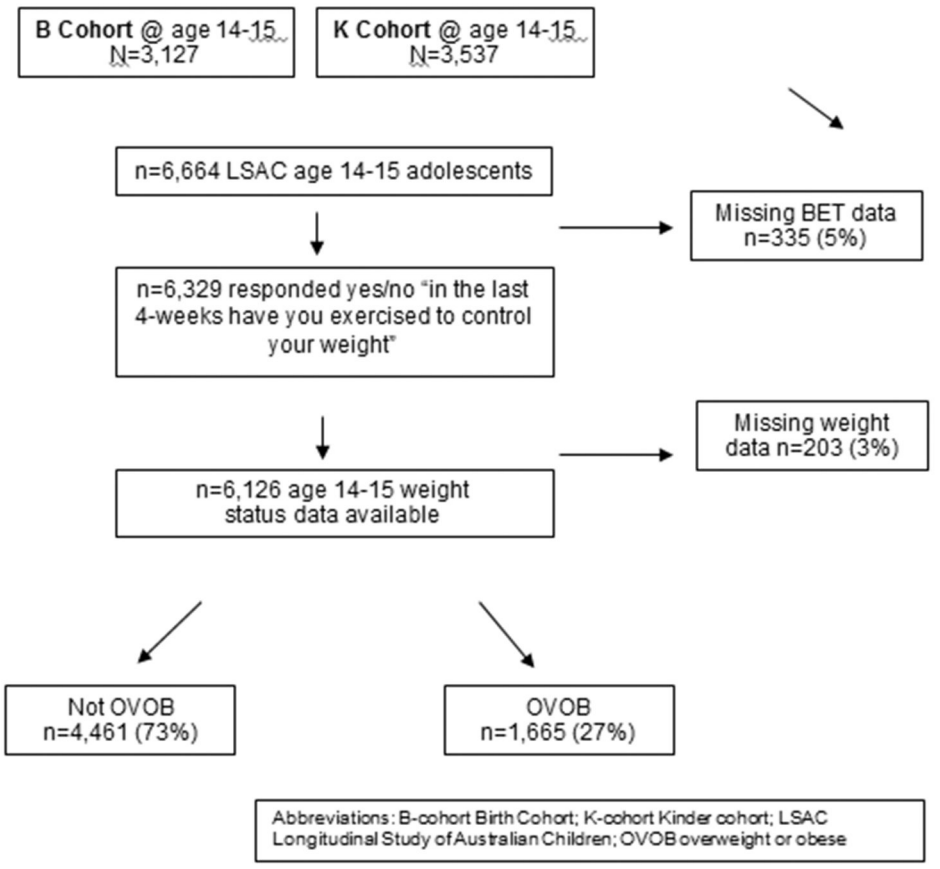

Figure 1:
Participant flowchart

Table 1:

Sample Characteristics at age 14-15

	Total Sample *n*=6,329	
	Mean	***SD***
Age, years	15	0.3
Female (%)	49	-
Puberty (%)	3	0.5
Pre to early puberty	4	-
Early to mid-puberty	34	-
Mid to late puberty	60	-
Late to complete puberty	3	-
Socioeconomic position z-score	0	1
Weight-control exercise, any (%)	49	-
Overweight or obese* current (%)	27	-
Overweight or obese history (%)	24	-

Note: *weight status available n=6,126. OVOB current is at age 14-15, OVOB history is at age 10-11 for participants in this sample. Socioeconomic position (SEP) z-score, standardised average position in LSAC cohort 0.0, SD 1.0.

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Table 2a:

Estimated proportion of cohort participating in weight-control exercise at age 14-15

		Total Age 14-15 Population				
		Hours/day				
		0 to <1	**1 to <2**	**2 to <4**	**≥4**	
Days/week	0 to <4	59%	16%	8%	1%	**84%**
	4-5	1%	5%	4%	1%	**11%**
	6-7	1%	2%	3%	1%	**7%**
		61%	**23%**	**15%**	**3%**	

LSAC observations n = 6,329

Categories/levels of exercise are mutually exclusive. Note: Presented population-level proportions are estimated using LSAC-derived survey weights (see text), based on population size 470,311.

Table 2b:

Estimated proportion of male and female adolescents participating in weight-control exercise at age 14-15, by weight status

	Males without current overweight/obesity LSAC n=2,332						**Females without current overweight/obesity LSAC n=2,129**				
	Hours/day						**Hours/day**				
Days/week	**0 to <1**	**1 to <2**	**2 to <4**	**≥4**		**Days/week**	**0 to <1**	**1 to <2**	**2 to <4**	**≥4**	
0 to <4	70%	11%	6%	1%	88%	0 to <4	60%	17%	7%	0%	84%
4 to 5	0%	3%	3%	0%	6%	4 to 5	1%	5%	3%	1%	10%
6 to 7	0%	2%	2%	1%	5%	6 to 7	1%	2%	2%	1%	6%
	70%	16%	11%	2%			62%	24%	12%	2%	
	Males with current overweight/obesity LSAC n=841						**Females with current overweight/obesity LSAC n=824**				
	Hours/day						**Hours/day**				
Days/week	**0 to <1**	**1 to <2**	**2 to <4**	**≥4**		**Days/week**	**0 to <1**	**1 to <2**	**2 to <4**	**≥4**	
0 to <4	45%	20%	12%	1%	78%	0 to <4	47%	21%	9%	1%	78%
4 to 5	1%	5%	5%	1%	12%	4 to 5	2%	6%	5%	1%	14%
6 to 7	1%	2%	4%	2%	9%	6 to 7	0%	3%	3%	1%	7%
	47%	27%	21%	4%			49%	30%	17%	3%	
	All males, regardless weight status LSAC n=3,239						**All females, regardless weight status LSAC n=3,090**				
	Hours/day						**Hours/day**				
Days/week	**0 to <1**	**1 to <2**	**2 to <4**	**≥4**		**Days/week**	**0 to <1**	**1 to <2**	**2 to <4**	**≥4**	
0 to <4	63%	14%	8%	1%	86%	0 to <4	56%	19%	8%	0%	83%
4 to 5	1%	4%	4%	0%	9%	4 to 5	2%	6%	4%	1%	13%
6 to 7	0%	2%	3%	2%	6%	6 to 7	1%	2%	2%	1%	6%
	64%	20%	15%	3%			59%	27%	14%	2%	

Note: Presented population-level proportions are estimated using LSAC-derived survey weights (see text), based on population size 470,311 (male population size 242,129; female population size 228,182).

Table 3:

Odds of endorsing weight-control exercise at age 14-15

		Males								Females							
		Hours/day										Hours/day					
		0 to <1		1 to < 2		≥ 2						0 to <1		1 to < 2		≥ 2	
Days/ week		**OR (95% CI)**	***p***	**OR (95% CI)**	***p***	**OR (95% CI)**	***p***		**Days/ week**		**OR (95% CI)**	***p***	**OR (95% CI)**	***p***	**OR (95% CI)**	***p***
0 to <4	OVOB age 10-11	0.3 (0.3-0.4)	<.001	2.1 (1.6-2.7)	<.001	2.2 (1.6-3.0)	<.001		0 to <4	OVOB age 10-11	0.6 (0.5-0.7)	<.001	1.3 (1.0-1.7)	0.04	1.5 (1.1-2.1)	0.02
4 to 7	OVOB age 10-11	2.4 (0.9-5.9)	0.07	1.8 (1.2-2.6)	0.01	1.9 (1.4-2.6)	<.001		4 to 7	OVOB age 10-11	1.5 (0.8-2.7)	0.19	1.3 (1.0-1.9)	0.09	1.4 (1.0-2.1)	0.06

Note: All models adjusted for socio-economic position. Reference group = those with non-OVOB history. OVOB: overweight or obese weight status. OR: Odds Ratio. CI: confidence interval. Age 10-11y weight status data was available for 5,946 participants.