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**Changes in the prevalence and correlates of weight-control behaviors and weight perception in adolescence from 1986 to 2015. Findings from three UK birth cohorts.**

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**Abstract**

**Importance**: In the context of the growing prevalence of childhood obesity, behaviors aimed at weight-loss and their psychological burden might be increasing.

**Objective:** To investigate whether the prevalence of weight-control behaviors and weight perception, and their association with depressive symptoms, has changed in the three decades between 1986 and 2015.

**Design**: Repeated cross-sections from successive longitudinal birth cohort studies

**Setting:** United Kingdom (UK) general population samples of 14/16 year olds from three birth cohorts: British Cohort Study 1970, data collected in 1986; Avon Longitudinal Study of Parents and Children, data collected in 2005; and Millennium Cohort Study, data collected in 2015.

**Participants:** 22,503 adolescents with data available on at least one weight-control and weight-perception variable in mid-adolescence.

**Main outcomes**: Self-reported lifetime dieting and exercise for weight loss, current intentions about weight (doing nothing, lose weight, stay the same, gain weight), and weight perception (underweight, about right, overweight) adjusted for Body Mass Index. Secondary outcome was depressive symptoms.

**Exposures:** The main exposure was time (i.e. cohort); secondary exposures were weight-change behaviors and weight perception.

**Results:** In 2015, 44% and 60% of all participants had dieted or exercised to lose weight compared to 38% and 7% in 1986. Furthermore, 42% were trying to lose weight in 2015 compared to 30% in 2005. Although girls were more likely to report these behaviors in all years, their prevalence increased more in boys over time (lifetime dieting [boys] odds ratio (OR): 1.79, 95% confidence intervals (CI): 1.24, 2.59, [girls] OR: 1.23, 95%CI: 0.91, 1.66; currently trying to lose weight [boys] OR: 2.75, 95%CI: 2.38, 3.19, [girls] OR: 1.70, 95%CI: 1.50, 1.92). Adolescents also became more likely to over-estimate their weight. These behaviors were associated with depressive symptoms, with the magnitude of this association increasing in girls over time.

**Conclusion and relevance:** The growing focus on obesity prevention might have had unintended consequences related to weight-control behaviors and mental ill-health. Public health campaigns addressing obesity should include prevention of disordered eating behaviors and be sensitive to negative impact on mental health.

**Key points**

**Question:** Has the prevalence of behaviors aimed at weight loss and weight-perception in adolescence, and their association with depressive symptoms changed over thirty years?

**Findings:** Using data from three UK cohorts spanning 30 years we find that the prevalence of behaviors aimed at achieving weight-loss has increased in 2015 compared to both 2005 and 1986 and that this is not explained by known changes in BMI alone. We also find that weight-control behaviors have increased more in boys than in girls, but that among the latter these behaviors were associated with greater depressive symptoms in 2015 compared to 2005 and 1986.

**Meaning:** It is possible that increased societal and public health focus on obesity could have had unintended consequences related to weight-control behaviors and mental ill-health. Public health campaigns around the prevention of obesity should include prevention of disordered eating behaviors and be sensitive to adverse outcomes such as mental ill-health.

**Introduction**

The proportion of adolescents with an overweight or obese body mass index(BMI) has almost tripled over the past 40 years in the United Kingdom(UK).1,2 Around 40% of UK adolescents aged 13 to 15 years have an overweight or obese BMI.2 Government strategies for the prevention of obesity in childhood include raising awareness of food caloric intake(e.g. the ‘traffic light’ system on food packaging),3 introducing the Soft Drinks Industry Levy in 2018,3 and increasing physical activity.4

Restrictive eating behaviors aimed at weight loss can be common in adolescence, particularly among adolescents who have an overweight BMI.5 Due to the increasing prevalence of obesity and widespread societal messages promoting thinness they might be becoming more common across the BMI spectrum. This is of concern because experimental studies find that dieting is ineffective at reducing body weight in young people6 and that restrictive eating behaviors are longitudinally associated with adverse mental health outcomes, including depression and eating disorders.7–13

We are not aware of any UK general population studies investigating time-trends in weight-control behaviors and weight-perception in adolescence, and changes to their psychological correlates. Recently, the UK Government has highlighted these issues as an area of increasing policy concern.14 Findings from other Western countries15–18 provide inconsistent evidence. Data from the US, Norway, Cyprus, Sweden, and New Zealand shows an increase in the proportion of weight-control behaviors in early adolescence, particularly in boys.15,16 However, two studies based in the US and Finland found that the prevalence of weight-control behaviors did not change over a 10-year time period(US: 1999-2010; Finland: 2003-2013),19,20 although girls in Finland became more likely to believe they would feel worthless if they could not achieve their desired weight.19 This suggests that the psychological burden associated with these behaviours might have increased over time.

In this study we used harmonized data spanning 30 years derived from three UK birth cohorts which collected data in mid-adolescence on weight perception and weight-control behaviors in 1986, 2005, and 2015, with two aims. First, we examine whether the prevalence of weight-control behaviors and weight perception changed in the three decades between 1986 and 2015 and whether any changes vary by sex. Second, we estimate their related psychological burden by investigating their associations with depressive symptoms and the magnitude of these associations has changed over time.

**METHOD**

**Participants/Cohorts**

We used data from three UK cohorts: 1970 British Cohort Study(BCS), Avon Longitudinal Study of Parents and Children(ALSPAC), and Millennium Cohort Study(MCS, details in **eMethod1**) collected when participants were approximately 16(BCS, in 1986) and 14 years(ALSPAC, in 2005, and MCS in 2015). Henceforth, we refer to each cohort by the year at which the outcomes were measured(1986, 2005, 2015). Ethics approval for BCS was obtained for all sweeps after the year 2000. Prior sweeps received internal approval in line with the regulations of the time.21 The ALSPAC Law and Ethics committee and the Local Research Ethics committees, and the Multi-Centre Research Ethics Committee(MREC) gave ethical approval ALSPAC and MCS. Participants gave written consent to take part in the studies.

In our sample we included participants with data available on at least one of the main weight-change/-perception outcomes. In case of twins(BCS: n=398; ALSPAC: n=202, MCS: n=246 twins and n=10 triplets), we retained one participant per twin or triplet at random, as their shared genetic and environmental exposures might otherwise lead to over-/underestimation of the associations. As not all outcomes were measured in all cohorts(**eTable1**) our analytical samples vary depending on the analyses of interest.

*Weight-control behaviors and weight perception*

ALSPAC and MCS asked what the adolescent was trying to do about their weight (not doing anything, stay the same, lose weight, gain weight). We harmonized questions on lifetime exercising for weight loss and dieting(responses yes/no) in BCS and MCS**(eTable1**). We also used a harmonized variable(in ALSPAC,MCS,BCS) indicating whether adolescents perceived themselves as underweight, about the right weight, or overweight(**eTable1**).

*Depressive symptoms*

In ALSPAC and MCS, depressive symptoms were assessed using the 12-item Short Moods and Feelings Questionnaire(SMFQ)22 and in BCS, using the nine-item Malaise Inventory23 (**eMethod2**). We used cohort-standardized scores from these scales as a measure of the sample distribution of depressive symptoms in each cohort.

*Other variables*

Given geographical and socio-demographic differences between cohorts24, we controlled our analyses for key socio-demographic characteristics, including: age, sex and ethnic group(white British or European/ethnic minority), maternal age at birth, maternal education(compulsory vs. non-compulsory) and paternal(where missing maternal) social class(manual vs non-manual profession).

Some of our analyses were adjusted for age and sex-standardized BMI(**eMethod3**).25–27

*Data analysis*

We imputed missing data for participants with at least one outcome variable available using multiple imputation by chained equations, imputing 50 datasets.28 We additionally created attrition weights as the inverse of the probability of having taken part in the sweep of interest to account for attrition from baseline. We ran all analyses in imputed datasets using attrition weights(**eMethod4**). Given aggregated cross-cohort analyses, we could not account for the stratified sampling of the MCS. As sensitivity check we calculated overall and sex-stratified prevalence of weight-related behaviours and regressions accounting for stratified sampling for this cohort (and found identical results).

To investigate the presence of cohort effects in outcome prevalence, we used multinomial logistic or logistic regression models(depending on the outcome variable) including a categorical exposure indicating to which cohort the participant belonged(BCS,ALSPAC,MCS). To account for socio-demographic differences between cohorts we then ran a multivariable model adjusting for child’s sex, age, and ethnicity, maternal age and education, paternal social class. We also tested for sex differences with interaction terms between sex and cohort.

We adjusted analyses of weight perception for BMI as we were interested in exploring changes in perception given known cohort-differences in BMI.24 Controlling for BMI can indicate whether the prevalence of attempts at weight-loss/gain has changed independently of BMI. We also adjusted analyses of current behaviors (‘what are you trying to do about weight?’) for BMI in a separate model(**eTable5**). We did not adjust analyses of lifetime dieting and exercising for BMI, because we could not know whether BMI at assessment was a risk factor for or a consequence of these behaviours. Our second aim was to investigate whether the magnitude of the cross-sectional associations between weight-change behaviors and weight perception, and depressive symptoms had changed over time. We first ran univariable and multivariable linear regression models adjusting for all covariates plus BMI. We then investigated the presence of sex- and cohort- specific changes over time with interaction terms between sex and cohort and weight-related behaviours. In all analyses, if there was evidence of an interaction, we presented all subsequent analyses stratified by sex. We performed all analyses in Stata15.29

We pre-registered the analytical plan of the study on the Open Science Framework website(link: <https://osf.io/7ghca>) on 25th July 2019. We report minor deviations from this in **eMethod5.**

**RESULTS**

In total, 22,503(BCS n=5,878; ALSPAC n=5,832; MCS n=10,793; 53.6% female) adolescents had at least one outcome variable available and were included in our study(**eTable2**). By the mid-adolescence assessment, loss to follow-up was 41.8% (MCS), 57.7%(ALSPAC)and 65.4%(BCS, factors associated with missingness in **eTable3**).

*Lifetime dieting and exercising for weight loss*

In 1986, 37.7% of adolescents reported having dieted and 6.8% exercised for weight loss, compared to 44.4% and 60.5%in 2015(**eTable4**). At both time-points more girls than boys reported these behaviors(**Table1**). There was an overall rise in dieting in 2015 compared to 1986, which differed by sex; boys showed a larger increase in dieting than girls(**Table2**). There was also evidence of a large increase in the prevalence of exercising to lose weight in 2015 compared to 1986 which did not vary by sex.

*Weight-loss & weight-gain attempts*

In 2015, a greater proportion of adolescents said that they were trying to lose(42.2%) or gain(8.5%) weight compared to 2005(28.6% and 5.2%, respectively. **eTable4**). At both time points more girls said they were trying to lose weight compared to boys, while more boys than girls said that they were trying to gain weight(**Table 1**). In regression analyses accounting for confounders, compared to 2005, in 2015 adolescents were more likely to say that they were trying to lose weight, to gain weight, or to stay the same weight than to say that they were doing nothing about their weight. These differences were greater for boys than girls across all three outcomes(**Table 2**). When we additionally adjusted for BMI, results did not change substantially(**eTable5**).

*Weight perception*

In 2005(27.0%) and 2015(33.4%) more adolescents said that they thought they were overweight than in 1986(22.2%, **eTable4**). Compared to 1986 and 2005, in 2015 more girls with underweight BMI thought their weight was ‘about right’, whereas more boys – both in 2005 and 2015 – in the normal BMI range thought they were overweight compared to 1986(**eTable6**). Similarly, the proportion of boys, but not girls, with overweight BMI who thought they were overweight increased in 2005, compared to 1986, and remained stable in 2015. After adjusting for BMI and other confounders, compared to 1986 adolescents were more likely to think they were overweight and less likely to think they were underweight in 2015(**Table2**). At any level of BMI boys, but not girls, were more likely to think they were overweight(vs the right weight) in 2005 and 2015 compared to 1986. They were also more likely to think they were underweight(vs the right weight) in 2005 compared to 1986, but no longer in 2015. By contrast, girls in 2015 became less likely to think they were underweight compared to 1986 and 2005, meaning that even at low BMI values they thought they were ‘about the right weight’.

*Associations of weight-change behaviors and weight perception with depressive symptoms*

Adolescents who dieted or exercised for weight loss and those who were trying to lose weight had greater depressive symptoms(**Table3**). The magnitude of these associations differed by sex, with girls engaging in these behaviors reporting greater levels of depression than boys. There was also evidence that girls who had dieted or exercised for weight loss in 2015 had greater depressive symptoms than those who engaged in these behaviors in 1986, with weaker evidence of difference observed for those who were currently trying to lose weight in 2015 compared to 2005. There was no evidence of such differences in boys(**Figure1**, **eTable7**).

Adolescents who thought they were underweight and those who thought they were overweight had greater depressive symptoms. There was evidence of a weight perception-by-sex interaction only among adolescents who said they were overweight, with girls who thought they were overweight reporting greater depressive symptoms than boys. There was also evidence that for girls the magnitude of this association progressively increased in 2005 and 2015 compared to 1986(**Table3**, **Figure2**, **eTable7**).

*Sensitivity analyses*

Models with complete cases(**eTables8, 10**) and with imputed dataset without attrition weights(**eTables9, 11**) demonstrate results not substantially different from those presented as main analyses. In MCS, prevalence and regression estimates did not vary from those in the main analyses when accounting for stratified sampling(**eTables12, 13, 14**).

**DISCUSSION**

Examining three cohorts born across 30 years in the UK, our study illustrates key trends in weight-change related behaviors that have occurred in parallel with decades of rising child obesity and their association with depressive symptoms indicating increasing psychological burden of these behaviors.

We found that the prevalence of weight-change behaviors has increased in 2015 compared to both 2005 and 1986. Although behaviors aimed at weight loss were more common in girls in all cohorts, their prevalence increased more in boys in recently-born cohorts, as also observed in other countries.15,16 In line with US evidence30, in our sample, weight-gain attempts were more common in boys and became increasingly prevalent in this group over 15 years. Recent evidence suggests that over the past couple of decades there has been a shift in media representation of male beauty ideals with lean muscular bodies increasingly being normalized, which could explain our findings.31–33 By contrast, pressures on women to be thin have been present for longer in society with increases in dieting ads already documented since the 1960s and 1970s in the US34–37, and becoming more common in the UK in the 1980s and 1990s.38

The prevalence of exercise for weight loss, on the other hand, has increased from 1986 to 2015, in both boys and girls. Interestingly, evidence suggests that the proportion of adolescents engaging in vigorous physical activity has remained relatively stable over the past few decades.39,40 It is thus possible that the growing narrative around physical activity as a way to prevent or reduce overweight and obesity–reflected in recent controversial calls to add ‘exercise-equivalent’ labels on food packaging41–might have led adolescents to think of exercise predominantly as a means to lose weight. Although exercise can be effective at reducing body weight42, evidence suggests that the motivation behind exercise such as wanting to lose weight and feeling guilty if not exercising are important indicators of negative psychopathology, including depressive and eating disorder symptoms.43 Public health campaigns and clinicians should therefore consider the potential negative implications of how messages around physical activity are delivered. These should not to foster feelings of guilt or shame, but, rather highlight broader positive aspects of exercise such as improving well-being and strength, learning new skills, and socialising with friends.

It is noteworthy that the trends we observed were not explained by changes in BMI across cohorts, and that adolescents increasingly overestimate their weight in more recent cohorts, albeit with different patterns in boys and girls. In 2015 and 2005 boys in the normal weight range became more likely to think they were overweight compared to 1986, whereas girls became more likely to think their weight was about right when underweight in 2015 compared to 1986 and 2005.Greater public health focus on calorie-restriction and exercise44–47, the proliferation of the fitness industry,48 and growing societal and media portrayals of lean female and male bodies49–53 could have led to adolescents’ increasingly internalising thin body ideals54 and weight stigma, known correlates and predictors of restrictive eating behaviors, poor self-esteem, and depression.55,56

A recent systematic review on young people’s view on body image and weight in the UK found that larger children report appearance-based bullying resulting in social isolation and low mood,57 and that young people think it is person’s responsibility to maintain a healthy weight – an idea often reinforced by media58 – leading to high levels of blame placed on themselves for failing to lose weight.57 A Finnish study observed similar patterns around blame19 which also find correspondence in our findings of increasing depressive symptoms associated with the thought of being overweight, and weight-loss behaviours in girls over the years. While in our study it was not possible to disentangle the direction of associations between weight perception and weight-change behaviours and depressive symptoms it is important that families, schools, and clinicians are aware of this comorbidity when interacting with adolescents about weight-related concerns.

*Limitations*

While BCS and MCS are national cohorts, the ALSPAC cohort is limited to children born in a south west region of England and might therefore not be representative of other areas of the UK. To account for observed differences in the make-up of the cohorts, we have included a number of socio-demographic and socio-economic variables in our analyses. Overall, the inclusion of covariates did not impact the results of our analyses suggesting that between-cohort sampling differences are unlikely to explain the observed cohort trends. All of these cohorts are affected by different degrees of attrition, which could have introduced selection bias in our analyses. To address this, we have imputed missing data for any individual who had at least one outcome measurement and used attrition weights in our analyses. The depression measure included in BCS differed from that used in ALSPAC and MCS, which could have resulted in under- or overestimating differences between cohorts if adolescents with weight-control behaviours report their depressive symptoms differently on these two measures. However, we believe this is unlikely to have occurred as we observed increased depressive symptoms in 2015 compared to 2005 when these were measured using the same instrument and did not see changes in boys (but did in girls), which we would have expected if differences were solely due to the instruments used. Future studies should collect data on anxiety, which is common in adolescence and also associated with disordered eating.59 The exercise question only focused on exercise for weight loss, but not weight gain and evidence suggests that exercising to increase muscularity is becoming more prevalent, particularly in boys33; something that studies should consider capturing in future.

*Conclusions*

The proportion of adolescents who were trying to lose weight at age 14 years has increased over the past 30 years. We acknowledge that there are health concerns associated with obesity, however, the finding that in 2015 44% of 14 year-old adolescents were dieting is concerning in light of evidence that dieting is generally ineffective for weight loss, and is longitudinally associated with weight gain and poor mental health.7–13 Importantly, we found that the association between dieting behaviors and overweight perception, and depressive symptoms in girls has increased in magnitude over the past 30 years. Although our study could not directly measure this, it is possible that mounting societal pressures to lose weight could be becoming more detrimental for young people’s mental health, and that they could be a contributor to the rising prevalence of adolescent mental health disorders. Early adolescence is a crucial developmental period, when dieting could have a range of negative outcomes, from delayed growth to long-term weight gain and eating disorders.60,61 Reducing the prevalence of restrictive eating behaviors and weight dissatisfaction should be considered an important public health priority in itself and these behaviors should not only be viewed as problematic when occurring alongside eating disorder diagnoses or in adolescents with low BMI. Public health campaigns around obesity should include prevention of disordered eating behaviors by: addressing weight stigma and avoid using body dissatisfaction as a motivator for weight change; advocating for health as opposed to ‘healthy weight’ or ‘thinness’; promoting family meals and, encouraging adolescents to exercise for health, wellbeing, and socialisation rather than as a means to achieve weight loss.46,62

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**Data access**: Dr Francesca Solmi (UCL Division of Psychiatry) had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis

**CONTRIBUTOR’S STATEMENT**

FS and PP conceptualized the study with input from all co-authors. FS conducted the analyses, interpreted results, and drafted the paper with supervision and input from PP. All authors helped with result interpretation and contributed to revising and drafting the manuscript.

**DATA SHARING**

Data for the British Cohort Study 1970 and Millennium Cohort Study are available free of cost to researchers from the UK Data Service website (<https://www.ukdataservice.ac.uk/>). The ALSPAC study website ([www.bristol.ac.uk/alspac](http://www.bristol.ac.uk/alspac)) provides more information on the sample and contains details of all the data that is available through a fully searchable data dictionary available at: <http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/>.

**Bibliography**

1. Johnson W, Li L, Kuh D, Hardy R. How Has the Age-Related Process of Overweight or Obesity Development Changed over Time? Co-ordinated Analyses of Individual Participant Data from Five United Kingdom Birth Cohorts. *PLoS Med*. 2015. doi:10.1371/journal.pmed.1001828

2. NHS Digital. *Health Survey for England 2017 Adult and Child Overweight and Obesity*.; 2018.

3. HM Government. *Childhood Obesity: A Plan for Action*.; 2018.

4. HM Government. *Sporting Future: A New Strategy for an Active Nation*.; 2015.

5. Neumark-Sztainer D, Story M, Hannan PJ, Perry CL, Irving LM. Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. *Arch Pediatr Adolesc Med*. 2002;156(2):171. doi:10.1001/archpedi.156.2.171

6. Brown T, Moore TH, Hooper L, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2019;(7). doi:10.1002/14651858.CD001871.pub4

7. Stice E, Gau JM, Rohde P, Shaw H. Risk factors that predict future onset of each DSM–5 eating disorder: Predictive specificity in high-risk adolescent females. *J Abnorm Psychol*. 2017;126(1):38-51. doi:10.1037/abn0000219

8. Kotler LA, Cohen P, Davies M, Pine DS, Walsh BT. Longitudinal relationships between childhood, adolescent, and adult eating disorders. *J Am Acad Child Adolesc Psychiatry*. 2001;40(12):1434-1440. doi:10.1097/00004583-200112000-00014

9. Rojo L, Livianos L, Conesa L, et al. Epidemiology and risk factors of eating disorders: A two-stage epidemiologic study in a Spanish population aged 12-18 years. *Int J Eat Disord*. 2003;34(3):281-291. doi:10.1002/eat.10179

10. Sharpe H, Patalay P, Choo TH, et al. Bidirectional associations between body dissatisfaction and depressive symptoms from adolescence through early adulthood. *Dev Psychopathol*. 2018. doi:10.1017/S0954579417001663

11. Neumark-Sztainer D, Wall M, Larson NI, Eisenberg ME, Loth K. Dieting and Disordered Eating Behaviors from Adolescence to Young Adulthood: Findings from a 10-Year Longitudinal Study. *J Am Diet Assoc*. 2011;111(7):1004-1011.

12. Micali N, Solmi F, Horton NJ, et al. Adolescent Eating Disorders Predict Psychiatric, High-Risk Behaviors and Weight Outcomes in Young Adulthood. *J Am Acad Child Adolesc Psychiatry*. 2015;54(8). doi:10.1016/j.jaac.2015.05.009

13. Conley A, Boardman JD. Weight overestimation as an indicator of disordered eating behaviors among young women in the United States. *Int J Eat Disord*. 2007;40(5):441-445. doi:10.1002/eat.20383

14. UK Parliament. Call for evidence Changing the perfect picture: an inquiry into body image. https://committees.parliament.uk/call-for-evidence/93/changing-the-perfect-picture-an-inquiry-into-body-image/. Published 2020. Accessed April 10, 2020.

15. Center for Disease Control and Prevention. Nutrition, Physical Activity, & Obesity Data & Statistics. https://www.cdc.gov/healthyyouth/data/topics/npao.htm. Accessed October 19, 2019.

16. Utter J, Haines J, Denny S, Teevale T. Trends in weight-related attitudes and behaviours among New Zealand adolescents, between 2007 and 2012. *J Paediatr Child Health*. 2019. doi:10.1111/jpc.14196

17. Berg C, Larsson C. Dieting, body weight concerns and health: trends and associations in Swedish schoolchildren. *BMC Public Health*. 2020;20(1):187. doi:10.1186/s12889-020-8295-7

18. Von Soest T, Wichstrøm L. Secular trends in eating problems among norwegian adolescents from 1992 to 2010. *Int J Eat Disord*. 2014. doi:10.1002/eat.22271

19. Litmanen J, Fröjd S, Marttunen M, Isomaa R, Kaltiala-Heino R. Are eating disorders and their symptoms increasing in prevalence among adolescent population? *Nord J Psychiatry*. 2017;71(1):61-66. doi:10.1080/08039488.2016.1224272

20. Loth K, Wall M, Larson N, Neumark-Sztainer D. Disordered eating and psychological well-being in overweight and nonoverweight adolescents: Secular trends from 1999 to 2010. *Int J Eat Disord*. 2015. doi:10.1002/eat.22382

21. Shepherd P. *1970 British Cohort Study Ethical Review and Consent*.; 2012.

22. Angold A, Costello EJ, Messer SC, Pickles A, Winder F, Silver D. Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *Int J Methods Psychiatr Res*. 1995;5:237-249.

23. Rutter M. *Education, Health and Behaviour*. Harlow: Longman; 1970.

24. Patalay P, Gage SH. Changes in millennial adolescent mental health and health-related behaviours over 10 years: a population cohort comparison study. *Int J Epidemiol*. February 2019. doi:10.1093/ije/dyz006

25. Vidmar SI, Cole TJ, Pan H. Standardizing anthropometric measures in children and adolescents with functions for egen: Update. *Stata J*. 2013;13(2):366-378.

26. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ*. 2007;335(7612).

27. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000;320(7244).

28. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. *Stat Med*. 2011;30(4):377-399. doi:10.1002/sim.4067

29. StataCorp. Stata Statistical Software: Release 15. 2017.

30. Nagata JM, Bibbins-Domingo K, Garber AK, Griffiths S, Vittinghoff E, Murray SB. Boys, Bulk, and Body Ideals: Sex Differences in Weight-Gain Attempts Among Adolescents in the United States. *J Adolesc Heal*. 2019. doi:10.1016/j.jadohealth.2018.09.002

31. Pope HG, Khalsa JH, Bhasin S, et al. Body Image Disorders and Abuse of Anabolic-Androgenic Steroids Among Men. *JAMA*. 2017;317(1):23. doi:10.1001/jama.2016.17441

32. Pope HG, Olivardia R, Gruber A, Borowiecki J. Evolving ideals of male body image as seen through action toys. *Int J Eat Disord*. 1999. doi:10.1002/(SICI)1098-108X(199907)26:1<65::AID-EAT8>3.0.CO;2-D

33. Lavender JM, Brown TA, Murray SB. Men, Muscles, and Eating Disorders: an Overview of Traditional and Muscularity-Oriented Disordered Eating. *Curr Psychiatry Rep*. 2017;19(6). doi:10.1007/s11920-017-0787-5

34. Garner DM, Garfinkel PE, Schwartz D, Thompson M. Cultural expectations of thinness in women. *Psychol Rep*. 1980. doi:10.2466/pr0.1980.47.2.483

35. Wiseman C V., Gray JJ, Mosimann JE, Ahrens AH. Cultural expectations of thinness in women: An update. *Int J Eat Disord*. 1992. doi:10.1002/1098-108X(199201)11:1<85::AID-EAT2260110112>3.0.CO;2-T

36. Wiseman C V., Gunning FM, Gray JJ. Increasing pressure to be thin: 19 years of diet products in television commercials. *Eat Disord*. 1993. doi:10.1080/10640269308248266

37. Irving LM. Mirror Images: Effects of the Standard of Beauty on the Self- and Body-Esteem of Women Exhibiting Varying Levels of Bulimic Symptoms. *J Soc Clin Psychol*. 1990. doi:10.1521/jscp.1990.9.2.230

38. Barker ME, McNeir K, Sameer S, Russell J. Food, nutrition and slimming messages in British women’s magazines, 1950-1998. *J Hum Nutr Diet*. 2014;27(SUPPL2):124-134. doi:10.1111/jhn.12076

39. Samdal O, Tynjälä J, Roberts C, Sallis JF, Villberg J, Wold B. Trends in vigorous physical activity and TV watching of adolescents from 1986 to 2002 in seven European Countries. *Eur J Public Health*. 2007. doi:10.1093/eurpub/ckl245

40. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *Lancet Child Adolesc Heal*. 2019;0(0). doi:10.1016/S2352-4642(19)30323-2

41. Daley AJ, McGee E, Bayliss S, Coombe A, Parretti HM. Effects of physical activity calorie equivalent food labelling to reduce food selection and consumption: systematic review and meta-analysis of randomised controlled studies. *J Epidemiol Community Health*. December 2019. doi:10.1136/jech-2019-213216

42. Brown T, Moore TH, Hooper L, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2019;(7). doi:10.1002/14651858.CD001871.pub4

43. Mond JM, Hay PJ, Rodgers B, Owen C. An update on the definition of “excessive exercise” in eating disorders research. *Int J Eat Disord*. 2006;39(2):147-153. doi:10.1002/eat.20214

44. National Eating Disorders Collaboration. *Evaluating the Risk of Harm of Weight-Related Public Messages*. Crows Nest; 2011.

45. O’Dea JA. Prevention of child obesity: “First, do no harm.” *Health Educ Res*. 2005. doi:10.1093/her/cyg116

46. Neumark-Sztainer D. Preventing Obesity and Eating Disorders in Adolescents: What Can Health Care Providers Do? *J Adolesc Heal*. 2009. doi:10.1016/j.jadohealth.2008.11.005

47. Sánchez-Carracedo D, Neumark-Sztainer D, López-Guimerà G. Integrated prevention of obesity and eating disorders: Barriers, developments and opportunities. *Public Health Nutr*. 2012. doi:10.1017/S1368980012000705

48. Unlocking Potential. *Active Health and Wellness Report*.; 2019.

49. Farquhar JC, Wasylkiw L. Media Images of Men: Trends and Consequences of Body Conceptualization. *Psychol Men Masculinity*. 2007. doi:10.1037/1524-9220.8.3.145

50. Reel J, Voelker D, Greenleaf C. Weight status and body image perceptions in adolescents: current perspectives. *Adolesc Health Med Ther*. 2015. doi:10.2147/ahmt.s68344

51. Harrison K. The body electric: Thin-ideal media and eating disorders in adolescents. *J Commun*. 2000. doi:10.1111/j.1460-2466.2000.tb02856.x

52. Hesse-Biber S, Leavy P, Quinn CE, Zoino J. The mass marketing of disordered eating and Eating Disorders: The social psychology of women, thinness and culture. *Womens Stud Int Forum*. 2006. doi:10.1016/j.wsif.2006.03.007

53. Owen PR, Laurel-Seller E. Weight and shape ideals: Thin is dangerously in. *J Appl Soc Psychol*. 2000. doi:10.1111/j.1559-1816.2000.tb02506.x

54. Bould H, Carnegie R, Allward H, et al. Effects of exposure to bodies of different sizes on perception of and satisfaction with own body size: two randomized studies. *R Soc Open Sci*. 2018;5(5):171387. doi:10.1098/rsos.171387

55. Flament MF, Hill EM, Buchholz A, Henderson K, Tasca GA, Goldfield G. Internalization of the thin and muscular body ideal and disordered eating in adolescence: The mediation effects of body esteem. *Body Image*. 2012. doi:10.1016/j.bodyim.2011.07.007

56. Thompson JK, Stice E. Thin-ideal internalization: Mounting evidence for a new risk factor for body-image disturbance and eating pathology. *Curr Dir Psychol Sci*. 2001. doi:10.1111/1467-8721.00144

57. Rees R, Caird J, Dickson K, Vigurs C, Thomas J. *The Views of Young People in the UK about Obesity, Body Size, Shape and Weight*. London, UK; 2013.

58. Ata RN, Thompson JK. Weight bias in the media: A review of recent research. *Obes Facts*. 2010. doi:10.1159/000276547

59. Schaumberg K, Zerwas S, Goodman E, Yilmaz Z, Bulik CM, Micali N. Anxiety disorder symptoms at age 10 predict eating disorder symptoms and diagnoses in adolescence. *J Child Psychol Psychiatry Allied Discip*. 2019. doi:10.1111/jcpp.12984

60. Canadian Paediatric Society. Dieting in adolescence. *Paediatr Child Health*. 2004;9(7):487-503. doi:10.1093/pch/9.7.487

61. Daee A, Robinson P, Lawson M, Turpin JA, Gregory B, Tobias JD. Psychologic and physiologic effects of dieting in adolescents. *South Med J*. 2002.

62. Golden NH, Schneider M, Wood C, et al. Preventing obesity and eating disorders in adolescents. *Pediatrics*. 2016. doi:10.1542/peds.2016-1649

**TABLES AND FIGURES**

**Table 1:** Prevalenceof dieting, exercising for weight loss, and intention to lose or gain weight by participant’s sex and cohort (based on imputed dataset with attrition weights.)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **1986****% (95%CI)** | **2005****% (95%CI)** | **2015****% (95%CI)** | **1986****% (95%CI)** | **2005****% (95%CI)** | **2015****% (95%CI)** |
| **Lifetime dieting** | **Males, n= 7,850** | **Females n=8,835** |
| *No* | 82.5%(80.8%- 84.1%) | N/A | 65.4%(64.1%-66.7%) | 40.8%(38.9%-42.7%) | N/A | 44.9%(43.6%-46.2%) |
| *Yes* | 17.5%(15.9%-19.2%) | N/A | 34.6%(33.2%-35.9%) | 59.2%(57.3% - 61.1%) | N/A | 55.1%(53.8%-56.4%) |
| **Lifetime Exercising for weight loss** | **Males, n= 7,850** | **Females n=8,835** |
| *No* | 95.1%(94.1%-96.1%) | N/A | 45.1%(43.7%-46.4%) | 91.2%(90.0%-92.3%) | N/A | 33.7%(32.4%-35.0%) |
| *Yes* | 4.9%(3.9%-5.9%) | N/A | 54.9%(53.6%-56.3%) | 8.8%(7.7%-10.0%) | N/A | 66.3%(65.0%- 67.6%) |
| **What are you trying to do about weight** | **Males, n=7,930** | **Females, n=8,698** |
| *Nothing* | N/A | 47.0%(45.0%-49.0%) | 27.1%(25.9%-28.3%) | N/A | 28.7%(27.1%-30.3%) | 20.4%(19.3%-21.5%) |
| *Lose weight* | N/A | 19.4%(17.8%-21.0%) | 31.8%(30.6%- 33.1%) | N/A | 40.3%(38.6%-42.1%) | 52.8%(51.1%-54.5%) |
| *Stay the same* | N/A | 26.2%(24.5%-28.0%) | 28.3%(27.1%-29.6%) | N/A | 28.0%(26.4%-29.6%) | 22.5%(21.1%-23.9%) |
| *Gain weight* | N/A | 7.3%(6.3%-8.3%) | 12.7%(11.8%- 13.6%) | N/A | 2.9%(2.3%-3.6%) | 4.1%(3.6%-4.6%) |

**Table 2**: Univariable and multivariable logistic regression models testing cohort effects in the prevalence of lifetime dieting and exercising for weight-loss and interactions with adolescent’s sex

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Univariable model | Multivariablea Model | Cohort\*sex interactionp-value | Multivariable Modelmales | Multivariable Modelfemales |
|  | OR (95%CI) | OR (95%CI) |  | OR (95%CI) | OR (95%CI) |
| **Lifetime dieting for weight lossb** (Comparing 2015 to 1986) |
| *Yes (2015 vs 1986)* | 1.33 (1.24, 1.43) | 1.55 (1.23, 1.95) | p<0.001 | 1.79 (1.24, 2.59) | 1.23 (0.91, 1.66) |
| **Lifetime exercising for weight lossb** (Comparing 2015 to 1986) |
| *Yes (2015 vs 1986)* | 20.92(18.42, 23.75) | 26.67(20.06, 35.40) | p=0.27 | - | - |
|  |  |  |  |  |  |
|  | RRR (95%CI) | RRR (95%CI) | Cohort\*sex interactionp-value | RRR (95%CI) | RRR (95%CI) |
| **What are you currently trying to do about your weight?** (Comparing 2015 to 2005)c |
| *Doing nothing* | Reference outcome | Referenceoutcome |  | Reference outcome | Reference outcome |
| *Lose weight**(2015 vs 2005)* | 2.29 (2.10, 2.48) | 2.18 (1.98, 2.38) | p<0.001 | 2.75 (2.38, 3.19) | 1.70 (1.50, 1.92) |
| *Stay Same**(2015 vs 2005)* | 1.51 (1.38, 1.64) | 1.52 (1.38, 1.68) | p<0.001 | 1.89 (1.63, 2.16) | 1.15 (1.00, 1.32), |
| *Gain weight**(2015 vs 2005)* | 2.62 (2.24, 3.05) | 1.99 (1.67, 2.36) | P=0.01 | 2.32 (1.89, 2.85) | 1.53 (1.14, 2.07), |
| **Do you think you are:** (Comparing 2015 and 2005 to 1986)d |
| *Underweight**(2005 vs 1986)* | 1.29 (1.15, 1.46) | 1.49 (1.00, 2.21) | p=0.73 | 1.89 (1.12, 3.18) | 1.00 (0.54, 1.82) |
| *Underweight**(2015 vs 1986)* | 0.64 (0.57, 0.72) | 0.72 (0.51, 1.03) | p=0.22 | 0.97 (0.61, 1.53) | 0.43 (0.25, 0.76) |
| *About the right weight* | Reference outcome | Referenceoutcome | Reference outcome | Reference outcome | Reference outcome |
| *Overweight**(2005 vs 1986)* | 1.36 (1.24, 1.49) | 1.64 (1.22, 2.19) | p<0.001 | 3.07 (1.82, 5.15) | 1.01 (0.71, 1.44) |
| *Overweight**(2015 vs 1986)* | 1.66 (1.54, 1.79) | 1.47 (1.14, 1.89) | p<0.001 | 2.59 (1.66, 4.06) | 0.95 (0.69, 1.30) |

a adjusted for: adolescent’s sex and ethnicity; maternal age and highest level of education; and paternal social class. (Analyses of question ‘do you think you are?’ are additionally adjusted for BMI) b sample size n= 16,671, c sample size n= 16,625, d sample size n =22,503.

List of abbreviations: CI= confidence interval, OR = odds ratio, RRR = relative risk ratio

##

## Table 3: Univariable and multivariable linear regression models testing the association between dieting, exercising for weight loss, weight intentions and weight perception with depressive symptoms. We additionally fit an interaction to the multivariable model to test for the presence of sex-specific associations and present sex-stratified models. In these we test for a cohort-by-exposure interaction to test for cohort effects (presented in Table 3 of the manuscript). All analyses based on a sample of participants with at least one outcome available at age 14 (16 in 1986) and imputed missing covariate; we additionally used attrition weights to account for attrition at this sweep since recruitment.

|  |
| --- |
| **Outcome: depressive symptoms** |
|  | **Univariable model****Mean difference****(95% CI)****p-value** | **Multivariable** a **Model****Mean difference****(95% CI)****p-value** | **Sex\* exposure interaction****p-value** | **Males:****Multivariable****Mean difference****(95% CI)****p-value** | **Exposure\*cohort interaction p-value (males)** | **Females Multivariable Model****Mean difference****(95% CI)****p-value** | **Exposure\*cohort interaction p-value (females)** |
| ***What are you currently trying to do about your weight? (Years included: 2005, 2015 (n=18,746))*** |
| *Dieting (yes vs no)* | 0.45(0.41, 0.48) | 0.37(0.33, 0.41) | p<0.001 | 0.26(0.20, 0.32) | p=0.11 | 0.49(0.43, 0.54) | p<0.001 |
| ***Lifetime exercise for weight loss ( Years included: 1986, 2015 (n=18,913))*** |
| *Exercise for weight loss (yes vs no)* | 0.23(0.20, 0.27) | 0.26(0.22, 0.30) | p<0.001 | 0.13(0.08, 0.19) | p=0.30 | 0.38(0.32, 0.44) | p<0.001 |

**Table 3** (continued)

|  |
| --- |
| **Outcome: depressive symptoms** |
|  | **Univariable model****Mean difference****(95% CI)****p-value** | **Multivariable** a **Model****Mean difference****(95% CI)****p-value** | **Sex\* exposure interaction****p-value** | **Males:****Multivariable****Mean difference****(95% CI)****p-value** | **Exposure\*cohort interaction p-value (males)** | **Females Multivariable Model****Mean difference****(95% CI)****p-value** | **Exposure\*cohort interaction p-value (females)** |
| ***Lifetime dieting ( Years included: 1986, 2015 (n=18,913))*** |
| *Lose weight (vs do nothing)* | 0.47(0.43, 0.51) | 0.39(0.34, 0.44) | p<0.001 | 0.23(0.17, 0.29) | p=0.99 | 0.51(0.45, 0.58) | p=0.09 |
| *Stay same (vs do nothing)* | 0.01(-0.03, 0.05) | -0.01(-0.06, 0.03) | p=0.13 | 0.03(-0.02, 0.08) | p=0.55 | -0.04(-0.11, 0.02) | p=0.23 |
| *Gain weight (vs do nothing)* | 0.16(0.08, 0.23) | 0.24(0.17, 0.30) | p=0.01 | 0.18(0.10, 0.26) | p=0.10 | 0.37(0.22, 0.51) | p=0.77 |
| ***Lifetime exercise for weight loss ( Years included: 1986, 2015 (n=18,913))*** |
| *Underweight (vs right weight)* | 0.25(0.19, 0.30) | 0.27(0.21, 0.33) | p=0.89 | 0.26(0.19, 0.34) | a | 0.29(0.20, 0.38) | c |
| *Overweight (vs right weight)* | 0.42(0.38, 0.45) | 0.38(0.36, 0.41) | p=0.01 | 0.27(0.20, 0.33) | b | 0.44(0.38, 0.49) | d |

a: underweight\*ALSPAC p=0.09 ; underweight\*MCS p=0.21

b: overweight\*ALSPAC p=0.21; overweight\*MCS p=0.33

c: underweight\*ALSPAC p=0.01 ; underweight\*MCS p=0.37

d: overweight\*ALSPAC p= 0.08 ;overweight\*MCS p<0.001

multivariable models adjusted adolescent’s sex, BMI, and ethnicity; maternal age and highest level of education; and paternal social class

Figure 1: changes in the association between weight-change behaviours and depressive symptoms by cohort and sex.

Figure 1 legend: The figure shows how the association between lifetime dieting and exercising for weight loss and depressive symptoms changed across cohorts in females and males. Parameters are derived from multivariate linear regression models in Table 3 with exposure\*cohort interaction and sex-stratified analyses presented in eTable7. The Y axis represents standardized depression scores (units are standard deviation), the X axis represents presence or absence of weight-change behavior.

Figure 2: changes in the association between weight perception and depressive symptoms by cohort and sex.

Figure 2 legend: The figure shows how the association between weight perception and depressive symptoms changed across cohorts in females and males. Parameters derived from multivariate linear regression models in Table 3 with exposure\*cohort interaction and sex-stratified analyses presented in eTable7. The Y axis represents standardized depression scores (units are standard deviation), the X axis represents different weight perceptions.