Obesity & Educational outcomes

Chapter for Final report- Fit Not Fat 2

4 The relationship between childhood obesity and educational outcomes

This chapter investigates the relationship between childhood obesity and a variety of educational outcomes. A data analysis covering 32 countries explores the association between school performance and obesity in children aged 11 to 15, and assesses the degree of inequality across countries. A longitudinal analysis investigates a potential causal relationship between childhood obesity and academic performance as well as education attainment in five countries. Finally, the chapter discusses the broader consequences of the relationship between obesity and educational outcomes, for the individuals and the economy.

Key findings

- Obesity and educational outcomes are interrelated, and mediated by biological (e.g. diseases), behavioural (e.g. lack of physical activity), emotional and mental health factors (e.g. low self-esteem, poor social connection).
- Analysis of HBSC data shows that obese children have a lower life satisfaction, and are more prone to being bullied by schoolmates. This can lead to lower class participation and reduced school performance.
- Inequalities in bullying are more pronounced in girls than in boys. In OECD countries, obese girls are 3 times more likely to be bullied than healthy-weight girls, while this ratio is 1.8 times in boys.
- The association between obesity and poor academic performance is well established in the 32 studied countries, after controlling for confounders. In OECD countries, healthy-weight children have roughly 13% more chance of performing well at school than obese children.
- Analysis of longitudinal data from national surveys suggests that this relationship is causal, as the presence of obesity at a young age appears to affect academic performance and education attainment later on in life.
- Childhood obesity has long-lasting effects, including health-threatening consequences over the life course. In addition, the relationship between childhood obesity and educational outcomes can constrain the formation of human capital and future socioeconomic status. As such, it affects both the individual as well as society and the economy.
- Policymakers should invest in a wide range of policy interventions aimed to tackle childhood obesity, reduce the obesity stigma, reduce bullying, and improve well-being and mental health of obese and overweight children.

4.1. The relationship between childhood obesity and educational outcomes is mediated by different factors

4.1.1. The evidence points to a significant relationship between childhood obesity and educational outcomes

1. Obesity rates among children have substantially increased over the past decades, similar to the rising obesity rates in adults (ref to preceding chapter). Childhood obesity rates will continue to rise if nothing is done to tackle the obesogenic factors (Sassi, 2010[1]; OECD, 2017[2]). The consequences of obesity and overweight in childhood are important and widespread: they affect individuals in their early life and may have an impact over the entire life course; and they include deteriorated health and well-being, emotional and mental health problems, bullying, and poor educational outcomes. This chapter seeks to shed light on the relationship between childhood obesity and educational outcomes.

2. Overall, a great number of studies published in the literature converge to show a significant association between childhood obesity and poor academic performance. These studies provide evidence for a variety of educational outcome measures (such as school grades, school absence, engagement, repeating a grade), and for different age groups. For instance, high body weight is associated with lower academic performance, as measured by grades, in United States university students (Anderson and Good, 2017[3]). Obesity in the Unites States is also related to more school problems and less school engagement

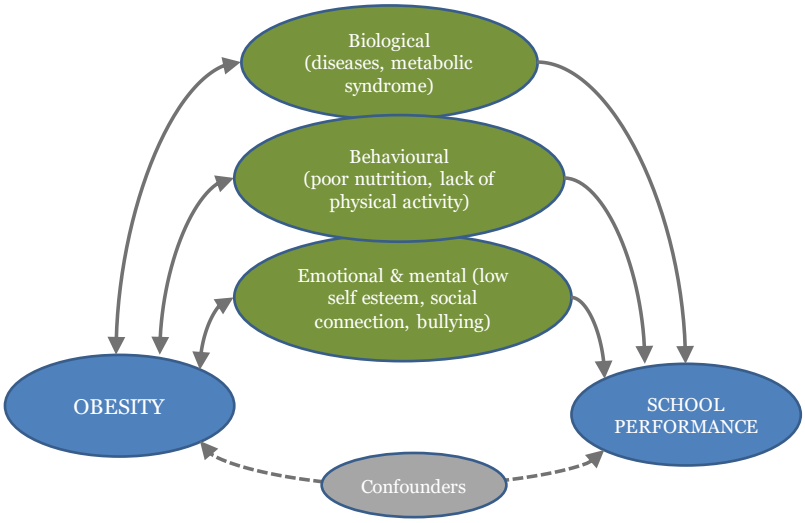
in adolescents (Carey et al., 2015[4]), and to more absence from school in children aged 6 to 11 (Li et al., 2012[5]), as well as in adolescents aged 12 to 17 (Pan et al., 2013[6]; Carey et al., 2015[4]).

3. However, some of these studies reach different conclusions once they controlled for confounders and mediating factors. For instance, while obesity in US schoolchildren appeared to be related to the likelihood of repeating grade, the relationship disappeared when controlling for confounders (Carey et al., 2015[4]). Similarly, in Spain, the relationship between obesity and test scores in children aged 9 to 11 vanished once controlling for confounders (Torrijos-Niño et al., 2014[7]). This exposes the complexity of the relationship between obesity and educational outcomes, which is influenced by and related to many other factors.

4.1.2. The relationship between obesity and educational outcomes is mediated by biological, behavioural and emotional factors

4. There are different pathways through which obesity is linked to educational outcomes. These pathways involve various mediating factors as described in Figure 4.1: biological factors (e.g. diseases), behavioural factors (poor nutrition and lack of physical activity), and emotional and mental health factors (e.g. low self-esteem, poor social connection).

Figure 4.1. Relationships between obesity and educational performance



Source: OECD analysis.

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Biological factors may adversely affect both body weight and cognitive functions

5. Obesity and its related diseases, such as metabolic syndrome, may have a direct effect on cognitive functions and concentration at school. For instance, metabolic syndrome was found to have an impact on cognitive functions and brain structure through physiological impairments (Yates et al., 2012[8]). Another study found a direct link between childhood obesity and lower cognitive performance, independently of physical activity, sleep, and diet (Hjorth et al., 2016[9]).

Lifestyle and behaviour may be associated with childhood obesity and lower concentration

6. There exists an interrelationship between unhealthy behaviours, obesity and educational outcomes. Behavioural risk factors, such as poor nutrition and lack of physical activity, may directly play a role on both obesity and low concentration at school, resulting in poor school performance. For example, insufficient levels of physical activity can be both a cause and a consequence of obesity, and can lead to lower concentration (Bustillo et al., 2016[10]).

7. A clear relationship between physical activity and cognition has been documented. A recent systematic review of 64 studies found that physical activity has a positive influence on cognitive functions as well as brain structure and function (Donnelly et al., 2016[11]). Similarly, a meta-analysis of 44 studies showed that physical activity has a positive association with cognition in children (Sibley and Etnier, 2003[12]).

8. Regarding the effect of physical activity on school achievement, a systematic review of 14 longitudinal studies found evidence for a significant longitudinal positive relationship between physical activity and academic performance, although the dose-response relationship needs further investigation (Singh et al., 2012[13]). In a Cochrane review, physical activity interventions produced small yet significant improvements in mathematics achievements (mean difference (MD) of 3 points on a scale of 0 to 100, P-value=0.008), executive function (MD 3, P-value=0.04), and working memory (MD 3, P-value=0.02) (Martin et al., 2014[14]). However, there was no evidence to suggests an effect on reading, vocabulary and language achievements, attention, inhibitory control and simultaneous processing. Hence, while the association between physical activity and cognitive functions and school achievement is evident, the best way to incorporate physical activity within schools to improve academic achievement (e.g. activity breaks versus active lessons) is less clear (Donnelly et al., 2016[11]).

Emotional and mental health problems, related to bullying and stigma, can lead to poor academic performance

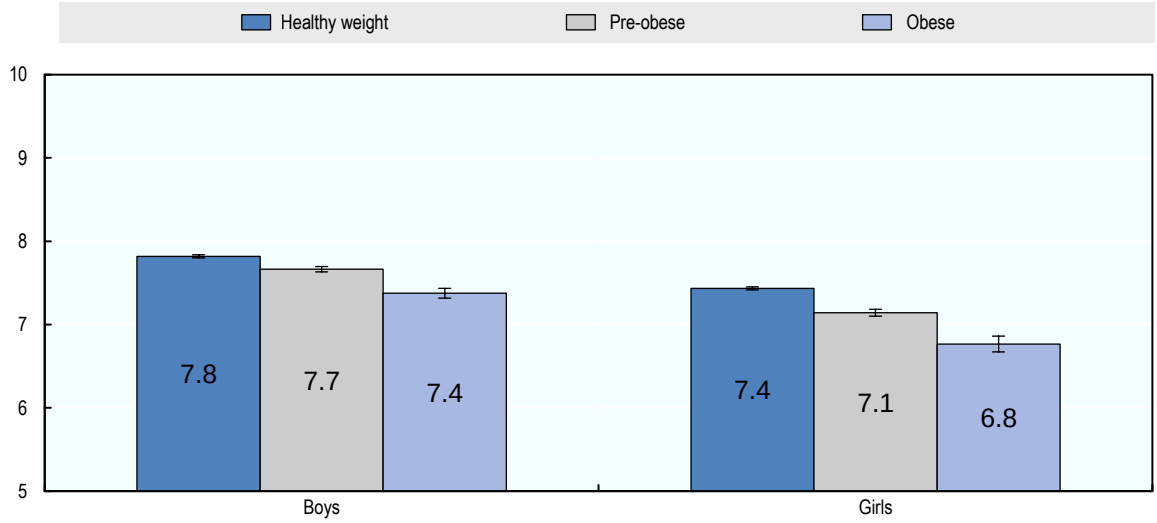
9. Emotional and mental health problems can also mediate the relationship between obesity and education performance. Overweight and obese children and adolescents may be often excluded from friendships and bullied by other kids. Because of this, overweight and obese children may feel isolated, lonely or socially disconnected, they may have lower self-esteem, poor well-being and suffer from emotional and mental health problems (Russell-Mayhew et al., 2012[15]; Strauss, 2000[16]).

10. These problems may have deleterious effects on educational outcomes. Children who are bullied and socially excluded by others engage less in class: they step aside and refuse to speak up in class for fear of getting bullied (Ladd, Ettekal and Kochenderfer-Ladd, 2017[17]). Moreover, behavioural problems in schools, such as disobedience and violence, may emerge.

11. OECD analysis of the Health-Behaviours in School-based Children (HBSC) survey 2013-14 points to a significant association between obesity and emotional and mental health problems (see data and methods in Box 4.1). In the HBSC survey, children aged 11-15 were invited to rate their life satisfaction from 0 (lowest) to 10 (highest). The average life satisfaction was 7.4 in obese boys compared to 7.8 in healthy-weight boys, and 6.8 in obese girls compared to 7.4 in healthy-weight girls, all other things being equal (Figure 4.2).

Figure 4.2. Life satisfaction by BMI category, children aged 11-15, OECD countries, 2013-14

Predicted score on life satisfaction, with 95% confidence interval



Note: Analysis adjusted for age, family affluence, smoking, and drunkenness in lifetime. OECD countries only.
Source: OECD estimates based on HBSC 2013-14 data.

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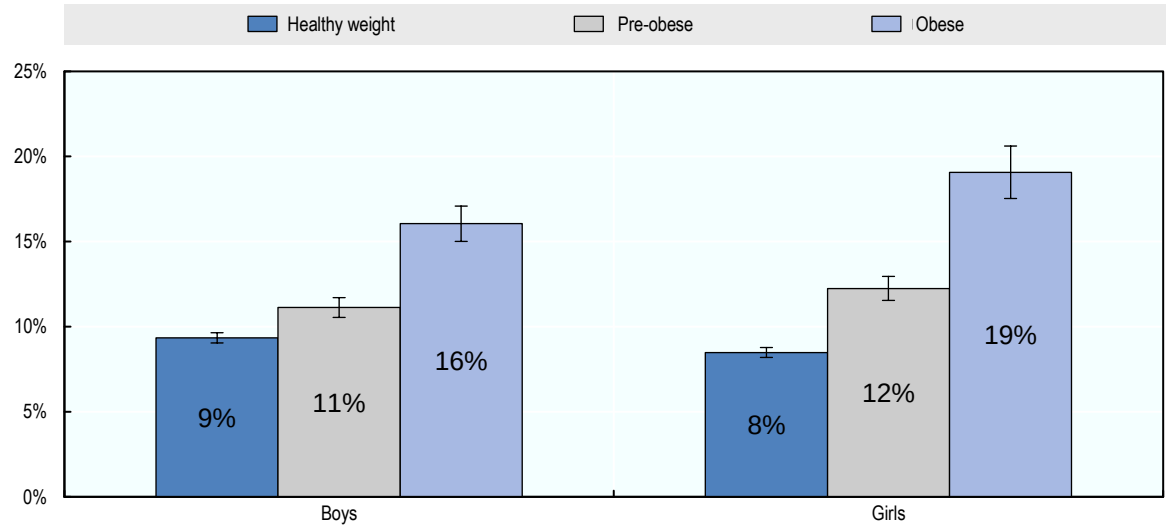
12. Bullying and obesity are also strongly associated. OECD analysis shows that 16% of the 11-15 year-old boys who were obese were bullied by schoolmates, compared to 9% in healthy-weight boys. This gap is even larger in girls (19% versus 8%) (Figure 4.3). This relationship was adjusted for family affluence and life satisfaction, meaning that high BMI has a direct relationship with bullying, not mediated by socioeconomic status or emotional health. A country-specific analysis confirms the obesity-related differences in the probability of being bullied in each country studied (Annex Figure 4.A.1).

Figure 4.3. Probability of being bullied by BMI category, children aged 11-15, OECD countries, 2013-14

Predicted probability of being bullied, with 95% confidence interval



Note: Analysis adjusted for age, family affluence, smoking, and drunkenness in lifetime. OECD countries only.
Source: OECD estimates based on HBSC 2013-14 data.

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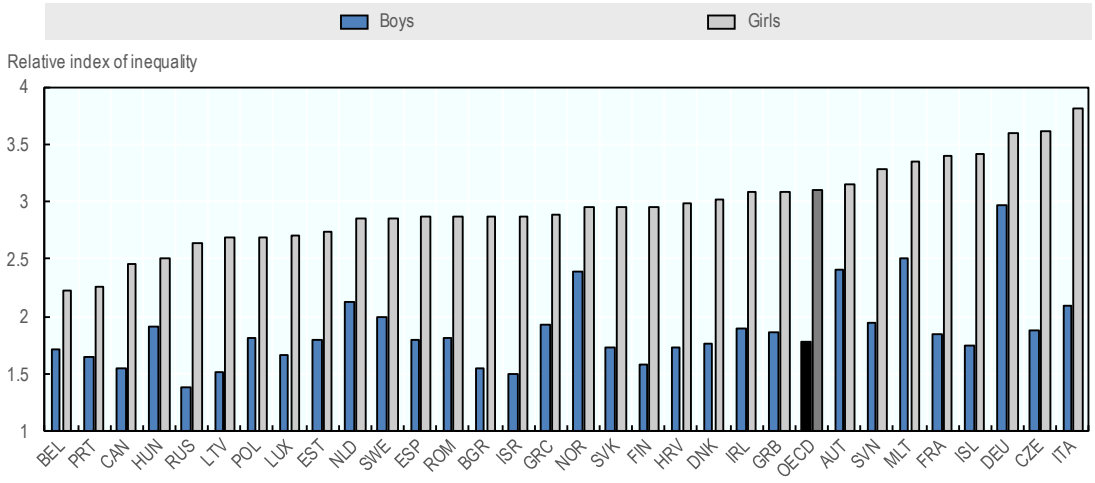
13. Germany, Czech Republic, and Italy have the largest obesity-related inequalities in bullying among girls, while Germany, Norway, Austria, and Malta show the largest inequalities among boys (Figure 4.4). The relation between obesity and bullying is much more pronounced in girls than in boys in all countries. On average in OECD countries, obese girls are 3.1 times more likely to be bullied than their healthy weight counterparts, compared to 1.8 in boys. This difference between sexes is especially marked in Czech Republic, Iceland, Israel and the Russian Federation, where the effect of obesity on bullying is two times larger in girls than in boys.

Figure 4.4. Relative index of inequality for being bullied by BMI category



Note: The RII is calculated as the ratio between the probability of obese children being bullied divided by the probability for healthy-weight children, taking into account the average BMI in each group. A RII greater than 1 means that the likelihood of being bullied increases with BMI. The higher the RII, the larger the inequality across BMI categories. For example, in Italy, the most obese girls are 3.8 times more likely to be bullied than healthy-weight girls. Data on bullying for Switzerland is missing. The OECD average is derived from a pooled countries analysis weighted by the national sample size.
Source: OECD analysis based on HBSC 2013-14.

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14. Differences in bullying with regard to obesity have remained stable over the last decade in girls, while they have increased in boys, on average in OECD countries (Annex Figure 4.A.2). A time-trend analysis showed that the probability of being bullied in boys has significantly decreased in healthy-weight and pre-obese boys compared to obese boys, widening inequalities. By contrast, bullying has not significantly changed in girls, on average in OECD countries.

15. Emotional and mental health consequences in children and adolescents are comparable with the well-known effects of the obesity stigma in adults. Weight bias and obesity stigma are associated with poor body image, low self-esteem, loneliness, suicidal thoughts and acts, depression, and anxiety (WHO Europe, 2017[18]). Obesity stigma leads to exclusion and marginalization of obese people, and to inequities. For example, people with obesity may not receive adequate health care or may be discriminated against in the workplace or in educational settings (WHO Europe, 2017[18]).

16. Discrimination against people with obesity has also been observed for young people. A study in the United States provides evidence that interviewers for graduate programs favoured thinner applicants, which could be due to a (conscious or unconscious) bias against obese applicants. However, it is also possible that stereotype threat or social identity threat led the applicant to under-perform (Burmeister et al., 2013[19]).

4.2. There is a clear association between childhood obesity and school performance in OECD countries

17. An OECD analysis based on HBSC data (Box 4.1) shows that obese children have significantly lower performance at school than their healthy weight counterparts, and obese teenagers are more often absent from school. These relationships remain significant after controlling for mediating and confounding factors such as family affluence, life satisfaction, and bullying.

Box 4.1. Data and methods for the analysis on obesity and educational outcomes

18. Analyses are based on the 2013-14 Health-Behaviours in School-based Children survey (HBSC) which collects information on school students aged 11, 13 and 15 years old every four years. School and health information are self-reported by children (e.g. school performance compared to classmates, bullying, life satisfaction, height and weight, smoking and alcohol drunkenness). Body mass index (BMI), measured from height and weight, was categorised into healthy-weight, pre-obese and obese, using the WHO age- and sex-specific BMI cut-off points for children (de Onis et al., 2007[20]). Analyses presented cover 32 HBSC countries: 26 European Union countries plus Canada, Iceland, Israel, Norway, Switzerland, and the Russian Federation.

19. A pooled-country multivariate logistic regression analysis was performed to assess the probability of being bullied and a linear model was used for the assessment of life satisfaction. Country-specific analyses of the probability of being bullied and having good performance at school were performed using a mixed logit model with random effects on the intercepts and the BMI coefficient at the country level, while controlling for individual characteristics. Predicted probabilities of being bullied and of self-perceived good performance at school were estimated for each BMI category. The relative index of inequality, which is a summary measure of inequality, was used to gauge obesity-related inequalities in bullying and school performance across countries.

Trends analysis

20. Four waves of the HBSC survey (2001-02, 2005-06, 2009-10, 2013-14) were combined for the trends analysis. A pooled-country logistic model of the probability of good performance at school was used to assess the effect of BMI categories, survey year (continuous), and their interaction term, while controlling for age, smoking status, drinking status and socioeconomic background. Separate models were run for boys and girls. The overall statistical difference in the trends coefficient for the three BMI categories was tested. A similar approach was used for the probability of being bullied.

School absence analysis

21. The United States NHANES data was used to study school absence. Four waves of NHANES, from 2001-02 to 2007-08, collect information on missed days of school. The analysis focused separately on children aged 6-11 and teenagers aged 12-19. BMI categories were defined using the WHO age- and sex-specific BMI cut-off points for children (de Onis et al., 2007[20]).

22. Multivariate logistic regression analysis was performed to assess the probability of missing school days according to BMI category, while adjusting for age, gender, ethnicity and socioeconomic status. A negative binomial model was used for the number of days of absence.

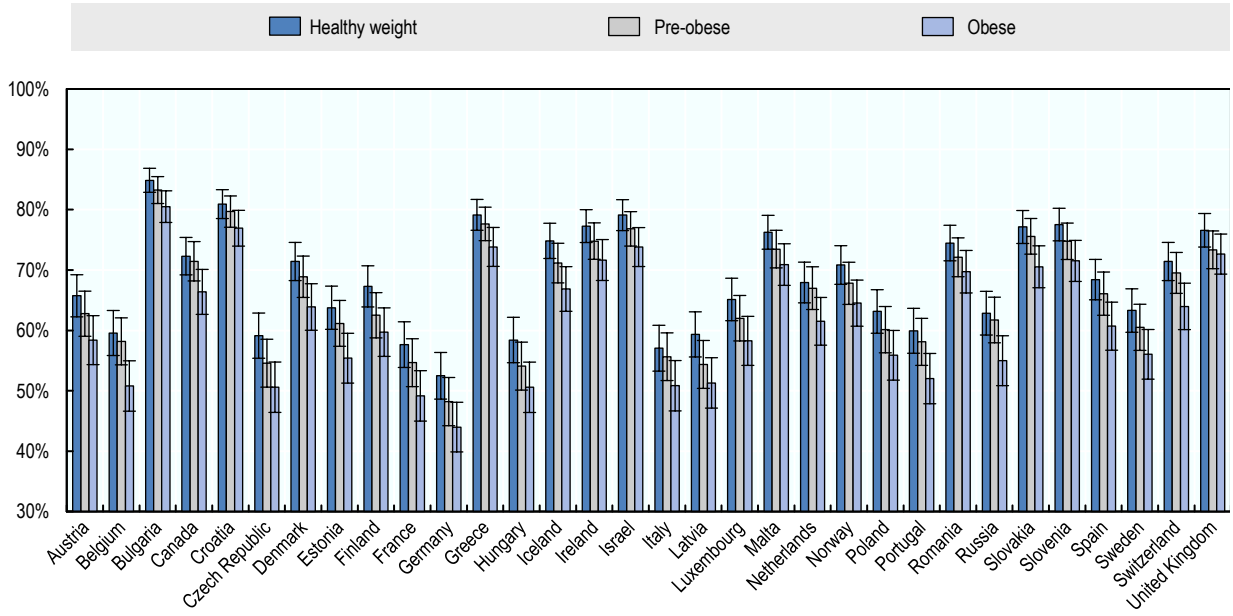
4.2.1. Obese children have lower performance at school than healthy-weight children

23. The analysis of HBSC data shows that high BMI levels in 11-15 year-olds are associated with poorer self-perceived school performance in the 32 countries studied (Figure 4.5). The strength of the relationship varied across countries. For instance in Italy, 58% of healthy-weight boys are likely to rate their performance above the class average compared to 52% of obese boys. The gradient is steeper in France, where 58% of healthy-weight boys perform above average compared to 49% of obese boys. Girls have better school performance than boys in all countries studied but Portugal.

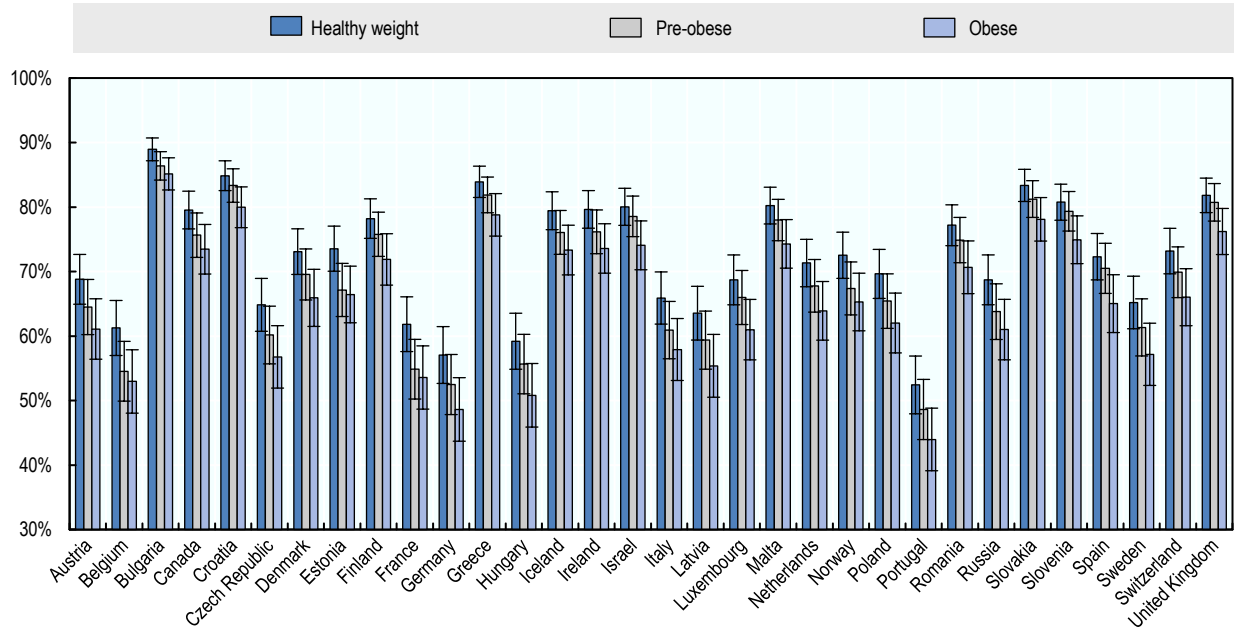
Figure 4.5. Probabilities of good performance at school by BMI level, boys and girls, by country

Predicted probability of good performance at school, with 95% confidence intervals

Panel a. Boys



Panel b. Girls



Note: Mixed model with random slope. Adjusted for age, family affluence, smoking, and drunkenness in lifetime. Covariates are set at fixed values (Age 13, Middle family affluence, Never drunk, Never smoke).

Source: OECD estimates based on 32 countries from HBSC 2013-14.

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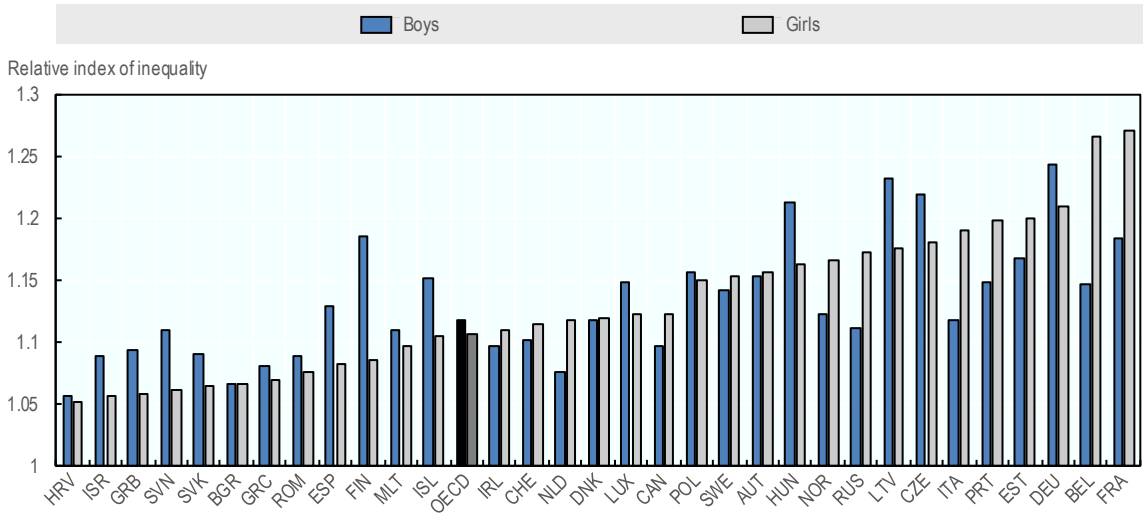
24. The gradient of inequalities – as measured by the relative index of inequality – confirms that the higher the BMI in childhood, the lower the school performance, in all countries (Figure 4.6). On average, boys and girls with a healthy weight are 13% more likely to report good school performance, compared to their peers with obesity. When the countries are pooled, boys with a healthy weight are 12% more likely to report good school performance and girls 11%.

25. Obesity-related inequalities in school performance are larger for boys in 19 countries and for girls in 15 countries. France and Belgium have the largest inequalities among girls - in both cases, girls with a healthy weight are about 27% more likely to report good school performance compared to girls with obesity. Germany and Latvia display the largest inequalities among boys, – with an increased probability for boys with a healthy weight to report good school performances of, respectively, +24% and +23%.

Figure 4.6. Relative index of inequality for good performance at school by BMI category



Note: The RII is calculated as the ratio between the probability of good school performance for obese children divided by the probability for healthy-weight children, taking into account the average BMI of each group. A RII greater than 1 means that the likelihood of good performance at school decreases with BMI. The greater the RII, the larger the inequality across BMI categories. For example, in France, healthy-weight girls have 27% more chance of performing well at school than the most obese girls. The OECD average is derived from a pooled countries analysis weighted by the national sample size.
Source: OECD analysis based on HBSC 2013-14.

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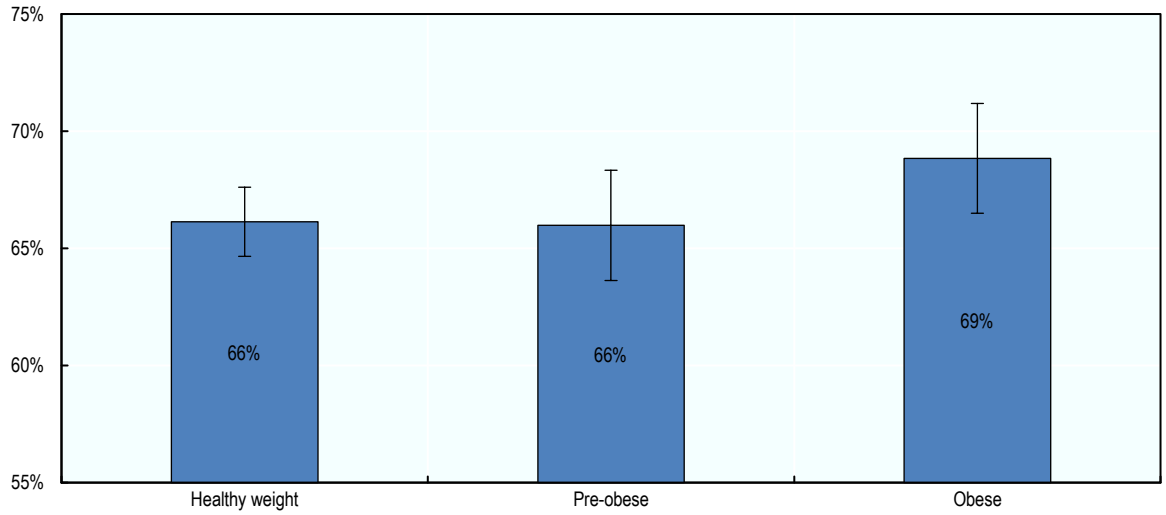
26. Differences in school performance have remained stable over the last decade. A time-trend analysis showed that from 2002 to 2014 there were no significant differences in school performance across BMI categories over time on average across OECD countries (Annex Figure 4.A.3). This finding applies for boys and girls, and is fairly consistent across countries.

4.2.2. Obese teenagers are more likely to miss school

27. Analysis based on the NHANES data shows that obese teenagers, aged 12-19, are more likely to miss school (Figure 4.7). 69% of obese adolescents had missed school days in the past 12 months compared to 66% of healthy-weight adolescents. The difference is not significant in children aged 6-11. The pattern is similar for boys and girls, and results are therefore presented together.

Figure 4.7. School absence and BMI categories, in children aged 12-19, United States

Predicted probability of being absent, with 95% confidence interval



Source: OECD analysis based on US NHANES 2001-2008.

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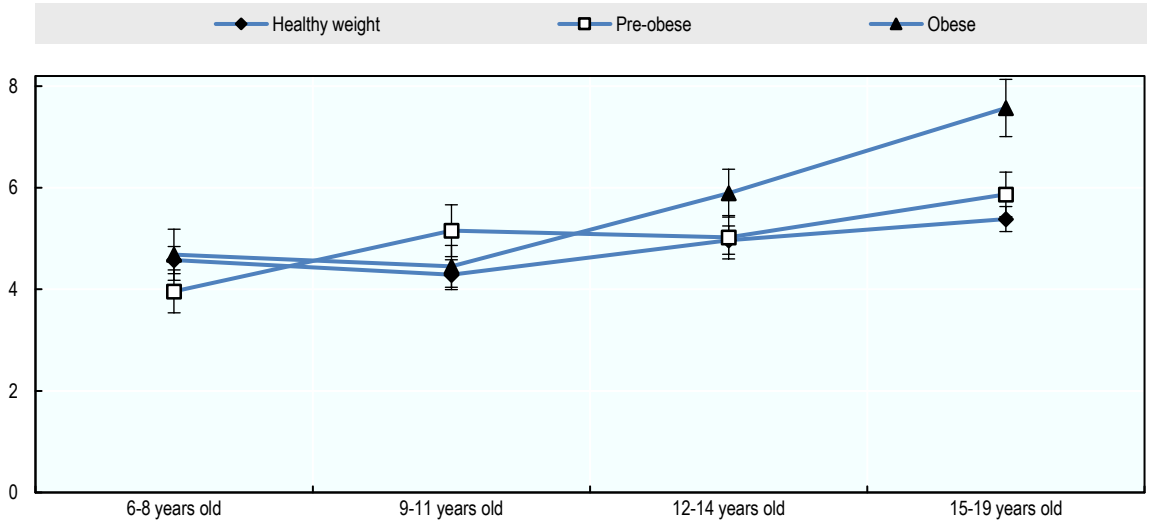
28. When absent from school, obese adolescents had significantly more days of absence than healthy-weight adolescents aged 12 and above (Figure 4.8). Among those aged 12-14, obese adolescents reported 5.9 days of absence per year compared to 5.0 days in healthy-weight adolescents. Obese and healthy weight adolescents aged 15-19 reported 7.6 days versus 5.4 days of absence, respectively.

Figure 4.8. Average number of days of absence when absent, by age group and BMI category, United States

Number of days of absence per year



Source: OECD analysis based on US NHANES 2001-2008.

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4.3. A potentially causal effect of childhood obesity on educational outcomes is found in five countries

29. From a policy perspective, it is important to understand the nature of the association between obesity and educational outcomes. If the relationship is causal, public health policy could help improve not only child health, but also educational outcomes such as bullying at school, absence, academic performance, and education attainment.

4.3.1. The literature presents mixed evidence for the causal effect of obesity on education

30. A number of studies have looked at the causal effect of obesity on educational outcomes, but with mixed results emerging. While some studies found a temporal association between obesity and educational outcomes, studies looking at younger children found no relation between obesity and educational outcomes, and yet others found different results for males and females.

31. A retrospective cohort study found a causal relationship between overweight and future academic performance among female high school students in Saudi Arabia. Girls who were overweight in 10th grade had 3.73 higher odds to experience a decline in grades between the 10th and 12th grade than healthy-weight students (Adaili, Mohamed and Alkhashan, 2017[21]). Similar evidence from Sweden suggests that male obesity may lead to lower educational attainment. Swedish men who were obese at age 18 had 70% less chance of completing at least 15 years of education than healthy-weight subjects, even when adjusting for intelligence and socioeconomic factors (Karnehed et al., 2006[22]).

32. Among younger children, evidence for a causal relationship is lacking. At least two studies found no significant relationship between child obesity and educational performance in primary school. A Dutch birth cohort study found no statistical association between the number of years that children were overweight and final year test scores or teacher assessment (Ruijsbroek et al., 2015[23]). Likewise, a Taiwanese study following elementary school children over six years found that BMI changes were not significantly associated with changes in academic performance (Chen et al., 2012[24]). Regarding education attainment, an analysis of the 1970 British Cohort Study found no significant relationship between obesity at 10 years old and educational attainment at 30 years old, after adjusting for confounders such as social class, parental BMI and education (Viner and Cole, 2005[25]).

33. Two studies found evidence for a causal association in girls, but not in boys. A UK study based on the ALSPAC cohort showed an impact of overweight on future test scores in girls. Obesity at age 11 decreased the English marks of girls at age 13 and 16, compared to healthy-weight girls, even after controlling for confounders. However, the effect was not significant for boys (Booth et al., 2014[26]). Similarly, a US study highlighted that becoming overweight between kindergarten entry and third grade was associated with reductions in test scores and teacher ratings of social-behavioural outcomes and approaches to learning for girls, but no such effects were found for boys (Datar and Sturm, 2006[27]).

4.3.2. An OECD analysis points to a negative causal relationship between obesity and educational outcomes in five countries

34. An OECD analysis based on longitudinal data available in five countries suggests that the relationship between obesity and educational outcomes may be causal. The data and methods are described in Box 4.2.

Box 4.2. Description of the longitudinal analyses

35. The objective of this analysis was to identify a potential causal relationship between obesity and educational outcomes. To investigate whether the relationship is causal, longitudinal datasets were used. By measuring obesity in one wave, and the educational outcomes in a later wave, temporal precedence can be established – one of the requirements for causality (Oppewal, 2010[18]). Lagged regression models were used to test this relationship.

36. The results in this section are based on data from longitudinal cohort studies in the United Kingdom (the 1970 British Cohort Study), the United States (the National Longitudinal Study of Adolescent to Adult Health, or Add Health), the Russian Federation (Russia Longitudinal Monitoring Survey, or RLMS), Germany (The German Health Interview and Examination Survey for Children and Adolescents, or KiGGS) and the Netherlands (The Prevention and Incidence of Asthma and Mite Allergy, or PIAMA). These longitudinal cohorts were selected as they included school-aged children and collected data on obesity and educational performance or attainment.

37. Educational outcomes were measured as educational performance and educational attainment. Educational performance is the performance of a student during his or her time in school. This included, for example, grades obtained in school subjects, teacher's assessment of performance relative to other students, or tests scores. Educational attainment is the level of education ultimately achieved. This was measured as the number of years spent in full-time education, or whether the student completed any degree-level higher education.

38. An effort was made to standardise the analyses across the different country datasets. However, due to differences in the collected and reported data, different variables and concepts were used per country. Obesity was deduced from body mass index (BMI) using the child cut-off values defined by the

WHO (de Onis et al., 2007[28]). To correct for confounders, the models were adjusted for age, ethnicity or minority status, social class and/or income, and alcohol consumption - depending on the availability of data.

39. *For more details on the datasets and the methods, please refer to OECD Health Working Paper 109 (* (Vuik, Devaux and Cecchini, 2019[29]).

Childhood obesity is associated with lower educational performance later on

Table 4.1. Lagged relation between obesity and educational performance

Country	Outcome	Method	Exposure	Male	Female
United States	GPA (1 to 4)	Lagged linear regression	Obesity (vs healthy weight)	**Coefficient: -0.11***	**Coefficient: -0.26****
			Pre-obesity (vs healthy weight)	Coefficient: -0.00	**Coefficient: -0.15****
			BMI	**Coefficient: -0.01****	**Coefficient: -0.02****
			BMI (quadratic)	**Coefficient: -0.0002****	**Coefficient: -0.0004****
Russia	Average grade (1 to 5)	Lagged linear regression	Obesity (vs healthy weight)	Coefficient: 0.03	**Coefficient: -0.11****
			Pre-obesity (vs healthy weight)	Coefficient: 0.03	Coefficient: -0.02
			BMI	**Coefficient: 0.01****	**Coefficient: -0.01****
			BMI (quadratic)	**Coefficient: 0.0001***	**Coefficient: -0.0001****
Germany	Average grade (6 to 1; *NOTE: lower grade is better performance)*	Lagged linear regression	Obesity (vs healthy weight)	Coefficient: 0.08	Coefficient: 0.05
			Pre-obesity (vs healthy weight)	Coefficient: 0.06	Coefficient: -0.02
			BMI	Coefficient: 0.01	Coefficient: -0.01
			BMI (quadratic)	Coefficient: 0.0162	Coefficient: -0.0002
Netherlands	High level of high school	Lagged logistic regression	Overweight (vs healthy weight)	**Risk ratio: 0.80****	Risk ratio: 0.89
			BMI	**Odds ratio: 0.91****	**Odds ratio: 0.94***
			BMI (quadratic)	**Odds ratio: 0.997****	**Odds ratio: 0.998***
	High school level below teacher assessment level	Lagged logistic regression	Overweight (vs healthy weight)	Risk ratio: 0.79	Risk ratio: 0.82
			BMI	Odds ratio: 0.98	Odds ratio: 1.003
			BMI (quadratic)	Odds ratio: 0.999	Odds ratio: 1.00002

Note: *** significant at 0.1 level; **: significant at 0.05 level; ***: significant at 0.01 level**
Results shown are adjusted for age, ethnicity or minority status, social class and/or income, and alcohol consumption (United States only). The coefficients of linear regression models can be interpreted as the increase in outcome for each unit increase in exposure; relative risks show how much more or less likely one group is to experience the outcome, with a value greater than one signifying a higher likelihood; odds ratios are similar to risk ratios but are based on odds rather than risk.

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40. In the United States study population, there was a statistically significant relation between BMI or obesity and GPA a year later, even when correcting for confounders such as age, gender, family income and ethnicity (note that all results presented here are adjusted for confounders). The GPA of girls with obesity was 0.26 points lower than those of girls with healthy weight. This equates to a student with a

median GPA of 2.75 dropping to the 45th percentile. For boys, obesity was associated with a 0.11 point lower GPA a year later – a smaller but still significant effect. Similarly, a point increase in BMI was associated with 0.009 points (95% CI: 0.0001 to 0.0178) decrease in GPA for boys; and 0.021 points (95% CI: 0.015 to 0.028) for girls.

41. In the Russian data sample, BMI was also associated with lower grades for girls, by 0.007 (0.002 to 0.012) points per point BMI. There also was a significant effect of BMI on grades for boys, but the effect was in the opposite direction: a one-point increase in BMI was linked to a 0.007 (0.001 to 0.012) point increase in average grade a year later.

42. In the Netherlands, performance was measured based on the different levels of high school that exist. The analysis showed that boys who were overweight at age 11 were 20% less likely to attend a high level of high school at the age of 17 (RR: 0.80, 0.65 to 0.95), while the effect for girls was not significant. However, when looking at performance relative to the teacher's assessment at age 11, there was no significant effect of overweight or BMI in either sex.

43. In Germany, no significant relation was found between obesity and educational performance six years later.

Childhood obesity during school years is associated with lower education attainment

Table 4.2. Results of obesity and educational attainment analyses

Country	Outcome	Method	Exposure	Male	Female
United States	Any higher education	Lagged log-binomial regression	Obesity (vs healthy weight)	Risk ratio: 0.88	**Risk ratio: 0.72*** **
			Pre-obesity (vs healthy weight)	Risk ratio: 0.97	**Risk ratio: 0.79*** **
			BMI	Risk ratio: 1.00	**Risk ratio: 0.98*** **
			BMI (quadratic)	Risk ratio: 0.9999	**Risk ratio: 0.9995*** **
United Kingdom	Any higher education	Lagged log-binomial regression (or logistic regression for odds ratio)	Obesity (vs healthy weight)	**Risk ratio: 0.42****	Risk ratio: 1.02
			Pre-obesity (vs healthy weight)	Risk ratio: 0.83	Risk ratio: 0.86
			Overweight (vs healthy weight)	**Risk ratio: 0.76****	Risk ratio: 0.88
			BMI	**Odds ratio: 0.95****	Risk ratio: 0.98*
			BMI (quadratic)	**Odds ratio: 0.9987****	**Risk ratio: 0.9996****
	Age left FT education	Lagged linear regression	Obesity (vs healthy weight)	Coefficient: -0.91*	Coefficient: -0.35
			Pre-obesity (vs healthy weight)	Coefficient: -0.19	Coefficient: -0.35*
			Overweight (vs healthy weight)	Coefficient: -0.33	Coefficient: -0.35*
			BMI	Coefficient: -0.04*	**Coefficient: -0.04****
			BMI (quadratic)	Coefficient: -0.0008*	**Coefficient: -0.0010****
Russia	Any higher education	Lagged log-binomial regression	Overweight (vs healthy weight)	Risk ratio: 0.73	Risk ratio: 0.94
			BMI	Risk ratio: 1.04	Risk ratio: 0.98
			BMI (quadratic)	Risk ratio: 1.0009	Risk ratio: 0.9995

Note: ***: significant at 0.1 level; **: significant at 0.05 level; ***: significant at 0.01 level**
Results shown are adjusted for age, ethnicity or minority status, social class and/or income, smoking status (except for the United States), and alcohol consumption. The coefficients of linear regression models can be interpreted as the increase in outcome for each unit increase in exposure; relative risks show how much more or less likely one group is to experience the outcome, with a value greater than one signifying a higher likelihood; odds ratios are similar to risk ratios but are based on odds rather than risk.

44. OECD analysis based on longitudinal data available in three countries points to a negative impact of obesity on educational attainment in the United States and the United Kingdom, while no significant relationship was found in Russia.

45. While neither obesity nor BMI in Wave 1 predicted whether a boy would complete higher education in the United States, both variables were significant predictors for girls. A girl who was obese in Wave 1 was 38% less likely to complete higher education 14 years later than someone of healthy weight (RR: 0.72, 0.59 to 0.88).

46. Conversely, in the United Kingdom, the relation between obesity and educational attainment was significant only for boys, who were 58% less likely to have completed higher education at the age of 29 if they were obese at age 16 (RR: 0.42, 0.16 to 0.95). However, a higher BMI did have a significant effect in girls: for each point increase in BMI at age 16, girls spent 0.044 (0.004 to 0.085) years less in higher education – approximately half a month.

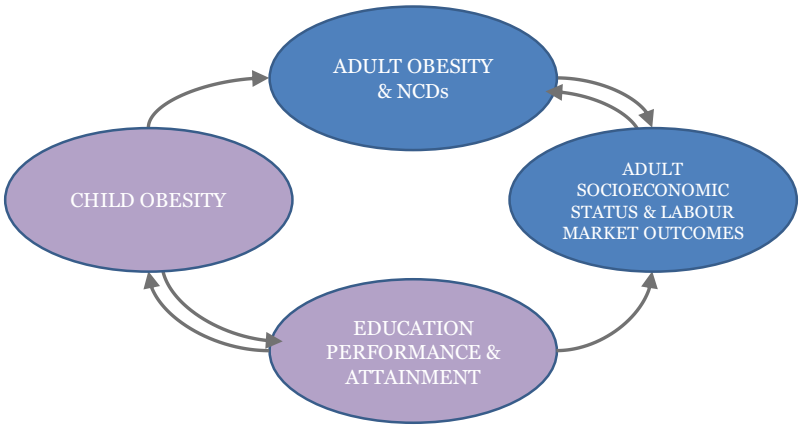
47. In Russia, no significant relation was found between obesity and educational attainment using lagged regression models.

48. Comparing effect sizes across countries is complicated by to differences in survey data. The diverging results that were found across countries may be the result of the national context; but they may also be caused by differences in the data. All cohorts collected data at different ages and at different intervals. While efforts were made to standardise the variables used for analysis, the data collected in each cohort was not always fully comparable. In particular, the type of variables available on socioeconomic status and ethnicity/minority status varied across datasets, and may have caused differences in the results. Moreover, the known difference between self-reported and measured BMI may have also contributed to differences between the countries (Devaux et al., 2011[30]).

4.4. The short-term and long-term consequences of childhood obesity are of concern for individuals and societies

49. The consequences of overweight in children are important because they affect the entire life span. Childhood obesity may have short-term direct effects on physical and mental health, and educational outcomes such as bullying, school absence, low concentration, and poor grades, as discussed in the previous sections. In addition to this, long-term consequences may emerge, affecting both health and economic outcomes. Figure 4.9 depicts the potential consequences of childhood obesity on adult economic outcomes. In particular, it highlights the double burden: (a) through obesity in adulthood, which in turn affects labour market outcomes, and (b) through potentially lower educational outcomes, which in turn affect adult socioeconomic status.

Figure 4.9. The double burden of childhood obesity on poor economic outcomes



Notes: Purple bubbles refer to childhood and adolescence, while blue ones refer to adulthood.

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50. Obesity in childhood has long-lasting health consequences. Obese children are more prone to become obese adults, and they have a higher risk of developing non-communicable diseases like diabetes, cardiovascular diseases, musculoskeletal disorders (Kelsey et al., 2014[31]). As the age of onset and the duration of obesity matter for NCDs, young obese children are more at risk of premature death and disability in adulthood (Abdullah et al., 2011[32]).

51. In addition to the health implications, obesity also carries adverse labour market outcomes. Childhood obesity is a leading determinant for adult obesity and related diseases, which in turn, have consequences on employment and work productivity. People who suffer from obesity and its related chronic diseases have lower chance to be employed, are more absence from work, and retire earlier (Devaux and Sassi, 2015[33]). Further evidence is provided in a subsequent Chapter (ref).

52. As shown in the analyses in this chapter, overweight and obesity in childhood are also related to educational outcomes. In addition to disadvantaging the individual, this effect also multiplies the negative impact of obesity on society and the economy at large.

53. First, school performance and educational outcomes are key determinants for the formation of human capital. As such, reduced school performance may affect a country's economic growth. An OECD report using Programme for International Student Assessment (PISA) data shows that improving the cognitive skills of the population can lead to significant economic gains and that relatively small improvements to labour force skills can largely impact the future well-being of a nation (OECD, 2010[34]). A modest goal of all OECD countries boosting their average PISA scores by 5% (25 points) over the next 20 years would increase OECD gross domestic product by USD 115 trillion over the lifetime of the generation born in 2010 (OECD, 2010[34]).

54. Second, differences in health and health behaviours can reinforce existing social inequalities, which in turn affect a country's social welfare. Differences in health arising from young ages perpetuate in adulthood, generating further inequalities in health status in adulthood but also social inequalities like inequalities in job prospect and income gaps (Michael Marmot, Peter Goldblatt, Jessica Allen, 2010[35]). Inequalities and social injustice can jeopardise a nation's social welfare. This is a main concern for European countries, which have recently agreed on the European Pillar of Social Rights that seeks to guarantee new and more effective rights to citizens. These range from equal opportunities and access to labour market to fairer working conditions and social protection and inclusion (Tajani and Juncker, 2017[36]).

4.5. Reducing childhood obesity would help to build future better lives and stronger societies

55. A significant association exists between childhood obesity and educational outcomes; this relationship is driven through mediating factors such as diseases, behaviours such as unhealthy diet and physical inactivity, and emotional and mental health problems. An OECD analysis based on longitudinal data from five countries suggests that the presence of obesity at a young age can, in some cases, affect school grades and educational attainment later on in life. As education is a determinant of the formation of human capital, future individual socioeconomic status and GDP, this effect can exacerbate the negative impact of obesity on society and the economy.

56. This chapter describes the implications of childhood obesity on well-being and mental health, educational outcomes, and furthermore, on the economy and the welfare of societies. Policymakers should invest in a wide range of policy interventions aimed to tackle childhood obesity, reduce the obesity stigma, reduce bullying, and improve the well-being and mental health of obese and overweight children. Such interventions have the potential to improve the lives of children by improving educational performance and attainment, future labour market prospects and overall health and wellbeing.

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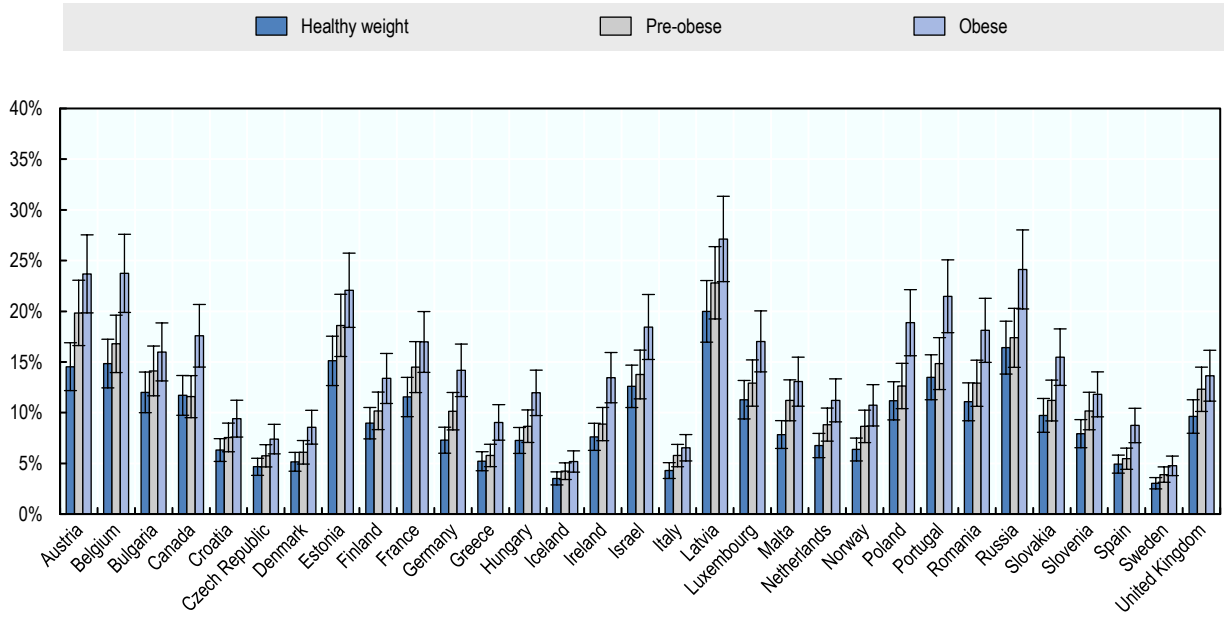
Annex 4.A. Further analyses on inequality

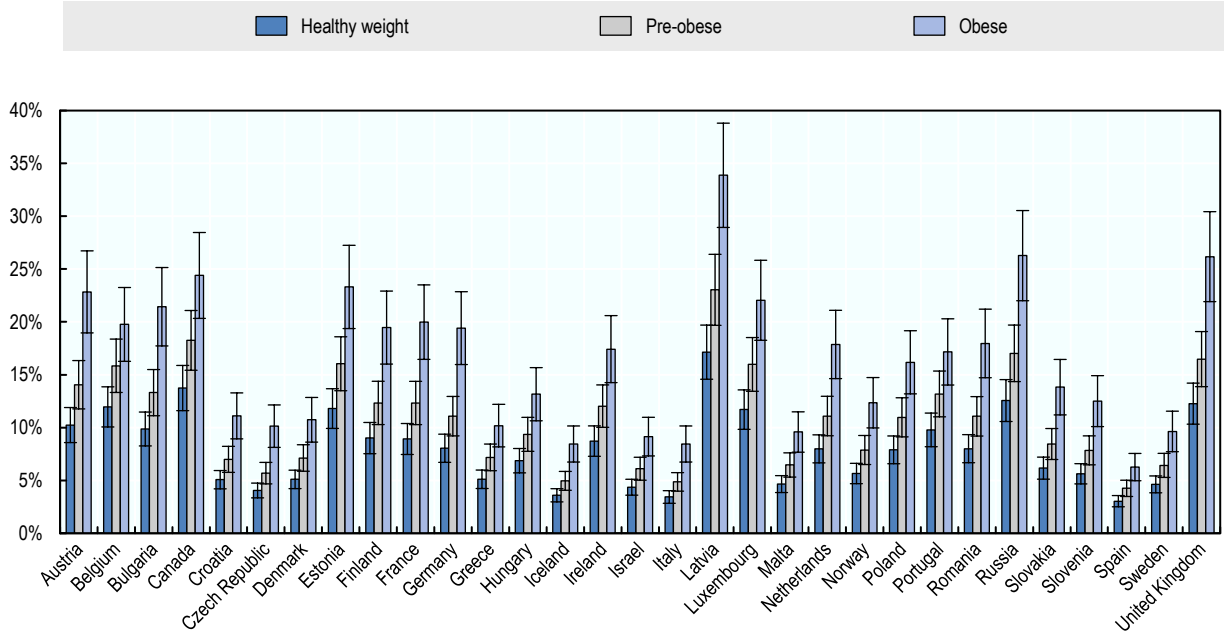
Annex Figure 4.A.1. Probabilities of being bullied by BMI level, boys and girls, by country

Predicted probability of being bullied, with 95% confidence intervals

Panel A. Boys



Panel B. Girls



Note: Mixed model with random slope. Adjusted for age, family affluence, smoking, and drunkenness in lifetime. Covariates are set at fixed values (Age 13, Middle family affluence, Never drunk, Never smoke).
Source: OECD analysis based on HBSC 2013-14.

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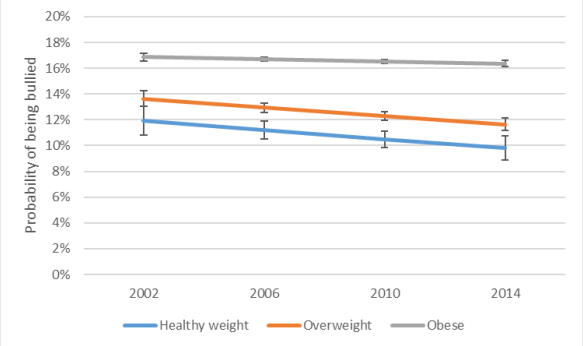
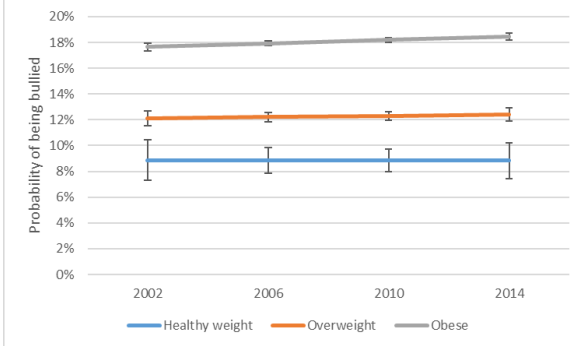
Annex Figure 4.A.2. Time evolution of the probability of being bullied, by BMI category, OECD countries

Boys, age 11-15



Girls, age 11-15



Note: Predicted probabilities obtained from logistic model, and adjusted for BMI categories, survey year, and their interaction term, as well as age, smoking status, drinking status and family socioeconomic background.
Source: OECD analysis based on four waves of HBSC survey.

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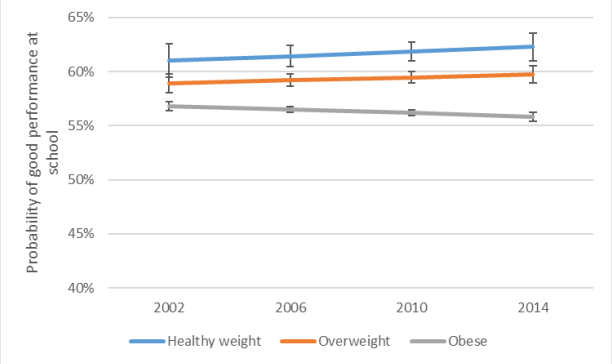
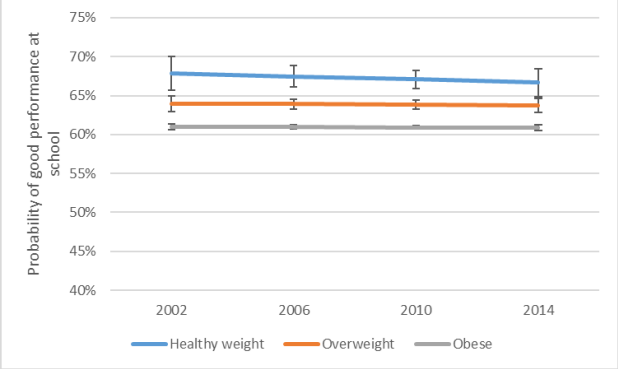
Annex Figure 4.A.3. Time evolution of the probability of school performance, by BMI category, OECD countries

Boys, age 11-15



Girls, age 11-15



Note: Predicted probabilities obtained from logistic model, and adjusted for BMI categories, survey year, and their interaction term, as well as age, smoking status, drinking status and family socioeconomic background.
Source: OECD analysis based on four waves of HBSC survey.

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