# Intergenerational effect of schooling and childhood overweight

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**Abstract**

Prevalence of overweight among children is at the top of health policy agenda in many developed countries. We study the causal effect of mothers' schooling on children's body weight. We exploit the 1972 schooling reform in England and Wales, which raised the minimum school leaving age from fifteen to sixteen. Our regression-discontinuity estimates use Health Survey for England (1998-2002) and show that the extra year of schooling for mothers induced by the reform significantly reduces their son's weight. There is little causal effect for daughters. Additionally, we do not find that mothers' schooling improves children's health behaviour, mothers' own weight, and mothers' own health behaviour.

Keywords: Childhood overweight, Education, Regression-discontinuity.

JEL: I12, I20.

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## 1 Introduction

Childhood overweight has been one of the most serious public health problems in developed and developing societies. In England, the prevalence of overweight children has increased at an alarming rate since the late 1980s. Rona and Chinn (2001) report that it was 5.4 percent for boys and 9.3 percent for girls in 1984, rising to 9.0 percent for boys and 13.5 percent for girls in 1994. Lobstein et al. (2004) update the information and note that the rate reached as high as 17.0 percent for boys and 23.6 percent for girls in 1998.[1]

Preventing childhood overweight is an important health-policy goal as it burdens society directly and indirectly. The direct burden is the health care cost in relation to obesity and associated diseases. The indirect one includes lower educational achievements and hence lower social and economic outcomes in the future (Ding et al., 2006). Preventing childhood overweight may also mitigate adulthood overweight (or obesity) because overweight children are more likely to become overweight adults.

In this study we investigate the relationship between a mother's schooling and her children's weight measures. In particular, we examine if the relationship is causal. Mothers' education is one of the most important socioeconomic factors predicting children's health (Case et al., 2002; Currie, 2009). Previous studies confirm that the children of educated mothers are more likely to be healthier as educated mothers tend to have higher salaries or marry high-earning husbands; they can therefore afford healthy foods. They are also better at processing nutritional information about various foods and are therefore more efficient at managing their children's weight.

Little is known, however, about whether mothers' schooling has a causal effect on children's weight. It is unlikely that children's weight affects mothers' schooling. However, unobserved third factors, such as a mother's general ability, will power, and time preference, may explain both her own schooling and children's weight. We investigate

[1] Rona and Chinn (2001) use a sample of children aged 4-11, while Lobstein et al. (2004) use children aged 7-11. They both use the definition of overweight which is recommended by the International Obesity Task Force.

the causality by exploiting the 1972 reform of the compulsory schooling law in England and Wales, which provides an exogenous variation in mothers' schooling. In the English and Welsh education system, all children of compulsory schooling age must engage in full time education. The compulsory schooling age is regulated by the law. In 1972, the minimum school leaving age was raised from fifteen to sixteen by the Raising of School Leaving Age (RoSLA) policy. That is, children who were born before September 1957 were permitted to leave school and work at age fifteen, whereas those who were born after this date were forced to stay in school until they became sixteen.

We employ regression-discontinuity design (RDD) to examine if the additional schooling induced by the reform has had a significant impact on the next generation's bodyweight. RDD is close to a local randomised experiment (Lee and Lemieux, 2009). We regard mothers who were born just before September 1957 (control group) as the counterfactual of those who were born just after this cut-off point (treatment group). The effect of the reform should be viewed as a local average treatment effect to mothers who would have left school at age fifteen, rather than the average treatment effect to the general population. We therefore focus on mothers who left school at age fifteen or sixteen in the main analysis (Black et al., 2005; Lindeboom et al., 2009). Finally, previous studies use year of birth as the assignment variable to determine whether one is exposed to the reform or not. However, since the reform was implemented in the middle of the year (1st September), measurement error in the treatment status may affect their results (Lee and Card, 2008). We use month of birth as well as year of birth as the assignment variable. We thus identify the treatment status much more efficiently.

Our main result is based on children aged five to fifteen and their mothers who were born between September 1952 and August 1962 and left school at age fifteen or sixteen from Health Survey for England (1998-2002). We find that the reform significantly increases mothers' schooling by about 0.35-0.45 years. An extra year of schooling generated by the reform significantly reduces their sons' BMI Z-score by about 0.55-0.9 points and the probability of being overweight by about 0.2-0.25 (depending on different specifications). There is little effect for daughters.

In addition to the main analysis, we investigate the impact of mothers' schooling on children's health behaviour such as fruit and vegetable consumption and physical activity. We find little causal effect of schooling on these variables. Also, we examine if a mother's schooling improves her own weight and health behaviour. We do not find any causal effect for mothers' own outcomes.

The paper proceeds as follows. Section 2 reviews previous literature. Section 3 describes our data set. Section 4 explains the empirical framework. Section 5 shows the main results. Section 6 gives the results of additional analyses. Finally, Section 7 concludes.

## 2 Literature

The association between parent's schooling and children's health is well documented in the literature (Currie, 2009 for survey). A large and significant association between mother's educational attainment and children's general health status is found in the US (Case et al., 2002), Canada (Currie and Stabile, 2003), and England (Currie et al., 2007). Chen and Li (2009) use samples from China, and find that mothers' education is positively associated with adopted children's height-for-age Z-score. They conclude that the positive association between mothers' education and children's health is not merely due to genetic factors. Finally, Stifel and Averett (2009) use samples from NLSY79 in the US, and find that mothers' education is associated with a decline of overweight for white boys, and also a decline of underweight for white girls.

Several studies address the endogeneity in schooling.[2] Currie and Moretti (2003) investigate the relationship between mothers' schooling and children's birth weight. They use samples from Vital Statistics Natality record in the US from 1970 to 1999. Their source of exogenous variation in schooling is the expansion of the number of colleges available for mothers when they were seventeen between 1940 and 1990. They conclude

[2]There are larger number of studies which investigate the causal relationship between education and adults' own health or own weight (Lleras-Muney, 2005; van Kippersluis et al., 2009; Clark and Royer, 2010; Blunello et al., 2009; Webbink et al., 2010). Their conclusions are mixed.

that mothers' schooling reduces the probability of low birth weight, notably by improving mothers' health behaviour with regard to habits such as smoking.

McCray and Royer (2006) examine the effect of mothers' schooling on low birth weight and infant mortality in California (1989-2002) and Texas (1989-2001) in the US. Their identification strategy is based on the policies for school entering age. One must be five years old on December 1st in California and on September 1st in Texas to enter school. Using the exact day of birth of mothers, they show that those who were born just after the cut-off point tend to be less educated compared to those who were born just before the cut-off point. They find that mothers' schooling has little effect on the low birth weight and infant mortality rates.

Chou et al. (2010) estimate the effect of parents' schooling on infant birth weight and mortality in Taiwan. Their sample is from all birth certificates and infant death certificates in Taiwan between 1978 and 1999. They construct their instrumental variable using the 1968 education reform, which raised the compulsory education from six to nine years, and the expansion of the number of junior high schools at the different rates in different regions. By doing so, they are able to deal with the treatment and also the intensity of the treatment on schooling. They find that both mothers' and fathers' schooling reduces the probability of low birth weight and infant mortality.

The following two studies are closest to our own study. Doyle et al. (2007) investigate the effect of parents' income and education on children's self-assessed health and chronic conditions. They use samples from the Health Survey for England (1997-2002). Their instrumental variable approach uses the 1972 compulsory education reform, which raised the minimum school leaving age from fifteen to sixteen. They allow for the impact of the reform on schooling varying across regions and find that it is significant in the North West region, where historically people are less educated. They find that mothers' schooling reduces children's self-assessed health and chronic conditions. Compared to our study, they use the same data set (HSE) and the reform (the 1972 reform). However, our study is different from theirs in several ways. First, we examine childhood overweight. We investigate variables such as body mass index, fruit and vegetable consumption, and physical activity. Second, we use regression-discontinuity framework to compare between parents who were born just before and just after the cut-off point. Finally, Doyle et al. (2007) highlight the regional variation in the impact of the reform on at all levels of education. By contrast, we focus on those who left school at age fifteen or sixteen (thus those who were directly affected by the reform) to verify the significance of the reform.

Lindeboom et al. (2009) examine the relationship between parents' schooling and children's various health outcomes including BMI and overweight status. Their sample is derived from children who were born in 1958 and part of the National Child Development Study in the UK. They use the 1947 compulsory education reform, which raised the minimum school leaving age from fourteen to fifteen, to instrument parents' schooling. They find that parents' schooling has little effect on all health outcomes of the children they study. However, they find that schooling significantly reduces financial difficulties. Their study is close to our study in that it investigates children's weight for the same country (UK). However, their analysis is based on children who were born in 1958. As childhood overweight has been prevalent since the late 1980s, it is important to extend their study by using an updated data set. We use a different reform which was conducted in 1972. We analyse children living between 1998 and 2002, which is reasonably recent. Moreover, we examine children's health behaviour (fruit and vegetable consumption and physical activity).

## 3 Data

We use the Health Survey for England 1998-2002. The HSE is an annually repeated cross-sectional survey, which has been conducted since 1992. Using the Postcode Address File, national representative samples from private households are studied.[3] Originally, the HSE covered adults only. From the 1995 survey onwards, up to two children from

[3] In each year the HSE oversamples particular groups of society (such as elders, ethnic minorities) in addition to general population. This study uses a general population sample only.

each household are studied.[4] The survey collects data by face-to-face interviews, self-completed questionnaires and nurse visits. The survey covers various topics including demographic, socioeconomic and health status.

In the HSE, information about month of birth and year of birth is available. Month of birth is only available in 1998-2002 surveys. Identifying the month of birth is crucial because it precisely determines whether a mother was exposed to the reform or not. Specifically, we need to know if a mother was born before or after September 1957.

Since the sampling framework of the HSE is at the household level, each individual has a household-ID. Therefore we are able to verify the relationship between members within a household. We match the information on a child with his/her mother's characteristics. We do not distinguish between natural, adopted, foster and step mothers. We identify 18053 mother-child pairs (including pairs where, for example, both child and mother are elders). The estimation sample is selected in the following way. Since we analyse childhood overweight, we focus on school children aged five to fifteen. We use mothers who were born between September 1952 and August 1962 to focus on those who were born just before or just after the reform. We drop observations which contain item non-response. Eventually, 3605 pairs remain.

We measure children's weight by BMI for age and gender Z-score (hereafter BMI Z-score). BMI is derived using measured height and weight. The Z-score is calculated by the LMS method using the reference distribution for British children in 1990. See Cole et al. (1995) for detail. We use the definition of overweight proposed by Cole et al. (2000). The threshold value for overweight is different across age and gender. Descriptive statistics are shown in Table 1.

[**Table 1 here**]

We show the results separately by mother's treatment status (i.e. pre-reform and post-

[4]Two children are randomly selected. The HSE defines children as individuals who are fifteen years old or younger. With children aged less than twelve, parents answer the questions with the child present. Children aged thirteen to fifteen can answer the questionnaire by themselves. Finally, adults (older than sixteen) answer by themselves.

reform cohorts) and by gender of the children. We provide results from two different samples. The first is the full sample, where mothers are from all education levels. The second is the restricted sample, where we use mothers who left school at age fifteen or sixteen. This is because the reform only affected those who would have left school at age fifteen. Column A shows the result for children using the full sample. The mean BMI Z-score is around 0.5-0.6 for both genders. This implies that children in 1998-2002 are heavier by 0.5-0.6 standard-deviation points than they were in 1990. Overweight rate ranges between 23 and 30 percent. Compared to the post-reform sample, the pre-reform sample exhibits a slightly higher BMI Z-score and overweight rate for sons, but it shows a lower BMI Z-score and overweight rate for daughters. Next, column B shows the result from the restricted sample. In this sample, both sons and daughters are slightly heavier compared to the full sample case. This is intuitive since children of less educated mothers are more likely to be heavier. Compared to the post-reform sample, the pre-reform sample displays a higher BMI Z-score and overweight rate for sons, while it displays a lower BMI Z-score and overweight rate for daughters.

We measure mother's schooling by school leaving age.[5] In the HSE, the variable is continuous but is bottom-coded at fourteen and top-coded at nineteen (i.e. 14 or less, 15, 16, 17, 18, 19 or more). Bottom-coding may not be so serious because the number of mothers who left school at fourteen or below is very small (1.7 percent). However, top-coding can be serious. As for mothers who left school at nineteen or above, we recode the variable following Doyle et al. (2007). We use information from the UK Labour Force Survey to get the average school leaving age for one's highest qualification. School leaving age is recoded to be twenty-one if one has a university degree. Also, it is recoded to twenty if one has a teaching qualification. As a result, school leaving age ranges between fourteen and twenty-one.[6] The average age of school leaving age is 17.12 (See Table A1 in the appendix).

In addition to these key variables, we have other control variables. They are mother's

[5]Mothers are asked to answer the following question. "At what age did you finish your continuous full-time education at school or college?"

[6]See Doyle et al. (2007) for more detailed procedure.

age, children's age, region of residence dummies, and survey year dummies. The average age of mothers is 43.9. The average age of sons is 10.74, whereas the average age of daughters is 10.70. The detail is given in Table A1 in the appendix.

## 4 Econometric framework

We employ a regression-discontinuity design (Hahn et al., 2001; Lee and Lemieux, 2009). We estimate the causal effect of mothers' schooling on children's BMI Z-scores and the probability of being overweight. The 1972 reform provides a sudden increase in mothers' schooling, particularly for those who would have left school at age fifteen.[7] Month of birth and year of birth determine whether a mother is exposed to the reform or not. Specifically, those who were born after September 1957 were exposed to the reform. Compliance to the reform was not universal and many mothers left school at age fifteen or below, even though they were exposed to the reform (about 9 percent of the full sample). We therefore conduct fuzzy regression-discontinuity analysis.

As explained in the previous section, we focus on mothers who were born between September 1952 and August 1962 (10-year window) in order to avoid using samples which are far from the cut-off point. Also, we focus on children aged five to fifteen. The effects of mothers' schooling may be different for sons and daughters. All analyses are done separately by gender of children.

We estimate the following equations:

$$Schooling_i = \alpha + \tau D_i + f(X_i) + Z_i'\theta + \varepsilon_i \quad (1)$$

$$Weight_i = \beta + \delta D_i + g(X_i) + Z_i'\phi + \epsilon_i. \quad (2)$$

In the first stage, we estimate Eq.(1). The dependent variable Schooling represents

[7] Although the RoSLA policy, which increased the minimum school leaving age, was introduced in 1972, it was preceded by the comprehensive education reform and move to selective-education systems for secondary education during the late 1960s and early 1970s. The comprehensive education reform was implemented in different regions at different speeds. Therefore the effect of this reform is not likely to affect the discontinuity in schooling at the September 1957 cohort.

mother's school leaving age. $D$ indicates whether a mother was exposed to the reform or not. We control for birth cohorts to isolate the jump in schooling at the cut-off point from the long-term trend. $X$ represents the mother's birth cohort. The function $f(X)$ is the low-order polynomial function of $X$, which is fully interacted with the reform dummy ($D$) to allow for the functional form being different on either side of the cut-off point. $Z$ represents additional control variables: mother's age, mother's age squared, children's age, children's age squared, region of residence dummies, and survey year dummies. We expect these variables to reduce sampling variations. We check if the result is robust to the inclusion of these variables.[8] We show results with and without these additional variables.

The polynomial function should fit the data well. We check the goodness-of-fit of the polynomial function using the G-test (Lee and Card, 2008). The G-test compares between the explained sum of squares of the model with polynomial function (restricted model) and that of the model with a full set of dummy variables of $X$ (unrestricted model).[9] If the two are very different we reject the null hypothesis that the polynomial specification is sufficiently flexible. Also, as X is a discrete variable, we estimate robust standard errors clustered at cohort level to take into account possible non-random specification errors at the cut-off point (Lee and Card, 2008). We determine the order of the polynomial using Akaike Information Criterion (AIC). We proceed to the next stage if the model passes the G-test and it is suggested by AIC.

We move to examine the reduced-form effect of the 1972 reform on children's BMI

[8]We follow Lee and Lemieux (2009). We estimate the first stage equation (without $Z$) by replacing the dependent variable with mother's age or child's age. We check if the reform affected these additional control variables.

[9]G-statistic is given as follows:

$$G = \frac{(ESS_R - ESS_{UR})/(J-K)}{ESS_{UR}/(N-J)}.$$

$ESS_R$ is the estimated error sum of squares of the restricted model, while $ESS_{UR}$ is that of the unrestricted model. J is the number of values of assignment variable, K is the number of parameters in the restricted models to be estimated, and N is the number of observations. The G-statistic follows $F(J-K, N-J)$ distribution. For more detail, see Lee and Card (2008).

Z-scores and the probability of being overweight. We do this by estimating Eq.(2) by OLS. We employ the linear probability model (LPM) when we estimate the probability of being overweight. We use the same specification as in the first stage estimation except for the dependent variable (Lee and Lemieux, 2009). We conduct a G-test to check if the polynomial function is sufficiently flexible. We estimate robust standard errors clustered at the cohort level (Lee and Card, 2008). All estimations are done separately by gender of children.

Finally, we show the fuzzy RD estimate. This is interpreted as the effect of an extra year of schooling *induced by the reform* on children's BMI Z-scores and the probability of being overweight. The effect is given by the ratio of the discontinuity in BMI Z-scores (or overweight) at the cut-off point to the discontinuity in mothers' schooling at the cut-off point (i.e. the Wald estimator). This is represented by $\delta/\tau$ in Eq.(1) and Eq.(2).[10] We estimate cluster robust standard errors at the cohort level.

We view our estimate as a local average treatment effect at the cut-off point (Lee and Lemieux, 2009; Imbens and Angrist, 1994). RD estimate reveals the causal effect of an extra year of schooling induced by the reform. Therefore the effect is only for those who complied with the reform. The 1972 reform increased the minimum school leaving age from fifteen to sixteen, and hence affected only those who would have left school at age fifteen. Moreover, as shown below, our main analysis is based on mothers who left school at age fifteen or sixteen. We should keep in mind that the estimated effect may be different from the one in the general population.

## 5 Results

In this section we discuss our main results, beginning with the first stage effect of the 1972 reform on mothers' schooling. Next, we show the reduced form estimate of the effect of the reform on children's BMI Z-scores and the probability of being overweight. We then show the fuzzy regression discontinuity estimates of the effect of an extra year

[10] In practice, the effect is estimated using two stage least squares (TSLS) because it provides numerically equivalent estimates.

of schooling induced by the reform on children's BMI Z-scores and the probability of being overweight.

### 5.1 Effect of the 1972 reform on mother's schooling

In the first stage, we estimate the effect of the 1972 reform on mothers' schooling. First, we check if there is really a discontinuity in schooling at the cut-off point by using graphs. The 1972 reform affected only those who would have left school at fifteen. To take this into account, we use two sets of samples. The first is the full sample, where we use mothers from all education levels. The second is a restricted sample, where we use only mothers who left school at age fifteen or sixteen. Figure 1 and Figure 2 plot mothers' average school leaving age by monthly birth cohort.

[**Figure 1 and Figure 2 here**]

In Figure 1, we use the full sample. In Figure 2, we use the restricted sample. Figure 1 displays little discontinuity around the cut-off point. In unreported analysis, we find no statistically significant increase in schooling. The full sample is not suited for RD design and therefore we do not pursue it. By contrast, Figure 2 shows a discontinuity at the cut-off point. We superimpose the flexible quadratic fit onto the plots. The fitted lines suggest that the reform extended schooling by about 0.4 years. In the following we focus on the restricted sample. Note that we no longer have the measurement error problem in schooling discussed in Section 3.

Given the graphical examination above, we formally analyse the effect of the 1972 reform on mothers' schooling. The parametric approach used in this study means it is important that the polynomial function fits the data well. We check the goodness-of-fit of polynomial functions by G-test (Lee and Card, 2008). The result indicates that single month-of-birth cohort, as drawn in Figure 2, is too noisy. To obtain a better fit of the function, we group several cohorts in order to increase the number of observations in each bin. We gradually increase the number of observations in each bin until we pass the goodness-of-fit test. Finally, we pass the test when we include ten month-of-birth cohorts in each bin (none of polynomial specifications from linear to quartic passed the test until then).

Next, we select the optimal order of polynomial by AIC. In an informal investigation, we compute AIC of fully interacted linear to quartic specifications. AIC suggests that we should adopt linear specification. In the following we present results from linear and quadratic specifications for robustness. We check if the result is sensitive to the inclusion of additional controls. The additional control variables are mother's age, mother's age squared, children's age, children's age squared, region of residence dummies (nine regions in England), and survey year dummies. We can safely include these variables into the model as we do not find any discontinuity around the cut-off point in any of these variables.[11]

Table 2 displays the result of the first stage estimates of the effect of the reform on mothers' school leaving age.

[**Table 2 here**]

The reform raises mothers' schooling by about 0.35 to 0.45 years, and the effect is highly significant in all models.[12] The result is overall robust to the inclusion of additional controls. Finally, as explained above, the G-test indicates that the models are sufficiently flexible.

We check the robustness of the effect by using narrower sample windows. In the main model, we use mothers who were born between September 1952 to August 1962, i.e. 60 month-of-birth cohorts on either side of the cut-off point. We now use 50 month-of-birth cohorts and 40 month-of-birth cohorts. As a result, the estimated effects are robust and are again highly significant.

[11]As explained in the previous section, we estimate the first-stage equation by replacing the dependent variable with each additional control variable. By doing this we can simply examine if there is a discontinuity in each control variable around the cut-off point. We do not find any discontinuity in any of the variables (details not reported).

[12]We check if the reform is a "weak" instrument. The F-statistic (not shown) is larger than 10 in all models, which implies that the reform is not weak (Staiger and Stock, 1997; Cameron and Trivedi, 2005).

To summarise, we conclude that the 1972 reform has a significant impact on mothers' schooling. Note that the result is based on the restricted sample: all mothers left school at age fifteen or sixteen.

### 5.2 Effect of the reform on children's BMI Z-scores and the probability of being overweight

Figure 3 to Figure 6 plot children's BMI Z-scores and overweight rate by mothers' month-of-birth cohort with flexible quadratic fit (separately by gender).

[**Figure 3 to Figure 6 here**]

Plots do not show a visually obvious discontinuity around the cut-off point in all cases. However, quadratic fit indicates that there is a small discontinuity at the cut-off point especially for sons' outcomes.

Next, we formally examine the reduced form effect of the reform on children's BMI Z-scores and the probability of being overweight. The results are given in Table 3.

[**Table 3 here**]

We use the same specification as in the first stage estimation. We conduct the goodness-of-fit test using the G-statistic. We find that all models are sufficiently flexible except for the linear polynomial cases for daughters (both BMI Z-scores and the probability of being overweight). We are less confident in the estimates from these specifications; however, note that they still provide consistent estimates (Lee and Card, 2008).

Column A in Table 3 gives the result for children's BMI Z-scores. For sons, the results are sensitive to specification but are robust to the inclusion of additional controls. The effect is negative and statistically significant in all models. The size of the effect is relatively small (-0.2 and -0.25 points) if we control for linear polynomial function. The effect becomes larger (-0.41 and -0.45 point) if we control for quadratic function. The AIC and G-test show that quadratic specification fits better, hence it is preferred. For daughters, the effect can be positive and negative. The size of the effect is small (-0.24 to

0.09 point) and statistically insignificant. Column B gives the result for the probability of being overweight. For sons, the reform decreases the probability of being overweight by about 0.08 to 0.11. The effect is statistically significant in all models. For daughters, the effect is insignificant, and even the sign of the effect is indeterminate.

### 5.3 Effect of an extra year of schooling on children's BMI Z-scores and the probability of being overweight

We move to the result of fuzzy RD estimation. RD estimates represent the effect of an extra year of schooling induced by the reform on children's BMI Z-scores and the probability of being overweight. Table 4 gives the result.

[**Table 4 here**]

Column A of Table 4 gives the result for BMI Z-scores. For sons, the estimate implies that an extra year of schooling for mothers significantly reduces their sons' BMI Z-scores by about 0.55 to 0.9 points. The size of the effect is sensitive to specification, but it is overall large. For daughters, the effect is again sensitive to specification, and is statistically insignificant. Column B presents the result for the probability of being overweight. For sons, an extra year of schooling for mothers reduces the prevalence of overweight by about 0.2 to 0.25. The effect is statistically significant in all models. For daughters, the effect is small and insignificant.

The size of the effect is a priori very large. There are several points to mention. First, RDD just identifies the effect around the cut-off point. Second, we use the restricted sample: all mothers left school at age fifteen or sixteen. Third, RDD gives a local average treatment effect, where the estimate only reflects the effect of one additional year of schooling to mothers who complied with the reform. The first-stage estimate indicates such mothers only account for 35-45 percent of the restricted sample (RD estimate is indeed given by the ratio of the reduced-form effect divided by the first-stage effect). We later check the robustness of the result by using a nonparametric method.

To summarise, we find that a mother's schooling has a causal effect on her son's BMI

Z-score and probability of being overweight. The magnitude of the effects is considerable. An extra year of schooling induced by the reform reduces the BMI Z-score by about 0.55 to 0.9 points and also reduces the probability of being overweight by 0.2 to 0.25. We do not find such effects for daughters.

### 5.4 Local linear regression approach

In this subsection we further check the robustness of our results by using an alternative nonparametric approach. We have so far captured the discontinuity around the cut-off point by controlling for the flexible polynomial functions of the mothers' birth cohort. As a result, we find that the RD estimates are somewhat sensitive to specification. In this subsection we capture the discontinuity by employing local linear regression (Hahn et al., 2001; Lee and Lemieux, 2008). Bandwidth selection is crucial. We obtain optimal bandwidth by employing "leave one out" cross-validation procedure (Ludwig and Miller, 2007; Imbens and Lemieux, 2008).

In this subsection we proceed in the following way. First, we estimate the first-stage effect of the reform on the mothers' school leaving age (FS). Next, we estimate the reduced-form effect of the reform on children's BMI Z-scores and the probability of being overweight (RF). Finally, we obtain an RD estimate of the effect of mothers' schooling induced by the reform on children's BMI Z-scores and the probability of being overweight (RD). We present results using optimal bandwidth, narrower bandwidth (dropping 10 month-of-birth cohorts from either side of the cut-off), and wider bandwidth (adding 10 month-of-birth cohorts) for assessing sensitivity to bandwidth selection. To save space, we only report results without additional control variables. In an unreported result we confirm that the result is robust to inclusion.

Table 5 gives the result.

[**Table 5 here**]

Column A shows the result for children's BMI Z-scores. For sons, first stage estimate indicates that the reform significantly increases mothers' schooling by about 0.30 to 0.41 years. The reduced form estimate shows that the reform significantly decreases the sons' BMI Z-score by about 0.3 to 0.51 points. RD estimate reveals that an extra year of schooling induced by the reform significantly reduces sons' BMI Z-score by about 1 to 1.2 points. Notice that the magnitude of the effect is larger than suggested by the polynomial approach. For daughters, first stage estimates suggest that the reform increases mothers' schooling by about 0.37 to 0.40 years. The reduced form effect of the reform on the BMI Z-score is small (-0.02 to -0.1) and statistically insignificant. The RD estimate is not significant accordingly. Column B shows the result for the probability of being overweight. For sons, the first stage effect is positive and significant (0.31 to 0.36 years). The reduced form effect is negative and significant (-0.09 to -0.12) except for one case. RD effect is significant in only one case. An extra year of schooling decreases the sons' BMI-Z score by 0.34, which is again larger (in absolute value) than suggested by the polynomial approach. For daughters, the reform increases mothers' schooling by about 0.36 to 0.45 years. The reduced form estimate and RD estimate are insignificant.

To summarise, using the local linear regression approach, we find that an extra year of schooling significantly reduces the sons' BMI Z-score. This supports the result of polynomial approach. However, the result for the sons' probability of being overweight is mixed. Although we find that mothers' schooling significantly reduces the probability of being overweight using the polynomial approach, this is not necessarily supported by the local linear regression approach. To be fair, we would conclude that mothers' schooling reduces sons' weight, but we are not sure if the effect is significant enough to make any difference at the overweight threshold. Our result is still of interest. Notice that sons in our sample are considerably heavier than they were in 1990: they are on average heavier by 0.6 standard deviation points (see Data section for construction of BMI Z-score). For daughters, on the other hand, mothers' schooling does not reduce BMI Z-scores and the probability of being overweight.

## 6 Other outcomes

In the previous section we found that additional schooling for mothers induced by the reform decreases the weight of their sons. To investigate the relationship in more detail, we present some additional results. First, we discuss the impact of mothers' schooling on children's health behaviour in areas such as diet and physical activity. Next, we show the impact of a mothers' schooling on her own BMI, probability of being overweight and health behaviour.

### 6.1 Effect of the 1972 reform on children's health behaviour

We investigate the effect of mothers' schooling on children's health behaviour. Specifically, we analyse (1) the total portion of fruit and vegetable consumption; and (2) whether children play any sports.[13] These factors are important because weight is determined by calorie intake and expenditure.

In the HSE, all respondents are asked how many portions of fruit and vegetable they had the day before the survey. Also, children are asked whether they have played any sports in the previous week (the variable is given as an indicator). Unfortunately, these variables are available only in limited survey years (2001 and 2002 for fruit & vegetable consumption; 1998, 1999, and 2002 for playing any sports), therefore the estimation sample is much smaller compared to that in the previous section. The analysis is based on the same specification as before. We focus on mothers who were born from September 1952 to August 1962. We restrict the sample to mothers who left school at age fifteen or sixteen. We analyse sons and daughters separately. The models pass relevant specification tests. To save space, we only present results without additional controls. The result is overall robust to the inclusion of additional controls (detail not

[13]For fruit and vegetable consumption, children are asked to answer several questions such as "How many tablespoons of vegetables did you eat yesterday?" The HSE derives the variable "Total portion of fruit and vegetables," which we use in this study. For sports, children are asked to answer the question "In the last week, that is last (date last week) up to yesterday, have you/has (name of child) done any sports or exercise activities, not counting things done as part of school lessons?"

reported). Finally, to save space we focus on presenting RD effects only.

Column A of Table 6 gives the RD effect of mothers' schooling induced by the reform on children's fruit and vegetable consumption.

[**Table 6 here**]

For sons, the effect is positive (0.75 and 3.00) but statistically insignificant. For daughters, the effect is again positive but small and statistically insignificant. Column B displays the result for the probability of playing any sports in the previous week. For both sons and daughters, the effects of schooling are positive but statistically insignificant.

To summarise, we fail to find a causal relationship between mothers' schooling and children's health behaviour as measured by fruit and vegetable consumption and playing sports.

### 6.2 Effect of the 1972 reform on mothers' own weight and health behaviour

Children may learn a healthy lifestyle by mimicking their mothers. Schooling may improve mothers' own outcomes, and then improve their children's outcomes. Blanchflower et al. (2009) discuss the possibility of "imitative obesity", where an individual's disutility from gaining additional weight is determined by the weight of others close to them. Obviously, the mother is one of the persons closest to children. In this subsection, we investigate mothers' own weight and behaviour. First, we examine the effect of schooling on mothers' own BMI and the probability of being overweight. Second, we examine the effect of schooling on mothers' own health behaviour, which is measured by fruit and vegetable consumption and physical activity.

In our data set, mothers' BMI is measured by a nurse visit. A mother is overweight if her BMI is 25 or above. Fruit and vegetable consumption is measured by, as in the children's case, the total portion of fruits and vegetables consumed on the day before the survey. Our measure of physical activity of mothers is a bit different from that of children. In the HSE, adults are asked whether they have done any physical activity in the past four weeks (thus it is binary).[14] This variable is available only in limited surveys (1998, 1999, and 2002). As in the previous section, we focus on mothers who were born between September 1952 and August 1962, and left school at age fifteen or sixteen. Again, we focus on presenting RD effects only.

Column A of Table 7 gives the RD effect of schooling induced by the reform on the mother's own BMI and probability of being overweight.

[**Table 7 here**]

The effect on BMI Z-score is positive (0.5 and 1.65 point) and statistically insignificant. Also, the effect on the probability of being overweight is insignificant. Column B shows the RD estimates for health behaviour. The effect on her own fruit and vegetable consumption can be positive or negative depending on the specification, and are all insignificant. Similarly, the effect on physical activity is insignificant.

To summarise, we do not find any evidence that an extra year of schooling for mothers induced by the reform has a causal effect on their own weight or their health behaviour.

## 7 Discussion and conclusion

In this study we investigate the causal effect of mothers' schooling on children's weight by exploiting the 1972 education reform in England and Wales, which raised the minimum leaving age from fifteen to sixteen. We use the Health Survey for England. We focus on mothers who were born between September 1952 and August 1962, and left school at age fifteen or sixteen (restricted sample). We conduct a regression-discontinuity analysis with polynomial functions. We find that an extra year of schooling induced by the reform significantly reduces sons' BMI Z-scores by about 0.55 to 0.9 points, and also significantly reduces sons' probability of being overweight by about 0.2 to 0.25. Local linear regression analysis shows that the result for BMI Z-scores is robust, but the result

[14] Mothers are asked to answer to several questions such as "Which have you done in the last four weeks? (swimming, cycling, workout, etc)." The HSE derives the variable "Any days active 30 mins +moderate+," which is binary.

for the probability of being overweight is mixed. We do not find any causal effect for daughters. Note that these main results are based on a restricted sample: all mothers left school at age fifteen or sixteen. Also, the RD estimate only reflects the local average treatment effect for mothers who actually complied with the reform (which accounts for 35 to 45 percent of the restricted sample). Therefore our estimate does not necessarily represent the effect for the general population. However, we believe our findings are still interesting because less educated individuals (those who left school at the minimum school leaving age) are often targeted in relevant policy discussions.

We complement the result of Lindeboom et al. (2009). They use the 1947 reform in England and conclude that there is no causal relationship between parents' schooling and children's BMI or the probability of being overweight. All children in their analysis were born in 1958, but childhood overweight has been growing since the mid-1980s. We use the 1972 reform and use more recent data (children aged five to fifteen in 1998-2002). We find an indication of causal effect (only for sons).

We fail to find that mothers' schooling increases children's fruit and vegetable consumption and daily physical activity. This result is somewhat puzzling because weight is basically determined by calorie intake and expenditure. Future work could focus on other important lifestyle variables such as snacking, soft drink consumption, and television watching. While these variables are closely related to overweight among children (Ludwig et al., 2001; Andersen et al., 1998), their causal relationship with mothers' schooling has not been examined.

We do not find that mother's schooling improves her own weight or behaviour. The result itself is in line with some previous studies (for example, Clark and Royer, 2010). However, it is worth noting that our findings indicate that additional schooling for mothers reduces their sons' overweight, even though it does not reduce mothers' own overweight status. One possible rationale relates to self-control problem among mothers. Suppose a mother with a self-control problem. Additional schooling may improve her health knowledge or ability to process information about health. However, she may not resist the temptation to overeat due to limited self-control, and therefore she may eventually fail to reduce weight. Nevertheless, the lack of self-control does not affect the way she takes care of her children. Therefore she could manage her children's weight more efficiently by making use of the knowledge and skills she obtained through additional schooling. Future study should investigate such specific channels throught which the effect of schooling transmits intergenerationally.

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## Table 1: Descriptive statistics of children's BMI Z-score and overweight rate

| *A: Full sample* | | | | |
|---|---|---|---|---|
| | **Son** | | **Daughter** | |
| | Pre-reform | Post-reform | Pre-reform | Post-reform |
| BMI Z-score | 0.597 (1.147) | 0.579 (1.118) | 0.512 (1.107) | 0.545 (1.100) |
| Overweight rate | 25.41% | 23.40% | 24.96% | 28.52% |
| Observations | 669 | 1222 | 669 | 1143 |
| ***B: Restricted sample (mother left school at 15 or 16)*** | | | | |
| | **Son** | | **Daughter** | |
| | Pre-reform | Post-reform | Pre-reform | Post-reform |
| BMI Z-score | 0.652 (1.141) | 0.557 (1.114) | 0.572 (1.172) | 0.613 (1.088) |
| Overweight rate | 27.51% | 23.33% | 27.07% | 30.03% |
| Observations | 309 | 660 | 314 | 596 |

Notes: Standard deviations are presented in parenthesis. In Pre-reform, mothers were born between September 1952 and August 1957. In Post-reform, mothers were born between September 1957 and August 1962.

## Table 2: Effect of the 1972 reform on mother's school leaving age

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| ***A: September 1952 to August 1962 cohort (60 months on either side of the cut-off point, N=1879)*** | | | | |
| Reform | 0.365*** | 0.378*** | 0.442*** | 0.460*** |
| | (0.024) | (0.031) | (0.018) | (0.016) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional control | No | Yes | No | Yes |
| AIC | 1968.54 | 1981.70 | 1970.81 | 1983.19 |
| G-statistics | 0.675 | 0.839 | 0.639 | 0.719 |
| ***B: Robustness check*** | | | | |
| **50 months on either side of the cut-off point (N=1583)** | | | | |
| Reform | 0.385*** | 0.411*** | 0.443*** | 0.476*** |
| | (0.024) | (0.030) | (0.024) | (0.033) |
| **40 months on either side of the cut-off point (N=1252)** | | | | |
| Reform | 0.409*** | 0.414*** | 0.398*** | 0.436*** |
| | (0.016) | (0.031) | (0.022) | (0.023) |

Notes: Robust standard errors clustered at birth cohort (in ten months) in parentheses. *** significant at 1% level, **significant at 5% level, * significant at 10% level. All models include polynomials in birth cohort (in ten months) fully interacted with the reform dummy. Additional control includes age of mother, squared age of mother, age of children, squared age of children, dummies for region of residence, and dummies for survey years.

**Table 3: Effect of the 1972 reform on children's BMIZ-score and the probability of being overweight**

| *A: Children's BMI Z-score* | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Son (N=969)** | | | | |
| Reform | -0.247* | -0.201* | -0.453*** | -0.411*** |
| | (0.136) | (0.104) | (0.103) | (0.108) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional control | No | Yes | No | Yes |
| AIC | 2977.43 | 2959.89 | 2976.82 | 2957.19 |
| G-statistics | 0.878 | 0.662 | 0.469 | 0.463 |
| **Daughter (N=910)** | | | | |
| Reform | -0.026 | 0.020 | -0.288 | -0.347 |
| | (0.215) | (0.146) | (0.190) | (0.190) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional order | No | Yes | No | Yes |
| AIC | 2790.38 | 2777.22 | 2780.23 | 2763.36 |
| G-statistics | 2.456 | 2.310 | 1.120 | 1.250 |
| *B: Children's probability of being overweight* | | | | |
| | (5) | (6) | (7) | (8) |
| **Son (N=969)** | | | | |
| Reform | -0.084** | -0.086*** | -0.114*** | -0.104** |
| | (0.028) | (0.024) | (0.034) | (0.035) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional control | No | Yes | No | Yes |
| AIC | 1123.36 | 1115.63 | 1126.91 | 1115.22 |
| G-statistics | 0.243 | 0.203 | 0.249 | 0.202 |
| **Daughter (N=910)** | | | | |
| Reform | 0.048 | 0.080 | -0.013 | -0.031 |
| | (0.091) | (0.060) | (0.057) | (0.057) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional order | No | Yes | No | Yes |
| AIC | 1151.43 | 1127.95 | 1141.44 | 1122.33 |
| G-statistics | 2.195 | 1.590 | 0.833 | 0.945 |

Notes: Robust standard errors clustered at birth cohort (in ten months) in parentheses. *** significant at 1% level, **significant at 5% level, * significant at 10% level. All models include polynomials in birth cohort (in ten months) fully interacted with the reform dummy. Additional control includes age of mother, squared age of mother, age of children, squared age of children, dummies for region of residence, and dummies for survey years.

**Table 4: RD estimate of the effect of mother's schooling on children's BMIZ-score and the probability of being overweight**

| *A: Children's BMI Z-score* | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Son (N=969)** | | | | |
| Reform | -0.734* | -0.552** | -0.920*** | -0.809*** |
| | (0.375) | (0.205) | (0.154) | (0.160) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional control | No | Yes | No | Yes |
| **Daughter (N=910)** | | | | |
| Reform | -0.067 | 0.052 | -0.751 | -0.858 |
| | (0.549) | (0.382) | (0.527) | (0.509) |
| Polynomial order | Linear | Linear | Quadratic | Quadratic |
| Additional order | No | Yes | No | Yes |
| ***B: Probability of being overweight*** | | | | |
| | (5) | (6) | (7) | (8) |
| **Son (N=969)** | | | | |
| Reform | -0.250*** | -0.237*** | -0.232*** | -0.205*** |
| | (0.073) | (0.048) | (0.055) | (0.054) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional control | No | Yes | No | Yes |
| **Daughter (N=910)** | | | | |
| Reform | 0.123 | 0.208 | -0.034 | -0.077 |
| | (0.236) | (0.149) | (0.150) | (0.143) |
| Polynomial speficication | Linear | Linear | Quadratic | Quadratic |
| Additional order | No | Yes | No | Yes |

Notes: Robust standard errors clustered at birth cohort (in ten months) in parentheses. *** significant at 1% level, **significant at 5% level, * significant at 10% level. All models include polynomials in birth cohort (in ten months) fully interacted with the reform dummy. Additional control includes age of mother, squared age of mother, age of children, squared age of children, dummies for region of residence, and dummies for survey years.

**Table 5: RD estimate of the effect of mother's schooling on children's BMIZ-score and the probability of being overweight (local linear regression approach)**

| | Son | | | Daughter | | |
|---|---|---|---|---|---|---|
| ***A: Children's BMI Z-score*** | | | | | | |
| | **FS** | **RF** | **RD** | **FS** | **RF** | **RD** |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ***Optimal bandwidth*** | | | | | | |
| Reform | 0.306*** | -0.300* | -0.981* | 0.371*** | -0.018 | -0.050 |
| | (0.076) | (0.165) | (0.555) | (0.054) | (0.141) | (0.394) |
| | N=543, Bandwidth=34 | | | N=859, Bandwidth=56 | | |
| ***Narrower bandwidth*** | | | | | | |
| Reform | 0.417*** | -0.513** | -1.230** | 0.408*** | -0.098 | -0.240 |
| | (0.094) | (0.228) | (0.555) | (0.064) | (0.141) | (0.348) |
| | N=373, Bandwidth=24 | | | N=710, Bandwidth=46 | | |
| ***Wider bandwidth*** | | | | | | |
| Reform | 0.309*** | -0.336** | -1.087** | 0.374*** | -0.063 | -0.167 |
| | (0.073) | (0.159) | (0.542) | (0.052) | (0.139) | (0.375) |
| | N=698, Bandwidth=44 | | | N=996, Bandwidth=66 | | |
| ***B: Children's probability of being overweight*** | | | | | | |
| | **Son** | | | **Daughter** | | |
| | **FS** | **RF** | **RD** | **FS** | **RF** | **RD** |
| | (7) | (8) | (9) | (10) | (11) | (12) |
| ***Optimal bandwidth*** | | | | | | |
| Reform | 0.317*** | -0.106* | -0.333 | 0.450*** | -0.039 | -0.087 |
| | (0.079) | (0.061) | (0.303) | (0.080) | (0.082) | (0.191) |
| | N=591, Bandwidth=37 | | | N=609, Bandwidth=38 | | |
| ***Narrower bandwidth*** | | | | | | |
| Reform | 0.363*** | -0.124** | -0.343* | 0.363*** | -0.125 | -0.344 |
| | (0.088) | (0.058) | (0.207) | (0.087) | (0.095) | (0.293) |
| | N=415, Bandwidth=27 | | | N=476, Bandwidth=28 | | |
| ***Wider bandwidth*** | | | | | | |
| Reform | 0.350*** | -0.086 | -0.245 | 0.437*** | 0.028 | 0.065 |
| | (0.070) | (0.064) | (0.209) | (0.069) | (0.069) | (0.168) |
| | N=749, Bandwidth=47 | | | N=778, Bandwidth=48 | | |

Notes: Bootstrap standard errors are presented in parenthesis. *** significant at 1% level, ** significant at 5% level, * significant at 10% level. FS: First stage effect of the reform on mother's schooling; RF: Reduced form effect of the reform on children's BMI or probability of being overweight; RD: RD estimate of the effect of mother's schooling on children's BMI or probability of being overweight. We obtain the optimal bandwidth in months (we report a half-width) by the cross-validation procedure suggested by Imbens and Lemieux (2008). For robustness check, results using a narrower bandwidth (-10 months) and a wider bandwidth (+10 months) are also reported. We use the rectangular kernel in local linear regression by following Imbens and Lemieux (2008) and Lee and Lemieux (2009).

**Table 6: RD estimate of the effect of mother's schooling on children's health behaviour**

| *A: Children's fruit & vegetable consumption* | | | | |
|---|---|---|---|---|
| | **Son (N=354)** | | **Daughter (N=317)** | |
| | (1) | (2) | (3) | (4) |
| Reform | 0.747 | 3.000 | 0.191 | 0.392 |
| | (2.487) | (2.991) | (0.522) | (0.844) |
| Polynomial order | Linear | Quadratic | Linear | Quadratic |
| Additional control | No | No | No | No |
| Mean of dependent variable | 2.65 | | 2.46 | |
| ***B: Children's sports (binary)*** | | | | |
| | **Son (N=537)** | | **Daughter (N=522)** | |
| | (5) | (6) | (7) | (8) |
| Reform | 0.112 | 0.014 | 0.119 | 0.103 |
| | (0.147) | (0.097) | (0.120) | (0.132) |
| Polynomial order | Linear | Quadratic | Linear | Quadratic |
| Additional control | No | No | No | No |
| Mean of dependent variable | 0.67 | | 0.57 | |

Notes: Robust standard errors clustered at birth cohort (in ten months) are presented in parentheses. *** significant at 1% level, ** significant at 5% level, * significant at 10% level. All models include polynomials in birth cohort (in ten months) fully interacted with the reform dummy. Mean of dependent variable gives the mean of the outcome variable for the last pre-refrom cohort.

**Table 7: RD estimate of the effect of mother's schooling on mother's own weight and health behaviour**

| *A: Mother's BMI and the probability of being overweight* | | | | |
|---|---|---|---|---|
| | **BMI (N=1806)** | | **Overweight (N=1806)** | |
| | (1) | (2) | (3) | (4) |
| Reform | 0.495 | 1.652 | -0.066 | 0.074 |
| | (1.720) | (1.449) | (0.133) | (0.107) |
| Polynomial order | Linear | Quadratic | Linear | Quadratic |
| Additional control | No | No | No | No |
| Mean of dependent variable | 26.55 | | 0.55 | |
| ***B: Mother's health behaviour*** | | | | |
| | **Fruit & vegetable (N=657)** | | **Sport (N=1030)** | |
| | (5) | (6) | (7) | (8) |
| Reform | -0.429 | 2.053 | 0.039 | -0.127 |
| | (1.556) | (1.175) | (0.096) | (0.147) |
| Polynomial order | Linear | Quadratic | Linear | Quadratic |
| Additional control | No | No | No | No |
| Mean of dependent variable | 2.97 | | 0.85 | |

Notes: Robust standard errors clustered at birth cohort (in ten months) are presented in parentheses. *** significant at 1% level, ** significant at 5% level, * significant at 10% level. All models include polynomials in birth cohort (in ten months) fully interacted with the reform dummy. Mean of dependent variable gives the mean of the outcome variable for the last pre-refrom cohort.

**Figure 1: Effect of the 1972 reform on mother's schooling (full sample)**

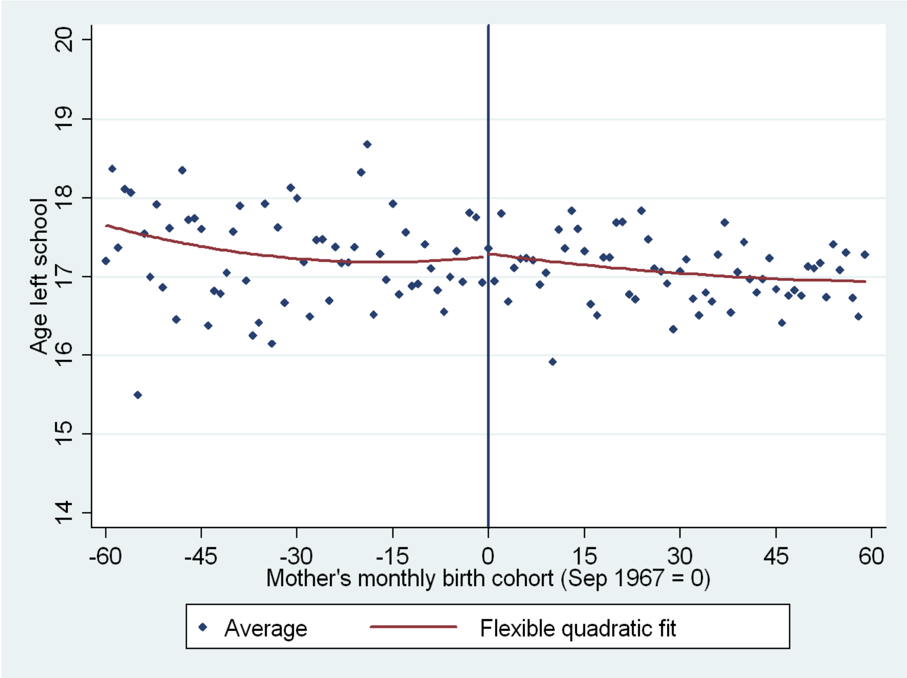



**Figure 2: Effect of the 1972 reform on mother's schooling (restricted sample)**

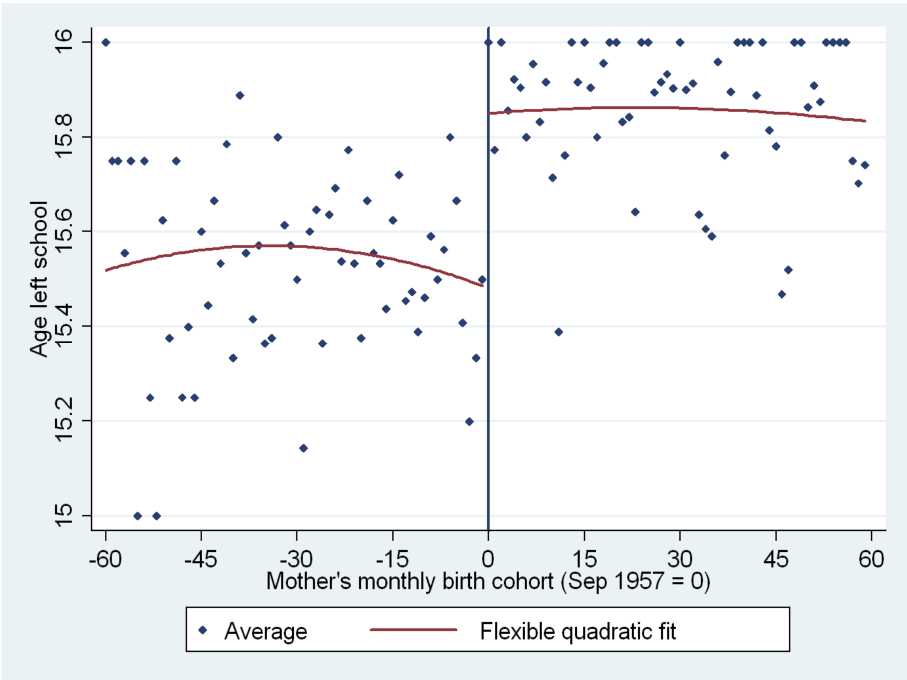


**Figure 3: Effect of the 1972 reform on son's BMI Z-score**

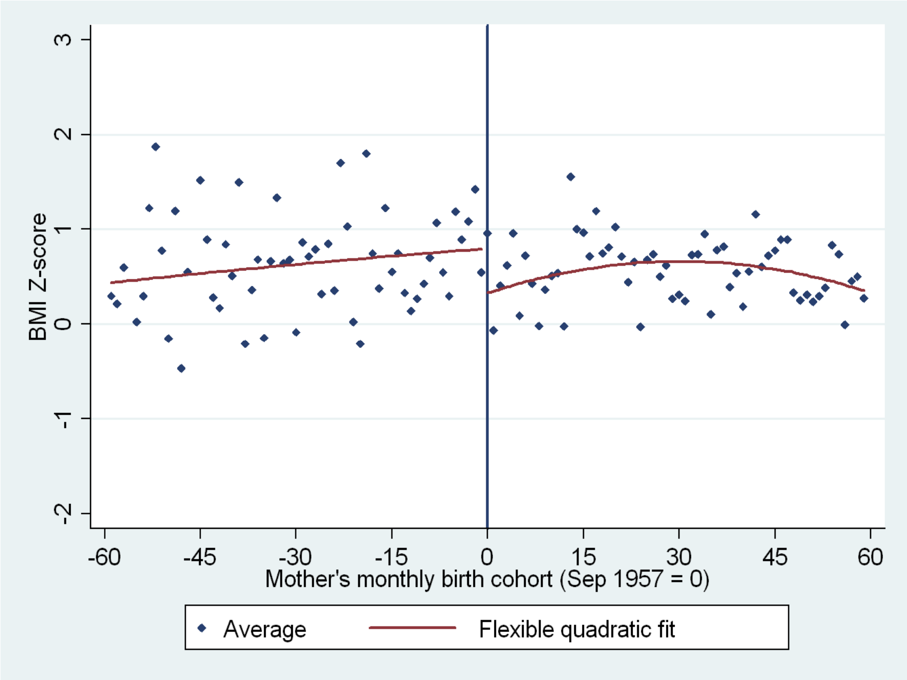



**Figure 4: Effect of the 1972 reform on daughter's BMI Z-score**

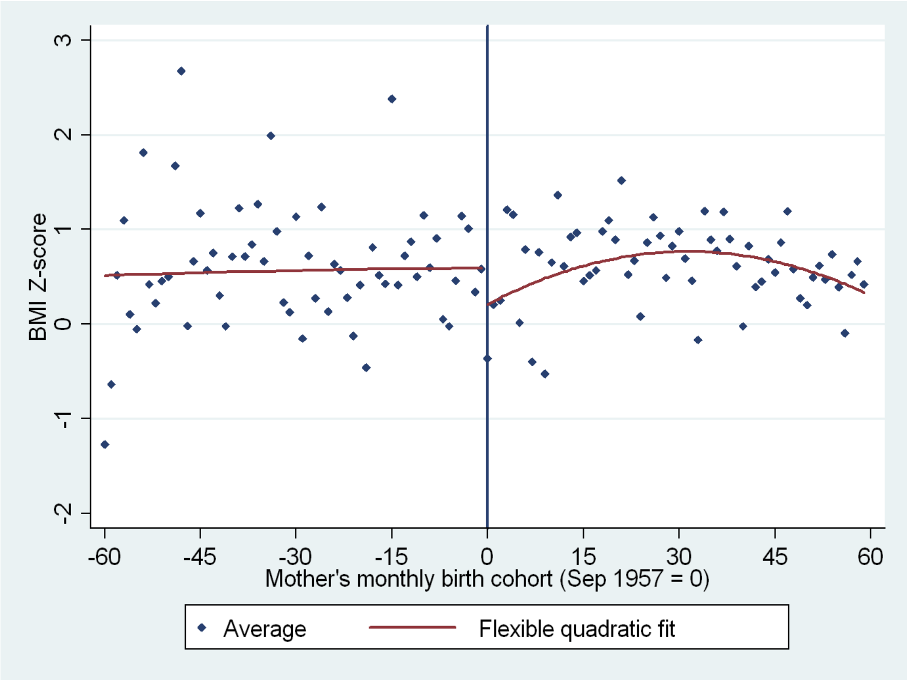


**Figure 5: Effect of the 1972 reform on son's probability of being overweight**

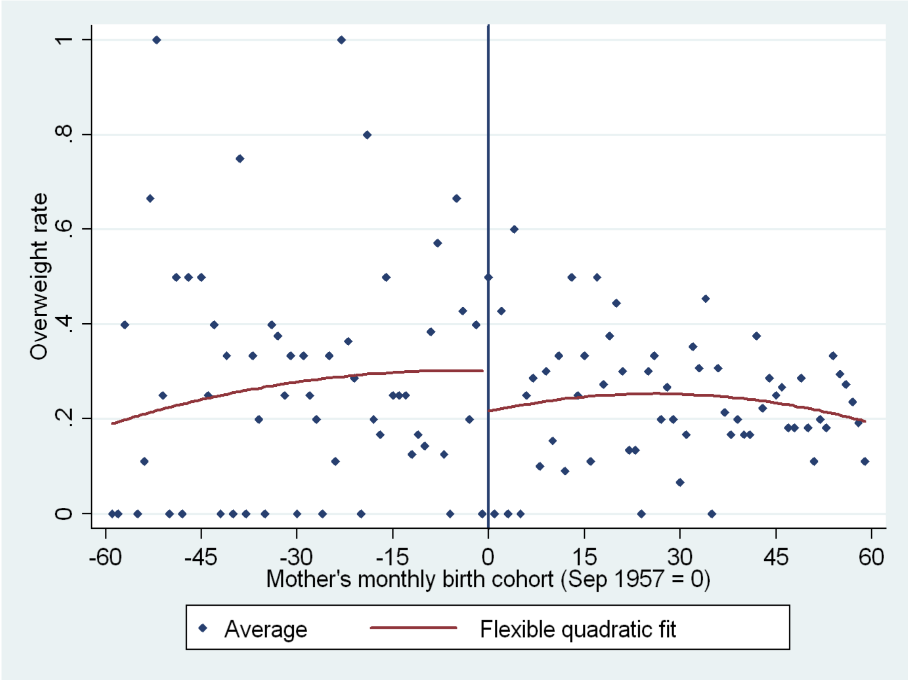
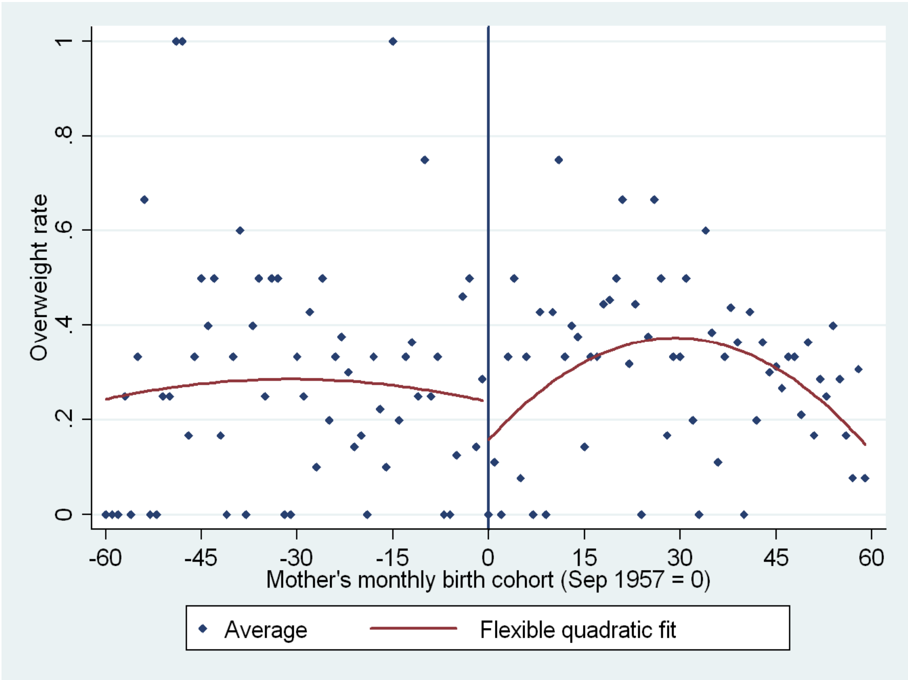



**Figure 6: Effect of the 1972 reform on daughter's probability of being overweight**



## Table A1: Descriptive statistics

| | Mean | Standard deviation | Observations |
|---|---|---|---|
| **Mother's characteristics** | | | |
| School leaving age (full sample) | 17.12 | 1.91 | 3605 |
| School leaving age (restricted sample) | 15.75 | 0.43 | 1879 |
| BMI | 27.03 | 5.66 | 1806 |
| Overweight rate | 56.8% | - | 1806 |
| Fruit & vegetable consumption (in portion) | 3.15 | 2.25 | 657 |
| Any physical activity (past 30 days; binary) | 88.0% | - | 1030 |
| Age at the survey (full sample) | 43.9 | 2.72 | 3605 |
| Age at the survey (restricted sample) | 43.66 | 2.66 | 1879 |
| **Son's characteristics** | | | |
| BMI Z-score | 0.59 | 1.12 | 969 |
| Overweight rate | 24.7% | - | 969 |
| Fruit & vegetable consumption (in portion) | 2.38 | 1.99 | 354 |
| Sports (previous week; binary) | 67.4% | - | 537 |
| Age at the survey (full sample) | 10.74 | 3.03 | 1836 |
| Age at the survey (restricted sample) | 11.00 | 2.96 | 969 |
| **Daughter's characteristics** | | | |
| BMI Z-score | 0.60 | 1.12 | 910 |
| Overweight rate | 29.0% | - | 910 |
| Fruit & vegetable consumption (in portion) | 2.55 | 2.18 | 317 |
| Sports (previous week; binary) | 60.5% | - | 522 |
| Age at the survey (full sample) | 10.70 | 3.04 | 1753 |
| Age at the survey (restricted sample) | 11.00 | 3.04 | 910 |

Notes: Summary statistics from the restricted sample are presented (otherwise indicated). Restricted sample includes only mothers who left school at age fifteen or sixteen. Descriptive statistics for region of residence and survey year dummies are omitted.