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Does education reduce the probability of being overweight?

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Abstract in English

The prevalence of overweight and obesity is growing rapidly in many countries. Education policies might be important for reducing this increase. This paper analyses the causal effect of education on the probability of being overweight by using longitudinal data of Australian identical twins. The data include self-reported and clinical measures of body size. Our cross-sectional estimates confirm the well-known negative association between education and the probability of being overweight. For men we find that education also reduces the probability of being overweight within pairs of identical twins. The estimated effect of education on overweight status increases with age. Remarkably, for women we find no negative effect of education on body size when fixed family effects are taken into account. Identical twin sisters that differ in educational attainment do not systematically differ in body size. This finding is robust to differences in employment and number of children.

Key words: education, overweight, body size.

JEL code: : I12, I18, I20.

Abstract in Dutch

Steeds meer mensen hebben last van overgewicht of zwaarlijvigheid. Internationale cijfers laten een verontrustende stijging zien. Onderwijsbeleid is mogelijk belangrijk voor het tegengaan van overgewicht. Deze studie onderzoekt het oorzakelijke effect van onderwijs op de kans op overgewicht aan de hand van longitudinale gegevens van eeneiige Australische tweelingen. Het onderzoek gebruikt zowel zelf gerapporteerde als klinisch gemeten informatie over lengte en gewicht. Als eerste stap in het onderzoek is de bekende negatieve samenhang tussen onderwijs en de kans op overgewicht gevonden. Vervolgens is gekeken of deze samenhang ook bestaat *binnen* tweelingen. Opvallend genoeg bleek dat wel het geval te zijn bij mannen maar niet bij vrouwen. Voor mannen leidt een jaar onderwijs tot 2 tot 4 procentpunten minder kans op overgewicht. Het effect van onderwijs neemt toe met de leeftijd. Hoger opgeleide vrouwen hebben daarentegen net zoveel kans op overgewicht als lager opgeleide vrouwen. De resultaten zijn robuust voor verschillen in arbeidsparticipatie of aantal kinderen.

Steekwoorden: onderwijs, overgewicht, BMI.

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Summary

The prevalence of overweight and obesity is growing rapidly in many countries. Education policies might be important for reducing this increase. A large literature documents a strong association between education and a wide variety of health measures, including body size. Better educated individuals tend to have better health and a lower risk of mortality. However, better educated individuals might also have unobserved factors that are important for health. Therefore, the crucial research question is whether the so-called gradients in health by education are causal effects of education or the result of unobserved factors correlated with higher levels of schooling or the result of reverse causality.

This paper analyses the causal effect of educational attainment on the probability of being overweight by using longitudinal data of Australian identical twins. The advantage of identical twins is that they share the same genes and socioeconomic background. By using within-twin estimation we can eliminate the bias by unobserved genetic and socioeconomic background factors. Although identical twins are very much alike, they are not completely the same. The remaining differences within pairs of identical twins can still bias the estimates because the within-twin estimation uses only a fraction of the total variation in educational attainment (Bound & Solon, 1999). We reduce this potential bias by taking advantage of the longitudinal character of the data. By including previous measures of body size in the model estimation we eliminate the bias by unobserved differences within pairs of identical twins that are constant over time. In addition, measurement error in schooling is an important concern in within-twin estimation and may bias the estimates downward. We address this issue by instrumenting with a second independent measure of education following the approach introduced by Ashenfelter and Krueger (1994).

Our paper makes several contributions to the literature on the effects of education on health. First, the empirical economic literature on the causal effect of education on body size is surprisingly small. We are aware of only three studies that report estimates of the effect of education on body size with a serious effort to address the endogeneity of education. We add to this literature and use an identification strategy that has not been applied before - that is, we use variation in schooling within pairs of identical twins. Second, even within pairs of identical twins the endogeneity of education might be a concern. We use the longitudinal character of our data, multiple measurements of body size ranging over a period of 13 years, to further reduce omitted variable bias. By including a previous measure of body size we may eliminate the bias from differences within pairs of identical twins that are constant over time. Third, our data include both self-reported and clinical measures of body size. Most previous studies rely on self-reports which tend to underestimate body size (Kenkel et al. 2006, Macgregor et al. 2006, Neidhammer et al. 2000). Fourth, we address the issue of reverse causality by analyzing the effect of education on body size for different age groups.

Our cross-sectional estimates confirm the well-known negative association between education and the probability of being overweight from the literature. For men the within-twin estimates also provide evidence that education reduces the probability of being overweight. We find that a year of education reduces the probability of being overweight with 2 to 4 percentage points. The estimated effects become larger when the estimation sample gets older. In addition, the largest estimates are found when using the clinical measures of body size. Remarkably, for women we find no negative effect of education on body size when fixed twin effects are taken into account. Instrumenting for measurement error in education does not affect the main findings but increases the estimates for men. The findings are robust for the inclusion of a previous measure of body size as a control variable for remaining fixed differences within twin pairs. We find no effect of education on overweight status for samples of relatively young twins. This suggests that reverse causality might not be an important concern. Separate analyses for the effect of education on the so-called body mass index (BMI) confirm the main pattern of findings. Unfortunately, the share of obese twins in our data is relatively small. This may explain why we do not find effects of education on obesity.

1 Introduction

The prevalence of overweight and obesity is growing rapidly in many countries and this may yield major risks for public health (International Obesity Task Force, 2005). Almost two-thirds of Americans 20 and older are classified as overweight in 1999-2000, compared to 46 percent in 1976-80 (Flegal et al. 1998, 2002). From 1980 to 1999-2000, for Australian people aged 25-64 years, the proportion of overweight women increased from 27% to 47%, and the proportion of overweight men increased from 47% to 66% (Dixon and Waters, 2003). Policies that reduce this strong increase would be important for public health.

Education policies might be important for reducing the increasing prevalence of overweight or obesity. A large literature documents a strong association between education and a wide variety of health measures, including body size (Cutler & Lleras-Muney, 2006). Better educated individuals tend to have better health and a lower risk of mortality. However, better educated individuals might also have unobserved factors that are important for health. Therefore, the crucial research question is whether the so-called gradients in health by education are causal effects of education or the result of unobserved factors correlated with higher levels of schooling or the result of reverse causality. Several recent studies in the health economics literature use an instrumental variable approach for identifying the causal effect of education (Lleras-Muney 2005, Adams 2002, Spasojevic 2003, Currie & Moretti 2003, Chou et al. 2004, Oreopoulos, 2006, Walque, de, 2007, Grimard & Parent, 2007). These studies typically find that more schooling leads to better health. The literature that focuses on the causal effect of education on body size is small. Three recent studies using educational policies or schooling reforms as an instrument for education estimate the effect of education on multiple health outcomes including body size (Arendt, 2005, Kenkel et al. 2006, Lindeboom et al. 2007). These studies find little evidence that schooling reduces the probability of being overweight or obese.

This paper analyses the causal effect of educational attainment on the probability of being overweight by using longitudinal data of Australian identical twins. The advantage of identical twins is that they share the same genes and socioeconomic background. By using within-twin estimation we can eliminate the bias by unobserved genetic and socioeconomic background factors. Although identical twins are very much alike, they are not completely the same. The remaining differences within pairs of identical twins can still bias the estimates because the within-twin estimation uses only a fraction of the total variation in educational attainment (Bound & Solon, 1999). We reduce this potential bias by taking advantage of the longitudinal character of the data. By including previous measures of body size in the model estimation we eliminate the bias by unobserved differences within pairs of identical twins that are constant over time. In addition, measurement error in schooling is an important concern in within-twin estimation and may bias the estimates downward. We address this issue by instrumenting with a second independent measure of education following the approach introduced by Ashenfelter and Krueger (1994).

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Our cross-sectional estimates confirm the well-known negative association between education and the probability of being overweight from the literature. For men the within-twin estimates also provide evidence that education reduces the probability of being overweight. We find that a year of education reduces the probability of being overweight with 2 to 4 percentage points. The estimated effects become larger when the estimation sample gets older. In addition, the largest estimates are found when using the clinical measures of body size. Remarkably, for women we find no negative effect of education on body size when fixed twin effects are taken into account. Instrumenting for measurement error in education does not affect the main findings but increases the estimates for men. The findings are robust for the inclusion of a previous measure of body size as a control variable for remaining fixed differences within twin pairs. We find no effect of education on overweight status for samples of relatively young twins. This suggests that reverse causality might not be an important concern. Separate analyses for the effect of education on the so-called body mass index (BMI) confirm the main pattern of findings. Unfortunately, the share of obese twins in our data is relatively small. This may explain why we do not find effects of education on obesity.

The remainder of this paper is organized as follows. The next section reviews previous studies on the effects of education on health and explains the methodology used in this paper. Section three describes the data. The main estimation results are shown in section 4. Section 5 and 6 address the issues of measurement error and endogeneity. Section 7 reports the results for some other measures of body size. Section 8 investigates several mechanisms through which education might have an effect on body size. Section 9 concludes

2 Previous studies and methodology

Many studies using regressions of education on health find large associations between education and various health measures and mortality rates (Cutler & Lleras-Muney, 2006, Grossman, 2005). These associations have been found in many countries and time periods and have been labelled as ‘the education health gradient’.

The causal effect of education on health has been explored in several studies using the instrumental variable approach. A first wave of IV studies, such as Berger and Leigh (1989), Sander (1995a, 1995b), Leigh and Dhir (1997), use various instruments like parents schooling and income, number of siblings or IQ for identifying the effect of education on various outcomes, such as blood pressure and health limitations, smoking and quitting smoking, disability and exercise. However, the validity of these instruments seems questionable (Kenkel et al. 2006).

Several recent studies exploit natural experiments for identifying the causal effect of education on health. For instance, Lleras-Muney (2005) studies the effect of schooling on mortality by using compulsory schooling laws, child labour laws, and state characteristics at age 14 as instruments for schooling. The same instruments have been used in a study of the effect of schooling on functional ability and self-rated health (Adams, 2002). Comparable studies have been done for Sweden (Spasojevic, 2003) and Taiwan (Chou et al. 2004). Intergenerational effects of education on birthweight, pre natal care and smoking have been studied using college openings in a woman’s seventeenth year as an instrument for maternal education (Currie & Moretti, 2003). Two recent studies use an instrumental variable approach which relies on the fact that during the Vietnam War college attendance provided a strategy to avoid the draft for estimating the effect of education on smoking (Walque, de, 2007, Grimard & Parent, 2007). These recent studies typically find that more schooling leads to better health.

Three recent studies that focus on the effect of education on health also report estimates of the effect of education on body size. Arendt (2005) used a Danish school reform as an instrument for educational attainment. He finds inconclusive results for the effect of education on body mass index. Kenkel et al. (2006) study the causal effect of high school completion and GED receipt on obesity using the 1998 wave of the National Longitudinal Survey of Youth 1979. The main identifying instrument in this study is within-state variation in educational policies. They find no evidence that high school completion or GED receipt reduces the probability of being overweight or obese. Lindeboom et al. (2007) used the British schooling reform of 1947, which raised the minimum school leaving age in the UK, as in instrument for schooling. They find no effect of education on body mass index and overweight status. All three studies do not find that the effect of education on body size depends on gender. Our paper uses variation in schooling within pairs of identical twins for identifying the causal effect of education on body size.

Methodology

Within twin estimation has been used in several studies on the returns to schooling (see for instance, Ashenfelter, et al., 1994, Miller, et al. 1995) and recently on the effect of parents education on the education of their children (Behrman and Rosenzweig, 2002). The typical econometric model used for within-twin estimation is:

$$y_{ij} = \alpha + \beta S_{ij} + \gamma X_{ij} + f_j + \varepsilon_{ij} \quad (2.1)$$

where Y_{ij} is the outcome of individual i in family j, S_{ij} a continuous variable for years of schooling, Xij a vector of covariates, f_j is an unobserved family effect common to all twins and ε_{ij} is a random error term. In this model the family fixed effect is removed by differencing between twins.

In this paper, we estimate the effect of schooling on body size using ‘within-family’ estimation on data of Australian identical twins. Identical twins are genetically identical and have similar family background. The within-twin estimator controls for all unobserved genetic and family factors that are shared by the identical twins. There are two important concerns in the use of within-twin estimation (Bound & Solon, 1999). First, measurement error in schooling may bias the estimates towards zero. A solution for this problem has been introduced by Ashenfelter and Krueger (1994). They obtained two measures of the schooling of a twin by asking the twin’s to report both on their own schooling as on the schooling of their sibling. The second measure of schooling can be used as an instrument to correct for measurement error. This approach has been used in several studies (for instance Miller et al. 1995, Behrman and Rosenzweig, 2002). In these studies the size of the estimated effects increases after instrumenting for measurement error. In this paper we follow the same approach to address the issue of measurement error in schooling.

The second concern in within-twin models is endogeneity bias. Although identical twins share the same genes and the same social environment they are not exactly identical. Bound and Solon (1999) show that the bias in the within-family estimator may not always be smaller than the bias in the cross-sectional estimator. This depends on the importance of the fixed family component in the unobservables that both affect teenage fertility and the outcome variable. If the family component accounts for a larger fraction of the variance in those unobservables then the bias of the within-estimator is smaller than the bias in the cross-sectional estimator. We address this possible bias by using previous measures of BMI as controls in our models. This eliminates the bias by unobserved differences within pairs of identical twins that are constant over time.

Another concern that might bias our results is reverse causality. If body size at an early age has an effect on educational attainment this might confound our findings. We address this issue by comparing the estimated effects of schooling on the probability of being overweight for different age groups. If we find negative effects of education on overweight status for young samples of twins this might be the result of reverse causality.

3 Data

In this study, we use data from a cohort of twins of the Australian Twin Register which is called the older cohort (or the Canberra sample).[1] The data were collected in two mail surveys, in 1980-1982 and 1988-1989. The sample consists of all 5967 twin pairs aged over 18 years enrolled in the Australian National Health and Medical Research Council Twin Registry at the time of the first survey. In the first survey 3808 complete pairs participated, in the follow-up survey 2934 twin pairs responded. (Miller, et al., 1995).

The surveys gathered information on the respondent's family background (parents, siblings, marital status, and children), socioeconomic status (education, employment status and income), health behaviour (body size, smoking and drinking habits), personality, and feelings and attitudes. Zygosity was determined by a combination of diagnostic questions plus blood grouping and genotyping.

Each survey included self report items on height and weight. Between 1993 and 1998 standardized clinical measures of BMI were obtained for subsets of the older cohort of twins through a clinical examination. Height and weight were measured with a stadiometer and accurate scales respectively. The body mass index (BMI) is defined as weight in kilograms divided by height in meters squared. Overweight is defined as having a BMI of over 25 and obesity is defined as having a BMI of over 30, underweight is defined as having a BMI of 18.5 or less (WHO, 2000).

The main independent variable in the analysis is educational attainment. Educational attainment was measured using a seven point scale and translated into years of education (Miller, et al. , 1995). This variable is measured in the same way in both surveys. We use information from both surveys to construct a variable for educational attainment. We start with information from the second survey because we are primarily interested in the effect of the level of completed education. If this information is missing we add information collected in the first survey. Respondents were also asked to report on the level of education of their sibling. We use this information to address the issue of measurement error. As covariates we use mother's and father's education, age and birth weight.

Our main estimation sample consists of twins below the age of 60. This age cut-off is used because ageing increasing the probability of having a disease which might affect body size and bias our results.

Table 3.1 shows sample means and proportions for background characteristics and outcome variables for the main estimation samples of identical twins below the age of 60 years. Statistics are shown for each year in which body size has been measured and separately for men and women.

[1] Data of a second cohort of twins, the so-called younger cohort, were collected in two surveys starting in 1989 and 1996. The estimation results for these data are very similar to the findings presented for twins younger than 40 years (table 7). In addition, these data do not include clinical measures of body size. We therefore do not report estimation results for this young cohort.

Table 3.1 Means (standard deviations) and proportions of main estimation sample

	1980		1988		1993	
	Female	Male	Female	Male	Female	Male
Twins report same (own) schooling (%)	62.5	50.2	62.3	51.3	65.5	53.0
Sibling's schooling	11.2 (2.5)	12.6 (2.4)	11.4 (2.4)	12.7 (2.4)	11.5 (2.4)	12.6 (2.3)
Mother's schooling	9.2 (2.6)	9.7 (2.3)	9.3 (2.4)	9.8 (2.3)	9.4 (2.4)	9.7 (2.1)
Father's schooling	9.6 (3.0)	10.4 (3.0)	9.7 (3.0)	10.5 (3.0)	9.9 (2.9)	10.3 (3.0)
Age	33.6 (11.7)	32.0 (10.7)	39.3 (8.9)	37.6 (8.2)	42.5 (7.5)	42.3 (6.6)
Birth weight	2380 (640)	2550 (640)	2370 (650)	2580 (600)	2370 (600)	2570 (580)
BMI	22.0 (3.2)	23.2 (2.8)	22.8 (3.6)	23.9 (2.8)	24.8 (4.6)	25.4 (3.2)
Overweight (%)	14.6	23.6	21.5	31.3	39.6	52.2
Obese (%)	2.6	1.0	4.9	2.3	12.8	7.8
Underweight (%)	4.8	1.7	3.0	0.7	1.9	0.0
N	2008	992	1450	694	916	370

Female twins more often report the same own level of schooling than male twins. Approximately half of the male pairs are discordant in schooling versus one third of female twin pairs. For most pairs the difference in schooling ranges from 1.5 to 4 years. For 3 (2) % of the male (female) pairs the difference in schooling is larger than 4 years (see also figure 1). The average age of our estimation samples increases with approximately 10 years between the first and third measurement of body size. Body size and the proportion of twins classified as overweight or obese also increase between 1980 and 1993. The increase in body size is largest between 1988 and 1993. It seems likely that this is related to the difference in measurement. There is evidence that self reports tend to underestimate body size (Kenkel et al. 2006, Macgregor et al. 2006, Neidhammer et al. 2000). The measures for 1980 and 1988 are based on self report items whereas in 1993 clinical measures of height and weight were obtained . Male twins have more body size and are more often overweight than female twins. The shares of obese twins or twins that are classified as underweight are quite small in our samples. A comparison with available population statistics indicates that the proportion of overweight individuals in our sample is lower than in the population. Dixon and Waters (2003) report that 45.5 % of men and 32.1 % of women are classified as overweight in 1989-1990 based on self report and in 1995 68.2 % of men and 49.3 % of women are classified as overweight based on measured height and weight.

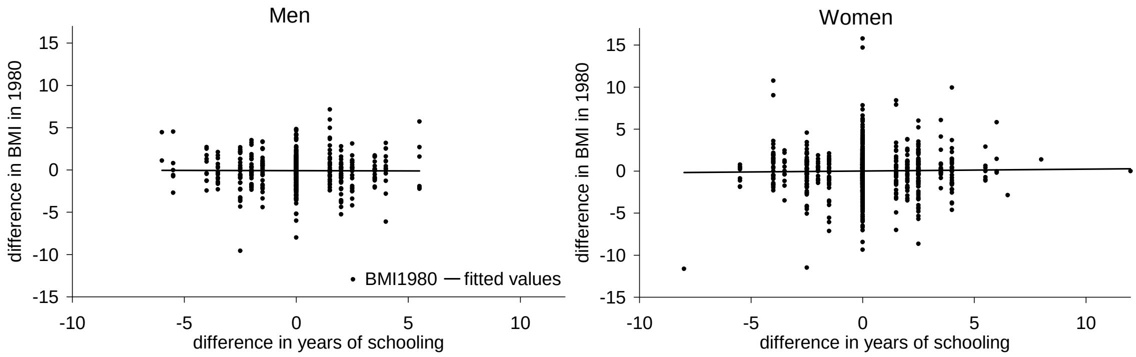
Table 3.2 shows BMI and overweight status by schooling level for men (top panel) and women (bottom panel).

Table 3.2	BMI and overweight status (%) by schooling level						
		Years of schooling					
		< 7	8	11	13	15	17
Men							
1980	BMI	22.1	23.7	23.3	23.5	22.3	22.7
1988	BMI	23.1	24.6	24.1	24.3	22.9	23.4
1993	BMI		25.5	25.9	25.2	24.5	25.2
1980	Overweight (%)	0	32.3	24.8	32.1	11.0	15.1
1988	Overweight (%)	0	40.4	36.1	37.6	17.5	25.0
1993	Overweight (%)	64.8	57.6	42.5	40.3	54.1	
1980	N	4	158	375	168	181	106
1988	N	2	94	241	117	160	80
1993	N		54	139	73	67	37
Women							
1980	BMI	24.9	22.7	21.7	21.7	21.3	21.4
1988	BMI	25.6	23.4	22.8	22.3	22.1	21.9
1993	BMI	30.0	25.8	24.7	23.7	24.3	24.0
1980	Overweight (%)	38.9	19.9	12.1	10.2	8.7	8.1
1988	Overweight (%)	63.2	26.9	20.6	16.7	14.1	10.6
1993	Overweight (%)	100	50.2	37.6	30.1	31.7	34.4
1980	N	36	719	718	275	161	99
1988	N	19	490	510	209	128	94
1993	N	5	265	362	143	77	64

The descriptive evidence in table 3.2 suggests a negative association between schooling level and body size. Both for men and women the average BMI is lower for high levels of schooling than for low levels of schooling. The proportion of twins classified as overweight is also higher for low levels of schooling than for high levels of schooling. It should be noted that the figures for the lowest level of schooling (less than 7 years of education) are based on a small number of twins, especially for men.

A first exploration of the relationship between schooling and body size within pairs of twins is shown in figure 3.1. The figure contains the scatter diagram of the intrapair difference in BMI measured in 1980 against the intrapair difference in years of schooling separately for men and women.

Figure 3.1 The relationship between intrapair differences in BMI measured in 1980 and intrapair difference in years of schooling for men and women



It should be noted that many twins report exactly the same level of schooling, so that many intrapair differences in schooling are zero, especially for women (see also table 3.1). In addition, there is a substantial variability in BMI at each level of intrapair schooling difference. Contrary to the cross-sectional statistics in table 3.2, figure 3.1 suggests that there is no clear relationship between years of schooling and BMI measured in 1980 within pairs of identical twins.

3.1 Main estimation results

The World Health Organization (WHO) defines overweight as a body mass index of 25 or higher and considers this to be a risk factor for health. We focus the analysis in this paper on this outcome. Our data contain a substantial proportion of twins classified as being overweight and this allows a precise estimation of the effects of education on the probability of being overweight. In section 7 we will also consider other measures of body size. Table 3.3 shows the estimated effects of years of education on the probability of being overweight (BMI $\geq$25) for three measurements. The left panel shows the result for men, the right panel shows the results for women. Columns (1) and (5) are based on a linear probability model of overweight status on education (standard errors are adjusted for clustering within pairs of twins). Columns (2) and (6) show the results after including age, age squared, the education of the parents and birth weight as covariates. Columns (3) and (7) show the within-twin estimates of a linear probability model for respectively men and women. Columns (4) and (8) show the within-twin estimates after including birth weight as control. Each cell shows the results of a separate estimation. The top panel shows the effects of education on the probability of being overweight measured in the first survey (1980-1982), the middle panel shows the effects on overweight status measured in 1988/1989 and the bottom panel shows the effects of education on overweight status measured in 1993-1996, which is the clinical measure.

Table 3.3 Estimates of the effect of education on the probability of being overweight

	Men				Women			
	Cross-section		Within twins		Cross-section		Within twins	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	– 0.023	– 0.019	– 0.015	– 0.014	– 0.021	– 0.008	0.007	0.007
	(0.006)***	(0.006)***	(0.009)	(0.009)	(0.004)***	(0.005)*	(0.006)	(0.006)
N	992	992	992	992	2008	2008	2008	2008
Twin pairs			496	496			1004	1004
1988/89	– 0.027	– 0.024	– 0.023	– 0.023	– 0.025	– 0.019	– 0.003	– 0.003
	(0.008)***	(0.008)***	(0.013)*	(0.013)*	(0.005)***	(0.006)***	(0.008)	(0.008)
N	694	694	694	694	1450	1450	1450	1450
Twin pairs			347	347			725	725
1993	– 0.026	– 0.029	– 0.028	– 0.031	– 0.030	– 0.021	0.008	0.008
	(0.013)**	(0.015)**	(0.018)	(0.018)*	(0.008)***	(0.009)**	(0.012)	(0.012)
N	370	370	370	370	916	916	916	916
Twin pairs			185	185			458	458
Controls	No	Yes	No	Yes	No	Yes	No	Yes

Note: Column (2) and (6) control for age, age squared, education of parents and birth weight, column (4) and (8) control for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

In line with the large literature on the education health gradient, the cross-sectional estimates show a negative and statistically significant association between years of education and the probability of being overweight (columns (1), (2), (5) and (6). For all three measurements and both for men and women we find a negative association between education and overweight status. The size of the estimated effects for 1988 and 1993 is somewhat larger than the findings reported in a recent study for the US (Cutler and Lleras-Muney, 2006). They report that a year of education reduces the probability of being overweight between 1.1 and 1.7 %-points.

When we estimate the effect of education on the probability of being overweight within pairs of identical twins we still find negative estimates (column (3) and (4)). The size of the fixed effect estimates is comparable to the size of the OLS estimates although the standard errors are larger. In addition, the estimated effects are larger for the second and third measurement of body size. The estimates suggest that a year of education reduces the probability of being overweight by 2 to 3 percentage points.

Remarkably, for women all within-twin estimates are statistically insignificant and we even find some positive point estimates (column (7) and (8)). Considering the relatively large sample sizes for women is seems unlikely that this result is driven by a lack of statistical power.

3.2 Overweight status, education and age

Gaining weight takes time and increases in weight typically occur and become observable when people grow older. These increases in weight might differ between levels of education. If this is the case we expect that the effect of education on overweight status will be more transparent in older samples of twins. We therefore also investigate the effect of schooling on the probability of being overweight for samples of older twins. Table 4 shows the fixed effect estimates of the effect of education on the probability of being overweight for samples that are older than respectively 30, 35 and 40 years. The models control for birth weight as in column (4) and (8) in table 3.3.

Table 3.4 **Estimates of the effect of schooling on the probability of being overweight using different age restrictions (fixed effect estimates)**

	Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)
Age	≥30	≥35	≥40	≥30	≥35	≥40
	– 1	– 2	– 3	– 4	– 5	– 6
1980	– 0.020	-0.030	– 0.031	0.008	0.004	-0.002
	(0.013)	(0.018)*	(0.023)	(0.009)	(0.012)	(0.015)
N	524	334	216	1098	828	598
Twin pairs	262	167	108	549	414	299
1988/89	– 0.024	– 0.032	– 0.035	0.000	0.002	– 0.006
	(0.014)*	(0.016)**	(0.020)*	(0.009)	(0.011)	(0.014)
N	558	418	256	1222	946	658
Twin pairs	279	209	128	611	473	329
1993	– 0.031	– 0.037	– 0.040	0.008	0.014	0.012
	(0.018)*	(0.018)**	(0.021)*	(0.012)	(0.014)	(0.019)
N	370	316	236	916	764	542
Twin pairs	185	158	118	458	382	271
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: Controls for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

3.3 Measurement error in education

Previous studies on the returns to schooling using within-twin estimation indicate that measurement error may bias the estimated effect of education downward (Ashenfelter, et al., 1994, Miller, et al. 1995). A solution for this problem may be found in instrumenting with a second independent measure of education. Ashenfelter et al. (1994) asked each sibling to report on both their own and their twin's schooling and used this information as independent measures of schooling. They constructed two instruments for the difference in education within twins depending on the assumptions about measurement error. Let S_1^1 refer to the self-reported education level of the first twin, S_1^2 to the sibling-reported education level of the first twin, S_2^2 to the self-reported education level of the second twin and S_2^1 to the sibling-reported education level of the second twin. The first instrument uses the difference in the twin's reports on the schooling of their sibling as an instrument for the difference in the report on the own schooling. Hence, $S_1^1 - S_2^2$ is instrumented with $S_1^2 - S_2^1$. The second instrument assumes that the measurement error of respondent's report on the own schooling and the schooling of their sibling is correlated. In the estimation the difference in the reports of twin A about the own schooling and the sibling's schooling is instrumented with the difference in the reports of twin B on the sibling's schooling and the own schooling. Hence, $S_1^1 - S_2^1$ is instrumented with $S_1^2 - S_2^2$. We can follow this approach because our data include the same questions on the sibling's schooling. In addition, our data contain measurements of own schooling from two surveys. We use the measurement of schooling in the first survey as a third instrument for the our main schooling variable. Let S_1^t refer to the own report of the education level of the first twin reported in year t. We instrument $S_1^{88} - S_2^{88}$ with $S_1^{80} - S_2^{80}$

Table 3.5 Instrumental variable estimates of the effect of education on overweight status

	Men			Women		
Instrument	I	II	III	I	II	III
	(1)	(2)	(3)	(4)	(5)	(6)
1980	– 0.016	– 0.015	– 0.011	0.047	0.018	0.011
	(0.019)	(0.014)	(0.014)	(0.021)**	(0.009)**	(0.010)
N	992	992	992	2008	2008	2008
Twin pairs	496	496	496	1004	1004	1004
1988	– 0.054	– 0.036	– 0.041	0.018	– 0.001	0.000
	(0.034)	(0.021)*	(0.023)*	(0.036)	(0.013)	(0.017)
N	694	694	694	1450	1450	1450
Twin pairs	347	347	347	725	725	725
1993	– 0.090	– 0.066	– 0.043	0.021	0.012	0.000
	(0.040)**	(0.028)**	(0.033)	(0.030)	(0.020)	(0.025)
N	370	370	370	916	916	916
Twin pairs	185	185	185	458	458	458

Note: Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

Table 3.5 shows the IV-estimates for the effect of education on the probability of being overweight separately for women and men. Columns (1) and (4) show the estimation results for the first instrument described above. Columns (2) and (5) show the results for the second instrument and columns (3) and (6) show the results for the third instrument

The results in table 5 suggest that measurement error might be important. The estimates for men strongly increase for the last two measurements of body size. The estimates confirm the negative effect of schooling on the probability of being overweight. Although instrumenting leads to larger standard errors most estimates for 1988 and 1993 are statistically significant. The largest effects are found for the clinical measures of body size. Again we find no evidence for a negative effect of education on the probability of being overweight for women. We even find two statistically significant positive effects for 1980.

We conclude that measurement error in education seems to be important. The estimates provides further evidence for a negative effect of schooling on the probability of being overweight for men. For women we do not find a negative effect of schooling on the probability of being overweight.

3.4 Endogeneity

The second main concern in using within-twin estimation is endogeneity. Although identical twins share the same genes and socioeconomic background they are not completely equal. Differences within pairs of identical twins may bias the results if these differences are both correlated with educational attainment and body size. In this section we exploit the longitudinal character of our data for reducing the potential endogeneity bias. If the bias by unobserved factors is constant over time we may eliminate it by including a previous measure of body size as a covariate in equation (1).

$$y_{ijt} = \alpha + \beta S_{ij} + \gamma X_{ijt} + \lambda BMI_{ijt-1} + f_j + \varepsilon_{ijt} \tag{3.1}$$

The previous measure of body size BMI_{ijt-1} controls for constant unobserved differences within pairs of twins that are correlated with educational attainment and the level of body size, and already have an effect on the first measured body size. In fact, this specification focuses on the growth of body size, whereas the previous sections focused on the level of body size. It should be noted that this specification might be overly restrictive. By controlling for a previous measure of body size we might also control for the effect of schooling on this previous measure which biases the effects towards zero.

Table 3.6 shows the estimates of the effect of education on the probability of being overweight for models that include a previous measure of BMI. The top panel analyses the effect on the probability of being overweight in 1988 controlling for BMI in 1980, the bottom panel analyses the effect on the overweight status in 1993 using the same controls. Column (1) and (5) show the OLS estimates with controls, columns (2) and (6) show the fixed effects estimates controlling for birth weight and the other columns show the fixed effect IV-results, using the conventional instruments introduced by A&K. The estimation sample is smaller because of missing values on body size in 1980.

The estimates in table 3.6 show that the previous results are robust for including body size measured in 1980. The estimates for men are comparable to the findings in the previous sections. The largest estimates are found when using the clinical measures of body size. Again we find no effect of schooling on the probability of being overweight for women. The findings in table 6 suggest that the bias by unobserved constant difference within pairs of twins is small.

Table 3.6	Estimates of the effect of education on overweight controlling for BMI in 1980							
	Men				Women			
	Cross-section	Within twins	FE IV1	FE IV2	Cross-section	Within twins	FE IV1	FE IV2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1988	– 0.005	– 0.026	– 0.067	– 0.036	– 0.010	– 0.007	0.008	– 0.006
	(0.007)	(0.013)**	(0.032)**	(0.020)*	(0.004)**	(0.008)	(0.038)	(0.014)
N	654	654	654	654	1276	1276	1276	1276
Twin pairs		327	327	327		638	638	638
1993	– 0.014	– 0.021	– 0.090	– 0.055	– 0.008	0.008	0.025	0.017
N	(0.013)	(0.018)	(0.037)**	(0.027)**	(0.007)	(0.013)	(0.032)	(0.020)
Twin pairs	344	344	344	344	802	802	802	802
		172	172	172		401	401	401
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: All models include BMI measured in 1980 and the same controls as in table 3. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

Another issue that might bias our results is reverse causality. If body size at an early age has a negative effect on educational attainment this could confound our findings. To investigate this issue we estimated our main models for the sample of twins not older than 40 years. If we find negative effects of schooling on overweight status for young twins this might be the result of reverse causality. Table 7 shows the results for the ‘young’ estimation sample.

Table 3.7	The effect of schooling on the probability of being overweight for twins below the age of 40							
	Men				Women			
	Cross-section		Within twins		Cross-section		Within twins	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	– 0.022	– 0.022	– 0.010	– 0.010	– 0.014	– 0.008	0.010	0.009
	(0.006)***	(0.006)***	(0.009)	(0.009)	(0.004)***	(0.005)*	(0.005)*	(0.005)*
N	776	776	776	776	1410	1410	1410	1410
Twin pairs			388	388			705	705
1988/89	– 0.024	– 0.027	– 0.007	– 0.008	– 0.023	– 0.023	– 0.002	– 0.003
	(0.011)**	(0.011)**	(0.017)	(0.017)	(0.006)***	(0.007)***	(0.010)	(0.010)
N	438	438	438	438	792	792	792	792
Twin pairs			219	219			396	396
1993	– 0.043	– 0.045	– 0.005	– 0.009	– 0.040	– 0.036	0.004	0.005
	(0.023)*	(0.026)*	(0.034)	(0.033)	(0.012)***	(0.013)***	(0.016)	(0.016)
N	134	134	134	134	374	374	374	374
Twin pairs			67	67			187	187
Controls	No	Yes	No	Yes	No	Yes	No	Yes

Note: Column (2) and (6) control for age, age squared, education of parents and birth weight, column (4) and (8) controls for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

For these ‘young’ twins we find no evidence for a negative effect of schooling on the probability of being overweight. Moving the age cutoff from 40 years to 35 or 30 years yields similar results. These findings suggests that reverse causality is not an important concern.
We conclude that this section provides additional evidence for a negative effect of education on overweight for men. For women we do not find an effect of education on body size. Reverse causality does not seem to be an important concern for our analysis.

3.5 Other indicators of body size

In the previous sections, we focused on the effect of education on the probability of being overweight, that means having a body mass index of 25 or higher. However, the cut-off level of 25, which is based on standard guidelines, might be arbitrary. In this section we investigate the effects of education on three other indicators of body size. First, we analyse the effect of education on BMI. Next, we investigate the effects on the probability of being obese or underweighted, using standard guidelines of the World Health Organisation.
Table 3.8. shows the effects of education on BMI for the main specifications of the previous sections.

Table 3.8 Estimates of the effect of education on BMI

	Men				Women			
	Cross-section	Within twins	FE IV1	FE IV2	Cross-section	Within twins	FE IV1	FE IV2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	– 0.107	– 0.007	0.058	0.018	– 0.097	0.019	0.357	0.106
	(0.041)***	(0.044)	(0.096)	(0.067)	(0.044)**	(0.040)	(0.150)**	(0.065)*
N	992	992	992	992	2008	2008	2008	2008
Twin pairs	496	496	496	496	1004	1004	1004	1004
88/89	– 0.185	– 0.138	– 0.200	– 0.190	– 0.134	– 0.049	– 0.057	– 0.120
	(0.057)***	(0.059)**	(0.152)	(0.097)**	(0.053)**	(0.055)	(0.245)	(0.092)
N	694	694	694	694	1450	1450	1450	1450
Twin pairs	347	347	347	347	725	725	725	725
1993	– 0.132	– 0.108	– 0.501	– 0.325	– 0.214	0.018	0.156	0.043
	(0.088)	(0.092)	(0.213)**	(0.149)**	(0.095)**	(0.091)	(0.221)	(0.143)
N	370	370	370	370	916	916	916	916
Twin pairs	185	185	185	185	458	458	458	458

Note: Column (1) and (5) control for age, age squared, education of parents and birth weight, the other columns control for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

The pattern of findings in table 3.8 is fairly similar to the findings in the previous sections. The cross-sectional estimates (column (1) and (5)) indicate a negative association between education and BMI. The size of the effects is comparable to the findings in a recent study for the US (Cutler and Lleras-Muney, 2006). They report that a year of education reduces BMI with 0.13 to 0.20 points

For men, the fixed effect estimates for 1988 and 1993 (column (2)) are comparable to the OLS estimates. In addition, instrumenting for measurement error in education yields larger estimates of the effect of education on BMI, especially for 1993. However, for women we find no evidence for a negative effect of education on BMI when fixed twin effects are taken into account. Next, we investigate the effect of schooling on BMI for samples of older twins (table 9).

After the exclusion of the youngest twins from the estimation samples, we find that all point estimates for men are negative and larger than in column (2) of table 3.8. Only the effects for 1988 are statistically significant. For women we again find no evidence for a negative effect of education on BMI.

The World Health Organization defines two other cut-offs for the body mass index. Obesity is defined as having a BMI of 30 or higher and underweight is defined as having a BMI of 18.5 or lower. We estimated the effect of education on these two outcomes (see table A1 and A2 in the appendix). The estimates provide no evidence that schooling has a negative effect on the probability of being obese or underweighted. Considering the previous findings on the probability of being overweight we might expect that education reduces obesity for men. However, it should be noted that the shares of obese men in our samples are relatively small, the largest share is 7.8 % in 1993 (29 individuals). These small sample sizes might prevent us to detect an effect of education on obesity. We also investigated whether there are effects of

Table 3.9 Estimates of the effect of education on BMI using different age restrictions (fixed effect estimates)

	Men			Women		
Age	≥30	≥35	≥40	≥30	≥35	≥40
	(1)	(2)	(3)	(4)	(5)	(6)
1980	– 0.070	– 0.057	– 0.087	0.059	0.023	– 0.067
	(0.060)	(0.076)	(0.091)	(0.065)	(0.077)	(0.096)
N	524	334	216	1098	828	598
Twin pairs	262	167	108	549	414	299
1988/89	– 0.162	– 0.224	– 0.205	– 0.051	– 0.097	– 0.050
	(0.066)**	(0.072)***	(0.092)**	(0.060)	(0.459)	(0.091)
N	558	418	256	1222	946	658
Twin pairs	279	209	128	611	473	329
1993	– 0.108	– 0.131	– 0.157	0.018	0.109	0.107
	(0.092)	(0.100)	(0.113)	(0.091)	(0.102)	(0.133)
N	370	316	236	916	764	542
Twin pairs	185	158	118	458	382	271
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: Controls for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

education on the probability of being underweighted in younger samples of twins as underweight might especially be an issue at an early age. However, we did not find an effect of schooling on the probability of being underweight.

Summarizing, in this section we investigated the effect of education on BMI. The pattern of findings is similar to the findings in the previous sections. We did not find an effect of schooling on obesity or the probability of being underweighted. This might be explained by lack of statistical power due to small samples of twins classified as obese or underweighted.

3.6 Mechanisms

Why does education have an effect on the probability of being overweight and why does this effect differ between men and women? In this section we investigate several mechanisms through which education could possibly affect overweight. We start with two mechanisms that might be relevant for both men and women. The first mechanism is that education might increase leisure activity which could reduce body size. The second mechanism is that education might affect the consumption of alcohol. Next, we consider two mechanisms that seems especially relevant for women and that might explain the difference in the estimates for men and women. The third mechanism is that education might increase employment opportunities which might affect body size through changes in food consumption. Several recent papers show that maternal employment has an effect on childhood obesity and relate this to the time mothers spend on preparing meals (Cawley & Liu, 2007). In line with these findings there might also be an effect on the body size of these employed women themselves. The fourth mechanism that we investigate is the number of children. We tested the impact of these mechanisms by including relevant indicators in our regressions. For testing the first mechanism we included information on leisure activity measured with a five point scale ranging from ‘jogging, cycling 3-4 times a week’ to ‘no leisure exercise or sport’ in the models. For the second mechanism we included the number of weekly drinks (measured with a ten point scale ranging from ‘none at all’ to 70+ drinks’) in the estimation models. For the third mechanism we included a dummy for being full-time employed and for the fourth mechanism we included the number of children in the models.

Table 3.10 shows the fixed effect estimates of education on the probability of being overweight after including controls for the three mechanisms. Column (1) and (4) repeat the results from table 3. Column (2) and (5) control for leisure activity, column (3) and (6) additionally control for the number of weekly drinks. Column (7) and (8) additionally control for ‘being fulltime employed’ and ‘the number of children’.

The estimation results for the effect of education on the probability of being overweight are robust for the inclusion of indicators of the four mechanisms. For men we even observe that the effects slightly increase when we take account of leisure activity and drinking. The results for women remain statistically insignificant. Adding controls for employment or number of children does not change our main findings. The results are also robust for other specifications of employment (including a dummy for part-time employment) or number of children. Hence, the last two mechanisms cannot explain the difference in the effect of education on overweight status between men and women.

Table 3.10 Estimates of the effect of education on overweight controlling for differences in leisure activity, drinking, employment and having children

	Men			Women				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1988	– 0.023	– 0.021	– 0.024	– 0.003	– 0.002	– 0.004	– 0.001	– 0.003
	(0.013)*	(0.013)	(0.014)*	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
N	694	694	661	1450	1450	1377	1369	1365
Twin pairs	347	347	339	725	725	713	711	708
1993	– 0.031	– 0.032	– 0.032	0.008	0.008	0.010	0.013	0.011
	(0.018)*	(0.018)*	(0.019)*	(0.012)	(0.012)	(0.013)	(0.014)	(0.014)
N	370	370	341	916	916	864	826	823
Twin pairs	185	185	177	458	458	448	437	435
Controls								
Activity	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Drinking	No	No	Yes	No	No	Yes	Yes	Yes
Employment	No	No	No	No	No	No	Yes	Yes
Children	No	No	No	No	No	No	No	Yes

Note: Controls for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

We further investigated whether the findings for women depend on the specification of the education variable by including high school completion in our models. However, we find a statistically insignificant positive point estimate of high school completion on overweight status for women. In addition, we used information on the contact between twins in the last years to investigate whether the results might be biased by spill over effects within pairs of twins. Twins were asked about the number of times they had seen or contacted each other in the last years. We split the sample in two sub samples depending on the number of contacts. However, the estimated effect of education on overweight for women where robust to the use of different sub samples.[2]

Summarizing, the difference in overweight status within male twin pairs that differ in level of education seems not to be the results of differences in leisure activity or drinking. In addition, the deviant results for women cannot be explained by the effects of education on employment or having children.

[2] All the results mentioned in this section can be obtained from the authors on request.

3.7 Conclusions

Our cross-sectional estimates confirm the well-known negative association between education and the probability of being overweight from the literature. For men the within-twin estimates also provide evidence that education reduces the probability of being overweight. We find that a year of education reduces the probability of being overweight with 2 to 4 percentage points. The estimated effects become larger when the estimation sample gets older. In addition, the largest estimates are found when using the clinical measures of body size. Remarkably, for women we find no negative effect of education on body size when fixed twin effects are taken into account. Measurement error in education seems to be important. Instrumenting for measurement error in education does not affect the main findings but increases the estimates for men. The findings are robust for the inclusion of a previous measure of body size as a control variable for remaining fixed differences within twin pairs. We find no effect of education on overweight status for samples of relatively young twins. This suggests that reverse causality might not be an important concern. Separate analyses for the effect of education on the so-called body mass index (BMI) confirm the main pattern of findings. Unfortunately, the share of obese twins in our data is relatively small. This may explain why we do not find effects of education on obesity. We further explored several mechanisms through which education might have an effect on body size. However, controlling for indicators of leisure activity or drinking did not reduce the effects of education on overweight status. This suggest that the effects of education on body size do not result from differences in leisure activity or drinking within pairs of identical twins. Our most remarkable finding is that men and women differ with respect to the effect of education on overweight status. Given the fact that the sample size for women is much larger than for men is seems not likely that lack of statistical power can explain this difference. One possible explanation, suggested in recent research, is that education increases the employment opportunities for women which might have an effect on food consumption as women have less time for preparing meals. However, including controls for employment does not change our main findings. We also find no evidence that the result are affected by differences in having children. Hence, our empirical estimates cannot explain the difference in the findings between men and women.

A factor that might play an important role is differences in attitudes towards physical appearance and weight control between men and women. Various studies reported greater concern with body weight and shape among women (Paxton *et al*., 1994; Rolls *et al*., 1997). A recent study among Australian adolescents confirmed these gender differences (O’Dea and Abraham, 1999). Unfortunately, we do not have indicators of these “cultural differences” between men and women in our data to empirically test this explanation.

The main findings from this paper suggest that education policies that succeed in raising the level of education might reduce the growth of body size for men. An additional year of education reduces the probability of being overweight between 2 and 4 percentage points. For women we find no effect of educational attainment on body size.

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Appendix

Table A1 Estimates of the effect of education on the probability of being obese (BMI≥30)

	Men Cross-section	Within twins	FE IV1	FE IV2	Women Cross-section	Within twins	FE IV1	FE IV2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	– 0.002	– 0.002	0.001	– 0.005	– 0.000	– 0.001	– 0.003	– 0.003
	(0.001)*	(0.003)	(0.006)	(0.004)	(0.002)	(0.003)	(0.010)	(0.005)
N	992	992	992	992	2008	2008	2008	2008
Twin pairs	496	496	496	496	1004	1004	1004	1004
1988/89	– 0.001	0.003	– 0.002	– 0.004	– 0.003	– 0.000	0.022	0.004
	(0.002)	(0.005)	(0.014)	(0.009)	(0.003)	(0.005)	(0.021)	(0.008)
N	694	694	694	694	1450	1450	1450	1450
Twin pairs	347	347	347	347	725	725	725	725
1993	– 0.002	0.021	– 0.022	0.015	– 0.010	0.010	– 0.012	0.010
	(0.006)	(0.012)*	(0.027)	(0.019)	(0.006)*	(0.008)	(0.020)	(0.013)
N	370	370	370	370	916	916	916	916
Twin pairs	185	185	185	185	458	458	458	458
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Column (1) and (5) control for age, age squared, education of parents and birth weight, the other columns control for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.

Table A2 The effect of education on the probability of being underweighted (BMI≤18.5)

	Men Cross-section	Within twins	FE IV1	FE IV2	Women Cross-section	Within twins	FE IV1	FE IV2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	0.002	0.002	– 0.003	0.002	0.002	– 0.002	– 0.007	– 0.006
	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)	(0.004)	(0.013)	(0.006)
N	992	992	992	992	2008	2008	2008	2008
Twin pairs		496	496	496		1004	1004	1004
1988/89	0.000	0.000	– 0.004	– 0.000	0.001	0.000	– 0.026	– 0.003
	(0.002)	(0.003)	(0.007)	(0.004)	(0.003)	(0.004)	(0.019)	(0.007)
N	694	694	694	694	1450	1450	1450	1450
Twin pairs		347	347	347		725	725	725
1993	0.000	0.000	0.000	0.000	0.000	– 0.003	– 0.008	– 0.006
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.005)	(0.011)	(0.007)
N	370	370	370	370	916	916	916	916
Twin pairs		185	185	185		458	458	458
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Column (1) and (5) control for age, age squared, education of parents and birth weight, the other columns control for birth weight. Standard errors in brackets. ***/**/* significant at 1 %/5 %/10 %-level.