Journal of Health Economics 29 (2010) 29–38

Contents lists available at ScienceDirect

Journal of Health Economics

journal homepage: www.elsevier.com/locate/econbase

Does education reduce the probability of being overweight?

Dinand Webbink[a,*], Nicholas G. Martin[b], Peter M. Visscher[b]

[a] CPB Netherlands Bureau for Economic Policy Analysis and TIER, University of Amsterdam, Netherlands
[b] Queensland Institute of Medical Research, Brisbane, Australia

ARTICLE INFO

Article history:
Received 13 March 2008
Received in revised form 22 July 2009
Accepted 19 November 2009
Available online 26 November 2009

JEL classification:
I12
I18
I20

Keywords:
Education
Overweight
Body size

ABSTRACT

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 who differ in educational attainment do not systematically differ in body size. Peer effects within pairs of identical twin sisters might play a role.

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 1976–1980 (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 and 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 and Moretti, 2003; Chou et al., 2004; Oreopoulos, 2006; Dechenes, 2007; Mazumder, 2007; Walque, 2007; Grimard and Parent, 2007; Albouy and Lequien, forthcoming; Clark and Royer, 2008). The findings from these studies are not consistent. Although most studies find that more schooling leads to better health, several studies find no effect of education on 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. 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

* Corresponding author. Tel.: +31 703383411.
E-mail address: webbink@cpb.nl (D. Webbink).

0167-6296/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.jhealeco.2009.11.013

endogeneity of education (Arendt, 2005; Kenkel et al., 2006; Lindeboom et al., 2007). 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, 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 and Solon, 1999). We reduce this potential bias by taking advantage of the longitudinal character of the data, multiple measurements of body size ranging over a period of 13 years. By including previous measures of body size in the model estimation we eliminate the bias by unobserved differences within pairs of identical twins that have an effect on the previous level of BMI. 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). 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 2–4 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. Peer effects within pairs of identical twins might explain the differences in findings between men and women.

There are two main caveats about this study. Firstly, in this study we use a sample of identical twins. It is possible that results from a sample of twins might not be transferable to the population at large. Secondly, the issues of reverse causality and endogeneity are important concerns. Although we find that our results are robust to sensitivity tests on these issues some caution seems appropriate.

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 3 describes the data. The main estimation results are shown in Section 4. Sections 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 explores several factors that might explain the differences in findings between men and women. 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 and 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'.

Several recent studies exploit natural experiments for identifying the causal effect of education on health. The effect of schooling on mortality has been investigated in five recent studies. Lleras-Muney (2005) used compulsory schooling laws, child labor laws, and state characteristics at age 14 as instruments for schooling. She finds that education has large effects on mortality. However, Mazumder (2007) showed that these estimates are sensitive to the inclusion of state-specific trends and that compulsory schooling laws might be weak instruments in this study. A recent study by Albouy and Lequien (forthcoming) identifies the effect of education on mortality from two raisings of the minimum school leaving age using French data. They find no effect of the increase of education induced by these reforms on health. Similar results are found for the UK in a study that uses the change in the minimum school leaving age from 14 to 15 in 1947 (Clark and Royer, 2008). Dechenes (2007) uses variation in education in the US from differences in cohort size by state and year. Larger cohorts have a lower completed educational attainment which might originate from resource constraints. He finds large effects of education on mortality and longevity.

Schooling reforms have also 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, prenatal care and smoking have been studied using college openings in a woman's 17th year as an instrument for maternal education (Currie and 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, 2007; Grimard and Parent, 2007). These studies, focused on various health outcomes, typically find that more schooling leads to better health. However, a recent study using high school availability and birth order as instruments for educational attainment of South Korean men finds little effect on smoking and drinking (Park and Kang, 2008).

The effect of education on body size has been investigated in three recent studies that focus on various health outcomes. 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 an 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 differs between men and women. Our paper uses variation in schooling within pairs of identical twins for identifying the causal effect of education on body size.

2.1. Methodology

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

$$y_{ij} = \alpha + \beta S_{ij} + \gamma X_{ij} + f_j + \varepsilon_{ij} \quad (1)$$

where y_{ij} is the outcome of individual i in family j, S_{ij} a continuous variable for years of schooling, X_{ij} 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 within pairs of twins:

$$y_{1j} - y_{2j} = \Delta y_j = \beta \ \Delta S_j + \gamma \, \Delta X_j + \Delta \varepsilon_j \quad (2)$$

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 and 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 schooling and the outcome variable. 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 affect the previous level of BMI (see Section 6).

Another concern that might bias our results is reverse causality. If body size at an early age has an effect on educational attainment this could 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). 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 behavior (body size, smoking and drinking habits), personality, 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 (obesity) is defined as having a BMI of 25 (30) or higher and underweight is defined as having a BMI of 18.5 or less (WHO, 2000).

The main independent variable in the analysis is educational attainment. In both surveys this variable was measured using a seven point scale: less than 7 years schooling; 8–10 years schooling; 11–12 years schooling; apprenticeship, diploma, certificate; technical or teachers' college; university, first degree; university, postgraduate degree. These categories have been recorded as 5, 9, 11.5, 13, 15 and 17 years of education, respectively (Miller et al., 1995). 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. We included parents education to control for the well-known association between socioeconomic background, education and health. Age might be important as increases in weight typically occur when people grow older and educational attainment might differ between cohorts. These controls are only important for the cross-sectional analysis and drop out in the fixed effect estimation. We include birth weight to control for differences within pairs of identical twins because recent research has shown that birth weight is an important predictor of later outcomes in life (Black et al., 2007). Parents education has been measured in the second survey (1988–1989), birth weight has been measured in the first survey (1980) and the information about the age has been derived from the Twin Registry. These measurements of the explanatory variables are used in all estimations.

Our main estimation samples consist of twins older than 24 and below the age of 60. We limit the samples to twins who are most likely done with school (at least age 25). The age cut-off of 60 is used because ageing increases the probability of having a disease which might affect body size and bias our results.

Table 1 shows sample means and proportions for background characteristics and outcome variables for the main estimation samples of identical twins of at least 25 and 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.

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 (not shown in Table 1). For 3 (2)% of the male (female) pairs the difference in schooling is larger than 4 years. The average age of the estimation samples of 1980 and 1988 is quite similar due to the age restrictions of 25 and 60, the average age of the sample of 1993 is higher due to the ageing of the total sample (all young twins are included in the sample of 1988). Body size and the proportion of twins classified as overweight or obese are quite similar in the samples of 1980 and 1988 but are higher in the sample of 1993. This might be explained by the ageing of the sample. However, the difference in measurement in 1993 might be more important. 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

Table 1
Means (standard deviations) and proportions of main estimation sample.

	1980		1988		1993	
	Men	Women	Men	Women	Men	Women
Own schooling (years)	12.5 (2.5)	10.9 (2.4)	12.8 (2.4)	11.5 (2.5)	12.6 (2.3)	11.7 (2.4)
Twins report same own schooling (%)	46.6	62.6	51.3	62.3	53.0	65.5
Sibling's schooling	12.5 (2.6)	10.9 (2.5)	12.7 (2.4)	11.4 (2.4)	12.6 (2.3)	11.5 (2.4)
Mother's schooling	9.6 (2.3)	9.0 (2.6)	9.8 (2.3)	9.3 (2.4)	9.7 (2.1)	9.4 (2.4)
Father's schooling	10.2 (3.0)	9.3 (3.0)	10.5 (3.0)	9.7 (3.0)	10.3 (3.0)	9.9 (2.9)
Age	36.9 (9.3)	38.7 (11.7)	37.6 (8.2)	39.3 (8.9)	42.3 (6.6)	42.5 (7.5)
Birth weight	2520 (670)	2360 (690)	2580 (600)	2370 (650)	2570 (580)	2370 (600)
BMI	23.8 (2.7)	22.5 (3.3)	23.9 (2.8)	22.8 (3.6)	25.4 (3.2)	24.8 (4.6)
Overweight (%)	31.0	17.6	31.3	21.5	52.2	39.6
Obese (%)	1.3	3.0	2.3	4.9	7.8	12.8
Underweight (%)	0.4	3.4	0.7	3.0	0.0	1.9
N	686	1428	694	1450	370	916

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. In addition, the distribution of self-reported education for the total sample of 1989 respondents has been contrasted with census data from the Australian Bureau of Statistics for a sample of men and women with a comparable age range (Baker et al., 1996). This comparison showed a slight upward bias in educational attainment in the sample of 1989 respondents, especially for men. This difference could be attributed, in part, to different age distributions in the two samples (in spite of the comparable age range). In this paper we focus on the sample of identical twins only. The distribution of self-reported education in the sample of identical twins is very similar to the distribution in the total sample of 1989 respondents.

The last row in Table 1 shows that the sample size in 1980 and 1988 is very similar. The age restrictions used for the selection of the samples generate samples of comparable size despite the lower participation of twins in the second survey (77% of the respondents of the first survey participated in the second survey). The 1993 sample is smaller because the clinical measurement of BMI was only obtained for subsets of the total sample. Although the means and standard deviations for the explanatory variables seem quite comparable to previous years this raises some concerns about attrition bias.

Table 2 shows BMI and overweight status by schooling level for men (top panel) and women (bottom panel). 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. The descriptive evidence in Table 2 suggests a negative association between schooling level and body size.

4. 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

Table 2
BMI and overweight status (%) by schooling level.

		Years of schooling					
		<7	8–10	11–12	13	15	17
Men							
1980	BMI	22.9	24.2	24.2	24.0	23.1	23.0
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	38.9	34.7	37.6	16.2	18.0
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*	3	126	236	133	99	89
1988	*N*	2	94	241	117	160	80
1993	*N*		54	139	73	67	37
Women							
1980	BMI	25.1	22.8	22.2	21.9	22.1	21.7
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 (%)	41.2	20.6	15.3	12.8	15.1	9.4
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*	34	626	431	187	86	64
1988	*N*	19	490	510	209	128	94
1993	*N*	5	265	362	143	77	64

Table 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	−0.028 (0.008)***	−0.019 (0.008)**	−0.018 (0.012)	−0.018 (0.011)	−0.018 (0.005)***	−0.007 (0.006)	0.008 (0.007)	0.007 (0.007)
N	686	686	686	686	1428	1428	1428	1428
Twin pairs			343	343			714	714
1988/1989	−0.027 (0.008)***	−0.024 (0.008)***	−0.023 (0.013)*	−0.023 (0.013)*	−0.025 (0.005)***	−0.019 (0.006)***	−0.003 (0.008)	−0.003 (0.008)
N	694	694	694	694	1450	1450	1450	1450
Twin pairs			347	347			725	725
1993	−0.026 (0.013)**	−0.029 (0.015)**	−0.028 (0.018)	−0.031 (0.018)*	−0.030 (0.008)***	−0.021 (0.009)**	0.008 (0.012)	0.008 (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 10% level.
** Significant at 5% level.
*** Significant at 1% level.

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 shows the estimated effects of years of education on the probability of being overweight (BMI ≥ 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.

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. Including parents' education, age and birth weight reduces the estimates (with one exception) which confirms that these factors are both correlated with educational attainment and body size. 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 percentage points.

When we estimate the effect of education on the probability of being overweight within pairs of identical twins we still find negative estimates for men (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 2–3 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 it seems unlikely that this result is driven by a lack of statistical power. To further increase the statistical power we pooled the data across years. However, the findings for the main models (column (4) and (8)) are very similar, for women the estimated effect is 0.004 (0.006), for men −0.020 (0.011)*.[1] Moreover, we tested whether the use of a linear probability model gives rise to the problem of prediction outside the unit interval for all three years and for the pooled sample. We found that this problem occurs only for one observation in the fixed effects models for women in 1980 and 1988. Using a conditional fixed effect logit model yields similar results. All estimates for women remain statistically insignificant. Moreover, we investigated whether the findings for women depend on the functional form of education. For each level of education we constructed dummy variables which had value one if the woman had attained at least this level and value zero if the woman had not attained this level. We did not find statistically significant negative estimates after including these variables in models that also included a twin fixed effect. For 1980, we even find statistically significant positive effects for having attained at least 13 or 15 years of schooling. The estimates for men are in line with those in Table 3. The point estimates are negative although not always statistically significant.

4.1. 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.

For men we find that the estimates increase by excluding more young twins, as shown in column (1), (2) and (3). This suggests that the effect of schooling on overweight increases with age. The largest estimates are found for the most valid measurement of body size: the clinical measure taken in 1993. The estimates indicate that an additional year of schooling reduces the probability

[1] Standard errors adjusted for clustering at the twin pair level.

Table 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
1980	−0.020 (0.013)	−0.030 (0.018)*	−0.031 (0.023)	0.008 (0.009)	0.004 (0.012)	−0.002 (0.015)
N	524	334	216	1098	828	598
Twin pairs	262	167	108	549	414	299
1988/1989	−0.024 (0.014)*	−0.032 (0.016)**	−0.035 (0.020)*	0.000 (0.009)	0.002 (0.011)	−0.006 (0.014)
N	558	418	256	1222	946	658
Twin pairs	279	209	128	611	473	329
1993	−0.031 (0.018)*	−0.037 (0.018)**	−0.040 (0.021)*	0.008 (0.012)	0.014 (0.014)	0.012 (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 10% level.
** Significant at 5% level.

Table 5
Instrumental variable estimates of the effect of education on overweight status.

	Men		Women	
	(1)	(2)	(3)	(4)
	FE-IV1	FE-IV2	FE-IV1	FE-IV2
1980	−0.018 (0.026)	−0.016 (0.017)	0.078 (0.034)**	0.024 (0.012)**
N	686	686	1428	1428
Twin pairs	343	343	714	714
1988	−0.054 (0.034)	−0.036 (0.021)*	0.018 (0.036)	−0.001 (0.013)
N	694	694	1450	1450
Twin pairs	347	347	725	725
1993	−0.090 (0.040)**	−0.066 (0.028)**	0.021 (0.030)	0.012 (0.020)
N	370	370	916	916
Twin pairs	185	185	458	458
Instrument	Uncorrelated errors	Correlated errors	Uncorrelated errors	Correlated errors

Note: Standard errors in brackets.
* Significant at 10% level.
** Significant at 5% level.

of being overweight with 2–4 percentage points. As in Table 3, we find no effect of education on the probability of being overweight for women. All fixed effect estimates remain statistically insignificant and most point estimates are even positive. In addition, the exclusion of twins below the age of 45 or 50 from the estimation samples does not change the results (not shown in Table 4). Hence, we do not find an effect of education on the probability of being overweight in samples of older women. It should be noted that cohort effects might also be important for the findings in Table 4. Additional analysis (not shown in Table 4) based on the same sample of twins and the same type of measurement of body size showed that the effect of education on the probability of being overweight increased between 1980 and 1988 for men but not for women.

Summarizing, the within-twin estimates for men confirm the education health gradient. We find that an additional year of schooling reduces the probability of being overweight with 2–4 percentage points and the effect increases with the age of the twins. In addition, the largest estimates are found for the clinical measures of body size. However, for women we do not find evidence that schooling reduces the probability of being overweight.

5. 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 and Krueger, 1994; Miller et al., 1995). A solution for this problem may be found in instrumenting with a second independent measure of education. Ashenfelter and Krueger (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 instrumented the difference in self-reported schooling levels by the difference in cross-reported schooling levels. A concern with this instrument is that measurement errors of respondent's report on the own schooling and the schooling of their sibling are correlated. Therefore, Ashenfelter and Krueger (1994) also used a second approach that takes the possibility of correlated measurement errors into account.[2] We can follow this approach because our data include the same questions on the siblings schooling.

The correlation between the self-reported and the sibling reported education level, which indicates the reliability ratio, is 0.88 for men and 0.87 for women. The first stage results of the IV-approach are satisfactory for both instruments. For the first instrument the coefficient ranges from 0.23 to 0.5 and the *F*-value of the excluded instrument is at least 38. For the second instrument the coefficient ranges from 0.65 to 0.75 and the *F*-value of the excluded instrument is at least 195.

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

[2] For a formal treatment, see Ashenfelter and Krueger (1994).

Table 6
Estimates of the effect of education on overweight controlling for BMI in 1980.

	Men				Women			
	Cross-section		Within twins		Cross-section		Within twins	
	OLS	FE	FE-IV1	FE-IV2	OLS	FE	FE-IV1	FE-IV2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1988	−0.005 (0.007)	−0.026 (0.013)**	−0.067 (0.032)**	−0.036 (0.020)*	−0.010 (0.004)**	−0.007 (0.008)	0.008 (0.038)	−0.006 (0.014)
N	654	654	654	654	1276	1276	1276	1276
Twin pairs		327	327	327		638	638	638
1993	−0.014 (0.013)	−0.021 (0.018)	−0.090 (0.037)**	−0.055 (0.027)**	−0.008 (0.007)	0.008 (0.013)	0.025 (0.032)	0.017 (0.020)
N	344	344	344	344	802	802	802	802
Twin pairs		172	172	172		401	401	401
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instrument			Uncorrelated errors	Correlated errors			Uncorrelated errors	Correlated errors

Note: All models include BMI measured in 1980 and the same controls as in Table 3. Standard errors in brackets.
* Significant at 10% level.
** Significant at 5% level.

Although the signal to noise ration in education is generally quite high the results in Table 5 suggest that measurement error is important when using differences in education. Previous papers using data on twins also report much larger estimates after instrumenting for measurement error (for instance, Ashenfelter and Krueger, 1994; Bonjour et al., 2003). 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. Pooling of the data yields similar results. For men we find that a year of education lowers the probability of being overweight between 2 and 3 percent, for women the point estimates are positive (0.010 and 0.037). It should also be noted that the first approach for instrumenting, assuming that the errors in reporting own schooling and siblings' schooling are uncorrelated, yields the largest estimates. This assumption might be incorrect. In addition, we tested whether the use of a linear probability model gives rise to the problem of prediction outside the unit interval. We found that this problem occurs for the models that yield the largest estimates; both models for women in 1980 and for men in 1993. As such, caution is needed when interpreting these relatively large estimates.

We conclude that measurement error in education seems to be important. The estimates provide 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.

6. 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. We test the robustness of our findings by including a previous measure of body size as a covariate in Eq. (2):

$$\Delta y_{jt} = \beta \, \Delta S_{jt} + \gamma \, \Delta X_{jt} + \lambda \, \Delta BMI_{jt-1} + \Delta \varepsilon_{jt} \qquad (3)$$

By including the difference in past BMI within pairs of twins we focus on the growth of body size, whereas the previous sections focused on the level of body size. In this specification only unobserved differences within pairs of twins that are correlated with the growth in body size and educational attainment can bias the estimated effect of education. Past BMI controls for unobserved factors within pairs of twins (Δu_{jt-1}) that have an effect on the level of past BMI:

$$\Delta \mathrm{BMI}_{jt-1} = \delta \; \Delta S_{jt-1} + \kappa \, \Delta X_{jt-1} + \Delta u_{jt-1} \qquad (4)$$

Eq. (4) also shows that specification (3) might be overly restrictive. By controlling for the difference in past BMI we also control for the effect of schooling on this previous measure which biases the effect of schooling towards zero.

Table 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 instruments introduced by Ashenfelter and Krueger (1994). The estimation sample is smaller because of missing values on body size in 1980.

The estimates in Table 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. Instrumenting for measurement error increases the estimated effects. 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 differences within pairs of twins is small.

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.

7. Other sensitivity tests

This section discusses the findings of several sensitivity tests.[3] An issue that might bias our previous results is reverse causality.

[3] All estimates from this section can be obtained from the authors on request.

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 would find negative effects of schooling on overweight status for young twins this might be the result of reverse causality. However, for these 'young' twins we find no evidence for a negative effect of schooling on the probability of being overweight. Moving the age cut-off from 40 years to 35 or 30 years yields similar results. These findings suggests that reverse causality is not an important concern.

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. We investigated this issue by re-estimating the previous models and using the so-called body mass index (BMI) as dependent variable. The pattern of findings is fairly similar to the findings in the previous sections. The cross-sectional estimates 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). For men the fixed effect estimates for 1988 and 1993 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 effects of education on the probability of being obese or underweighted, using standard guidelines of the World Health Organisation. Obesity is defined as having a BMI of 30 or higher and underweight is defined as having a BMI of 18.5 or lower. 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.

8. Why does the effect of education differ between men and women?

The most remarkable finding from the previous sections is that education reduces overweight for men but not for women. In the literature gender differences in the relationship between socioeconomic status and body size have been noted before. For instance, Sobal and Stunkard (1989) reviewed 144 published studies of the relationship between socioeconomic status (SES) and obesity. For women in developed societies they found a strong inverse relationship. However, the relationship is inconsistent for men and children in developed societies. Two recent studies (Behrman and Rosenzweig, 2002; Plug, 2004) on the effect of parental education on a child's education, using data of twins and adoptees respectively, report differences in the effect of schooling that are similar to our findings. Both studies find positive schooling effects for fathers but no effects for mothers. In this section we explore several factors that might explain the difference in findings between men and women.

The difference in findings between men and women might be related with differential costs of higher body size. The costs of overweight or obesity, for instance in terms of reduced labor market or marriage opportunities, seem to be higher for women than for men. A recent study finds that an increase in body size has negative effects on family income, occupational prestige, likelihood of marriage, spouse's occupational prestige and earnings for women but not for men (Conley and Glauber, 2005). These differential costs might induce differential attitudes towards physical appearance and weight control between men and women. Various studies reported that women are more concerned with body weight and shape than men (Paxton et al., 1994; Rolls et al., 1997). A study among Australian adolescents confirmed these gender differences (O'Dea and Abraham, 1999). A greater concern about body weight and shape among women may reduce the proportion of women classified as being overweight and leaves less variation in overweight. In our data we observe that the proportion of women that is classified as being overweight is substantially lower than the proportion of men in all three years. This makes it more difficult to detect an effect of schooling on the probability of being overweight for women than for men.

A factor that seems related to this greater concern about physical appearance among women is peer effects. Several studies indicate that peer effects might differ between men and women. For instance, Argys and Rees (2008) find that female adolescents seem to do as their peers do but find little evidence that male adolescents also do as their peers do. They also note that this finding is in line with a large body of experimental work investigating whether susceptibility to influence is related to gender (see also Eagly and Carli, 1981). In addition, Kling et al. (2007) find that neighborhood effects are very different for girls than for boys. If peer effects within pairs of twins are important (the educational attainment of the sibling has an effect on the body size of the other twin) this might bias the within-twin estimates. For instance, the fixed effect estimates will underestimate the effect of education on body size when the higher educated sibling induces a greater concern with body size in her twin sister, reducing the difference in body size within this pair. A recent paper by Fletcher and Wolfe (2008) analyzed this issue with respect to the effect of ADHD on human capital. In their approach they assumed that the so-called endogenous effects (Manski, 1993) do not play a role.[4] We follow their approach by using a specification that includes the sibling's schooling in a random effects regression controlling for own education.

$$y_{ij} = \alpha + \beta S_{1j} + \delta S_{2j} + \gamma X_{ij} + r_j + \varepsilon_{ij} \quad (5)$$

The estimates are shown in Table 7, the top panel shows the results for men, the results for women are shown in the bottom panel.

The estimates in Table 7 show a remarkable pattern. For men we find no effect of sibling's schooling. However, for women we find a statistically significant effect of sibling's schooling for all three measurements. The estimates suggest that having a higher (lower) educated sister reduces (increases) the probability of being overweight. These findings support the idea that peer effects within pairs of identical twins are more important for women than for men. As a consequence, the fixed effect estimates for women might underestimate the effect of schooling. However, the results in Table 7 should be interpreted with care. The identification of peer effects is complicated and the specification used in Table 7 does not take correlated peer effects (unobserved factors) or endogenous effects into account. Therefore, the findings should merely be considered as indicative of peer effects within pairs of twins.

Summarizing, higher costs of body size for women might reduce the variation in overweight and makes is more difficult to detect an effect of schooling on overweight for women. A factor that might also play a role in the outlying results for women is peer effects within pairs of twins. Having a higher (lower) educated sister seems to reduce (increase) the probability of being overweight.

[4] Manski (1993) distinguishes between endogenous, contextual and correlated effects. Our exploration of peer effects only focuses on the contextual effects.

Table 7
Random effect estimates of own and sibling's schooling on overweight.

	1980		1988/1989		1993	
	(1)	(2)	(3)	(4)	(5)	(6)
Men						
Own schooling	−0.018 (0.008)**	−0.018 (0.008)**	−0.023 (0.008)***	−0.023 (0.009)***	−0.030 (0.013)**	−0.030 (0.013)**
Sibling's schooling		−0.001 (0.008)		−0.001 (0.009)		−0.004 (0.012)
N	686	686	694	694	370	370
Women						
Own schooling	−0.002 (0.005)	−0.001 (0.005)	−0.015 (0.005)***	−0.013 (0.005)**	−0.012 (0.008)	−0.008 (0.008)
Sibling's schooling		−0.009 (0.005)*		−0.009 (0.005)*		−0.019 (0.008)**
N	1428	1428	1450	1450	916	916

Note: All models include the same controls as in Table 3. Standard errors in brackets.
* Significant at 10% level.
** Significant at 5% level.
*** Signficant at 1% level.

9. Conclusions and discussion

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 2–4 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 twin fixed 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. 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.

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. In addition, pooling of the data yielded similar results. A factor that might explain the difference in findings between men and women is peer effects within pairs of twins. We find some evidence that the schooling of the sister has an effect on the probability of being overweight, but the schooling of the twin brother has no effect. Other recent studies also indicate that women are more susceptible to peer influences than men. If peer effects are important this might bias our fixed effect estimates. However, our findings on peer effects within pairs of twins might be biased by unobserved factors. Therefore, these findings should be interpreted as indicative and not as conclusive.

Previous studies on the effect of education on body size found little evidence that schooling reduces the probability of being overweight or obese. Our findings, especially those for men, differ. All three previous studies used an instrumental variable approach based on schooling reforms and only exploit variation in educational attainment induced by these reforms. Our paper exploits variation over the total range of educational attainment. This might explain the discrepancy in findings in case the variation in education that is induced by these reforms did not capture the changes in human capital which are relevant to controlling body size. Other factors that might explain the discrepancy in findings are the differences in the populations that are studied. In this study we focus on a sample of Australian twins whereas previous studies focused on individuals from Denmark, Great Britain or the US.

Some cautionary notes about this study are in order. In our study we use a sample of identical twins. Although various studies that have compared samples of twins with the population at large on outcomes such as, educational attainment, IQ, psychiatric symptoms or personality (Baker et al., 1996; Calvin et al., 2009; Kendler et al., 1986; Webbink et al., 2008), have found that the twins seem more or less representative of the wider population, it is possible that results from a sample of twins might not be transferable to the population at large. In addition, the proportion of overweight individuals in our sample is somewhat lower than in the population and the educational attainment in our sample is slightly higher than in the population. Moreover, due to the difference in measurement the sample in 1993 is smaller which might have induced some attrition bias. Finally, the issues of reverse causality and endogeneity are important concerns. Although we find that our results are robust to sensitivity tests on these issues some caution seems appropriate.

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 the impact of education policies is not clear. We find no effect of educational attainment on body size but these estimates might be biased by peer effects within pairs of identical twins.

References

Adams, S.J., 2002. Educational attainment and health: evidence of a sample of older adults. Education Economics 10, 97–109.
Albouy, V., Lequien, L., forthcoming. Does compulsory education lower mortality? Journal of Health Economics.
Arendt, J.N., 2005. Does education cause better health? A panel data analysis using school reforms for identification. Economics of Education Review 24, 149–160.
Argys, L.M., Rees, D.I., 2008. Searching for peer group effects: a test of the contagion hypothesis. The Review of Economics and Statistics 90 (3), 442–458.
Ashenfelter, O., Krueger, A.B., 1994. Estimates of the economic return to schooling from a new sample of twins. American Economic Review 84 (5), 1157–1173.
Baker, L.A., Treloar, S.A., Reynolds, C.A., Heath, A.C., Martin, N.G., 1996. Genetics of educational attainment in Australian twins: sex differences and secular changes. Behavior Genetics 26 (2), 89–102.
Black, S.E., Devereux, P.J., Salvanes, K.G., 2007. From the cradle to the labor market? The effect of birth weight on adult outcomes. Quarterly Journal of Economics 122 (1), 409–439.
Behrman, J.R., Rosenzweig, M.R., 2002. Does increasing women's schooling raise the schooling of the next generation? American Economic Review 92 (1), 323–334.
Bonjour, D., Cherkas, L.F., Haskel, J.E., Hawkes, D.D., Spector, T.D., 2003. Returns to education: evidence from U.K. twins. American Economic Review 93 (5), 1799–1812.

Bound, J., Solon, G., 1999. Double trouble: on the value of twins-based estimation of the returns to schooling. Economics of Education Review 18 (2), 169–182.

Calvin, C., Fernandes, C., Smith, P., Visscher, P.M., Deary, I.J., 2009. Is there still a cognitive cost of being a twin in the UK? Intelligence 37 (3), 243–248.

Chou, S., Liu J., Grossman, M., Joyce, T., 2004. Parental education and child health: evidence from a natural experiment in Taiwan. Working paper, City University of New York.

Clark, D., Royer, H., 2008. The effect of education on adult mortality and health: evidence from the United Kingdom. Unpublished paper.

Conley, D., Glauber, R., 2005. Gender, body mass and economic status. NBER Working Paper 11343.

Currie, J., Moretti, E., 2003. Mother's education and the intergenerational transmission of human capital: evidence from college openings. Quarterly Journal of Economics 118, 1495–1532.

Cutler, D.M., Lleras-Muney, A., 2006. Education and health: evaluating theories and evidence. NBER Working Paper 12352.

Dechenes, O., 2007, The effect of education on adult mortality: evidence from the baby-boom generation. University of California, Santa Barbara, unpublished paper.

Dixon T., Waters A.M., 2003. A growing problem: trends and patterns in overweight and obesity among adults in Australia, 1980 to 2001. Bulletin No. 8. AIHW Cat. No. AUS 36, AIHW, Canberra.

Eagly, A.H., Carli, L.L., July 1981. Sex of researchers and sex-typed communications as determinants of sex differences in influence-ability: a meta-analysis of social influence studies. Psychological Bulletin 90, 1–20.

Flegal, K.M., Carrol, M.D., Kucmarski, R.J., Johnson, C.L., 1998. Overweight and obesity in the United States: prevalence and trends, 1960–1994. International Journal of Obesity 22, 39–47.

Flegal, K.M., Carrol, M.D., Ogden, C.L., Johnson, C.L., 2002. Prevalence and trends in obesity among US adults, 1999–2000. JAMA 288, 1723–1727.

Fletcher, J., Wolfe, B.L., 2008. Child mental health and human capital accumulation: the case of ADHD revisited. Journal of Health Economics 27, 794–800.

Grimard, F., Parent, D., 2007. Education and smoking: were Vietnam war draft avoiders also more likely to avoid smoking? Journal of Health Economics 26 (5), 896–926.

Grossman, M., 2005. Education and nonmarket outcomes. NBER Working Paper 11582.

International Obesity Task Force, 2005. EU Platform on Diet, Physical Activity and Health. International Obesity Task Force, Brussels.

Kling, J.R., Liebman, J.B., Katz, L.F., 2007. Experimental analysis of neighborhood effects. Econometrica 75 (January 2007), 83–91.

Kendler, K.S., Heath, A.C., Martin, N.G., Eaves, L.J., 1986. Symptoms of anxiety and depression in a volunteer twin population: the etiologic role of genetic and environmental factors. Archives of General Psychiatry 43, 213–221.

Kenkel, D., Lillard, D., Mathios, A., 2006. The roles of high school completion and GED receipt in smoking and obesity. Journal of Labor Economics 24 (3), 635–660.

Lindeboom, M., Llena-Nozal, A., van der, Klaauw B., 2007. Parental Education and Child Health: Evidence Form a Schooling Reform. Free University Amsterdam.

Lleras-Muney, A., 2005. The relationship between education and adult mortality in the United States. The Review of Economic Studies 72, 189–221.

Macgregor, S., Cornes, B.K., Martin, N.G., Visscher, P.M., 2006. Bias, precision and heritability of self-reported and clinically measured height in Australian twins. Human Genetics, doi:10.1007/s00439-006-0240-2.

Manski, C.F., 1993. Identification of endogenous social effects: the reflection problem. Review of Economic Studies 60, 531–542.

Mazumder, B., 2007. How did schooling laws improve long-term health and lower mortality? Federal Reserve Bank of Chicago. WP 2006-23, Chicago, IL (revised 24.01.07).

Miller, P.W., Mulvey, C., Martin, N., 1995. What do twin studies reveal about the economic returns to education? A comparison of Australian and U.S. findings. American Economic Review 85 (3), 586–599.

Neidhammer, I., Bugel, I., Bonenfant, S., Goldberg, M., Leclerc, A., 2000. Validity of selfreported weight and height in the French GAZEL cohort. International Journal of Obesity and Related Metabolic Disorders 24 (9), 1111–1118.

O'Dea, J., Abraham, S., 1999. Association between self concept and body weight, gender and pubertal development among male and female adolescents. Adolescence 34, 69–79.

Oreopoulos, P., 2006. Estimating average and local average treatment effects of education when compulsory schooling laws really matter. American Economic Review 96, 152–175.

Park, C., Kang, C., 2008. Does education induce healthy lifestyle? Journal of Health Economics 27 (6), 1516–1531.

Paxton, S.J., Sculthorpe, A., Gibbons, K., 1994. Weight-loss strategies and beliefs in high and low socioeconomic areas of Melbourne. Australian Journal of Public Health 18, 412–417.

Plug, E., 2004. Estimating the effect of mother's schooling on children's schooling using a sample of adoptees. American Economic Review 94 (1), 358–368.

Rolls, B.J., Fedoroff, I.C., Guthrie, J.F., 1997. Gender differences in eating behavior and weight regulation. Health Psychology 10, 133–142.

Sobal, J., Stunkard, A.J., 1989. Socioeconomic status and obesity: a review of the literature. Psychological Bulletin 105 (22), 260–275.

Spasojevic, J., 2003. Effects of education on adult health in Sweden: results from a natural experiment. Ph.D. Dissertation, City University of New York Graduate Center.

Walque, D.de, 2007. Does education affect smoking behaviors? Evidence using the Vietnam draft as an instrument for college education. Journal of Health Economics 26 (5), 877–895.

Webbink, D., Posthuma, D., Boomsma, D., Geus, J.de, Visscher, P.M., 2008. Do twins have lower cognitive ability than singletons? Intelligence 36 (6), 539–547.

WHO (World Health Organization), 2000. Obesity: preventing and managing the global epidemic, report of a WHO consultation. Technical Report Series 894, Geneva.