The impact of higher education on body weight

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Abstract: A large and growing body of literature has examined the causal impact of schooling on health and health behaviors. Most of this research exploits changes in education due to compulsory schooling requirements and thus the effect is estimated at a margin—one more year of schooling—at the lower end of the education distribution. This paper is the first paper to estimate the causal effect of higher education, i.e., more than two years in addition to 12 years of primary and secondary education (e.g., a Bachelor of Art degree or a Master of Art degree), on body weight. To identify the causal effect we exploit a reform of the Danish student's grant scheme in 1988, which involved a grant increase of approximately 60% and apply an instrumental variable approach. The grant scheme covers students' costs of living throughout their college education. We found that completing a higher education significantly reduced the probability of being overweight (Body Mass Index >25) among men. This effect is identified for a group of people that are much more likely to come from a low income background.

JEL classification: I12, I14, I23

Key words: returns to education, higher education, overweight, selection bias, instrumental variable approach, parental income background

1 Introduction

The effects of non-pecuniary returns to schooling, for example effects on health, crime and marital outcomes is a well-researched area in the economic literature (Oreopoulos and Salvanes, 2011; Lochner, 2011). Given the importance of the obesity epidemic, prevalent in almost all developed countries, a considerable part of the effect of total returns to schooling may be a reduced body weight.

To our knowledge, this paper is the first to examine the impact of higher education, i.e., more than two years in addition to 12 years of primary and secondary education (e.g., a bachelor's degree or graduate degree), on body weight. As overweight and obesity are unequally distributed across socio-economic groups, policies aimed at vulnerable groups should be emphasized (OECD, 2012). We therefore conducted a separate analysis of the impact of higher education on body weight for people growing up in low income households

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(parental income below 60% of the median average income over a seven-year period).¹ From a policy perspective, a significant impact of higher education on non-pecuniary outcomes such as lower body weight, among people from low-income background adds to the discussion on the benefits of subsidizing higher education.

We use an instrumental variable approach and the 1988 reform of the student's grant scheme (hereafter referred to as the 1988 Reform) to identify the effect. The reform involved a grant increase of approximately 60% and therefore increased the incentive to enroll in a higher education. Although we cannot identify the group for whom we estimate the latent average treatment effect (LATE), we follow Angrist and Pischke (2009) and describe the relevant group.²

Explanations for the mechanism by which education affects health and health behaviors include a more efficient health 'production' (Grossman, 1972), an increase in allocative efficiency (Rosenzweig and Schultz, 1982; Kenkel, 1991), an increase in specific health knowledge (Kenkel, 1991; Nayga, 2000; Johnston et al., 2015) and improvements in general skills, critical thinking and decision-making abilities (e.g., Cutler and Lleras-Muney, 2010). The link between education and body weight might also be explained by unobserved factors, such as 'value of the future' and individual preferences (Fuchs, 1982) or by reverse causality, i.e. body weight might affect educational attainment.

The influence of peers at school has been shown to affect health behaviors, such as eating and physical exercise (Yakusheva et al., 2011). Increasing the number of years in school for young people from low income families might give them a different social network or environment from the environment in which they grew up. As educated people generally eat more healthily, exercise more and are less likely to be obese, people from disadvantaged families might be motivated to adjust to the healthy lifestyle social norm of their educated peers. Although the effect of an educated social network does not explain why education in itself decreases the likelihood of being obese, it might explain why the effect differs according to parental income background.

Several papers have studied the impact of one more year of education for students at the lower end of the education distribution (using changes in compulsory schooling laws) on body weight.³ Most of these studies found that the effect on body weight of education disappeared among men, when the endogeneity problem was addressed (Arendt, 2005; Kenkel et al., 2006; Reinholdt and Jürges, 2009; Clark and Royer, 2010; Jürges et al., 2011; Brunello et al., 2013; Lundborg, 2013; Amin et al., 2015; Fletcher, 2015). However, using changes in compulsory schooling laws in 1949 and 1969, Kemptner et al. (2011) found that an extra year of compulsory schooling reduced the probability of being overweight in men by 3–4%. Using the Australian twin register, Webbink et al. (2010) found similar results. Using variation caused by state-specific compulsory school laws in the US, Grabner (2009) found that one more year of schooling reduced the probability of being overweight by three percentage points. Although previous studies have achieved different results for the causal

¹ All measures of income are gross. Information on gross income is taken from the Income Statistics Register since 1980. This registry builds on a variety of smaller registries, the main sources being the Central Taxpayers' Registry and the Salary Information Registry (Baadsgaard and Quitzau, 2011). The variable that measures gross income includes all taxable income, including grants, public transfers and income from securities.

² Denmark constitutes a good model for this study as approximately half of the young cohorts in Denmark are expected to complete a tertiary, largely theory-based education in their lifetime (OECD, 2012), and as a relatively high level of social mobility exists in Denmark (OECD, 2015), completing a higher education is not a rare event.

³ For reviews of studies on education and body weight see, e.g., Lochner (2011), Brunello et al. (2013) and Grossman (2015).

effect of education on body weight, most found that controlling for unobserved factors in this relationship was important.

The initial dataset contains very few underweight men but a significant number of underweight women, indicating that the explanations behind men's and women's body weights are different and require different empirical estimation models. Thus in this paper, we focus on the results for men. Although the overall results on women do not differ much from the results on men, the mechanism might be different (see, e.g., Brunello et al., 2013). Thus we present the results on women in appendix and comment only briefly on these.

2 The Danish Education system, the student's grant scheme and the 1988 Reform

All Danish colleges and universities are publicly subsidized, and tuition is free for Danish students, all EU/EEA⁴ students and students participating in exchange programs. As the Danish student's grant scheme (hereafter referred to as the grant) is universal, nearly all students receive a grant for most of their time in education. This grant scheme is administered by the Danish Educational Support Agency in collaboration with educational institutions. A comprehensive description can be found in SU-styrelsen (1999), the student grant institution.

Two important changes in the grant scheme was implemented in 1988 affecting cohort enrolled in a higher education by September 1988. First, the age at which students were eligible to receive a grant was lowered from 19 to 18 years. Second, the amount a student could receive per year was increased by nearly 60% (ending at €6,430, in 2000 prices). Every student enrolled in a higher education course was entitled to a number of monthly grants corresponding to the prescribed duration of the chosen study plus 12 months. If the increase in the grant motivated more young people to enroll in a higher education, the alternative – the wage an individual could earn by working – would have to have been roughly constant over the same period. This was in fact the case, as between 1987 and 1990 real wages changed a few percentage points only (Statistics Denmark 2001), whereas the grant increased by 60%.

Together with the grant, students are offered supplementary state loans at highly favorable interest rates.⁵ By September 1988, both the amount of money students could borrow from the state and the maximum amount that a student was allowed to earn while receiving the grant were increased. These changes further increased the motivation for taking and completing a higher education in 1988 and later.

Figure 1 shows the enrolment rate among men by age group for each year from 1983 to 1994. There was an almost constant enrollment rate for most age groups until 1988-1989. Before the change in 1988, the age groups with the highest enrolment rates were 19 to 22-year-olds. Immediately following the reform, the enrolment rate increased for most age groups. However, the enrolment rates among the 19 and 23-year-olds increased a year later than for the other age groups.

Two previous studies have examined the effects of the 1988 Reform. In a sample of high school students, Nielsen et al. (2010) found that the 1988 Reform increased college enrolment. Another relevant result from this paper is that the reform did not change the composition of enrolled students with respect to high school grades. Using a discrete duration model based on a sample of graduate students, Arendt (2012) found that the 1988

⁴ European Economic Area.

⁵ Of the total grants given to students, the student grant makes up two-thirds of the total support and loans one-third. The interest rate for the loans is set by Parliament. The loan must be repaid within 15 years. About half of all students use the state loan program.

Reform reduced both the number of dropouts and the number of hours worked while studying. The effect on completion rates seems to be significant and high, three years after the designated study time, but the effect was only significant among students with certain academic majors in, for example, natural science.

Figure 1: Fraction of men enrolled in higher education by age groups, 18 to 24 years of age, from 1984 to 1995.

Note: Authors' calculations on the full Danish population from Statistics Denmark registry data base. The 18-year-olds comprise a relatively small group of entrants, because most high school students do not finish high school before they turn 19.

3 Data

Our results are based on the Danish Work Environment Cohort Study (DWECS), a survey carried out in 1995 (response rate 80%) and 2000 (response rate 75%) on a random sample of people who were aged 18-59. Due to a unique personal identification number that all people who live in Denmark are given, the survey variables are merged with information from administrative registries which besides information on education, income and employment status also contain the same information for family members. Thus we have information on both parental education and income background.

We selected a group of men between 15 and 35 years of age in 1988 because most of the members of this age group had completed their education in 1995 or 2000, when their body weight was measured, while the group still contains some variation in age. We excluded men with missing information on height, weight or parental income. The final pooled dataset for 1995 and 2000 consisted of 3,007 men.⁶

⁶ Our data set consisted of 2,468 women. As for men, women with missing information on height, weight or parental income were excluded. Furthermore, pregnant women were excluded from our sample. Table A1 shows the results for women.

The primary body weight measure used in most empirical literature is the Body Mass Index (BMI), i.e., weight in kilograms divided by height in meters (kg/m²). Using BMI as a body weight measure has two drawbacks. Firstly, medical research shows a tendency for people to under-report their true weight but over-report their height. Secondly, a number of studies found that BMI is a poor predictor of body fat (Burkhauser and Cawley 2008). To correct for reporting error in BMI, we used a Danish medical study's predictions on the relationship between reported and true BMI (Bendixen et al. 2004).⁷ As the results were virtually the same with or without correction for reporting errors, we present the results based on the fitted self-reported BMI values only. We use both the continuous measure of BMI and an indicator for being overweight (BMI>25) and obese (BMI>30).

To determine the parental income background of each respondent, we used paternal income. The respondent was categorized as coming from a low income background, if the paternal income was below 60% of the median average income among men in the same paternal age group in 1994-2000. If the paternal income was missing, we used maternal income.⁸

We control for parental education in our models, as it may reveal differences in competencies in acquiring and understanding health information, as well as differences in habits and norms related to health. Although parental education is correlated with parental income, we found a significant number of parents with several years of education in the low income group. In addition to having few financial resources for purchasing healthy food, people coming from the low income group generally lived in neighborhoods with the lowest housing prices and less privileged environments. The results sorted by subgroup of income background might therefore suggest how the impact of a higher education varies depending on the economic and social environment during childhood and adulthood.

We categorized people who were enrolled in or had already completed a higher education program (e.g., a bachelor's degree or graduate degree) at a nationally recognized institution at the time of the interview (1995 or 2000) as 'people with a higher education'.⁹ We used a binary indicator for higher education to study the effect of more education at the top end of the education distribution. As the Danish higher education system is organized in blocks (for example, a bachelor's degree takes 3 years and a master's degree 2 years), and students often spend more than the designated study time on completing a degree, an estimation of the effect of one further year of schooling seems less relevant.

The descriptive statistics for all included variables are presented in Table 1 and show, for example, that, 49% and 8% of the men are overweight and obese, 16% has a higher education and 16% come from a low income background. On average, men from different income backgrounds differ significantly on all the control variables.

⁷ In these prediction models, separately by gender, actual BMI was regressed on the self-reported BMI and age.

⁸ Reliable information on parental income is available from 1994. However, it is a realistic assumption that the average relative parental income in the 7-year period from 1994 to 2000 did not differ from the relative average parental income from 1988 to 1994 (i.e. the treatment period).

⁹ People who were enrolled in and later dropped out of a higher education program before the interview date are categorized as not having a higher education. The level of education was measured at the same time as BMI. Thus people who were enrolled in a higher education program at the time they were interviewed may have dropped out later. As those who dropped out mainly did so during the first years of the study, we tested whether the results differ when leaving out the group of men enrolled in a higher education within the last 2 years in 1995 and 2000. The results in these models are virtually the same as in the main models we present in section 5.

Table 1: Descriptive statistics, all men and men according to parental income background. Year 1995 and 2000. Mean and standard deviation (SD) in parentheses.

	All		Low income		Higher income	
	mean	SD	Mean	SD	mean	SD
Underweight (%)	0.006	(0.075)	0.006	(0.074)	0.006	(0.080)
Healthy weight (%)	0.506	(0.500)	0.514 [†]	(0.500)	0.461	(0.499)
Overweight (%)	0.489	(0.500)	0.480 [†]	(0.500)	0.533	(0.499)
Obese (%)	0.080	(0.272)	0.075 [†]	(0.264)	0.106	(0.308)
BMI (kg/m ²)	25.331	(3.219)	25.257 [†]	(3.181)	25.730	(3.389)
Higher ed. (0/1)	0.263	(0.441)	0.274 [†]	(0.446)	0.206	(0.405)
Low income (0/1)	0.157	(0.364)				
Age (years) in reform year	24.073	(5.561)	23.929	(5.497)	24.845	(5.839)
Married (0/1)	0.717	(0.450)	0.720	(0.449)	0.701	(0.459)
Ln (Income when BMI was measured (10,000 DKK))	3.242	(0.480)	3.255 [†]	(0.486)	3.171	(0.439)
Ln (average yearly income age 20–28 (1,000 DKK))	2.407	(4.837)	2.548 [†]	(4.734)	1.649	(5.297)
Mother, higher ed. (0/1)	0.136	(0.343)	0.147 [†]	(0.354)	0.076	(0.266)
Father, higher ed. (0/1)	0.157	(0.364)	0.156	(0.363)	0.159	(0.366)
Observations	3,007		2,536		471	

The sample includes men 15–35 years old in 1988. Being underweight is defined as BMI ≤ 18.5 , healthy weight is defined as BMI >18.5 and BMI ≤ 25 , overweight is defined as BMI >25 and being obese as BMI ≥ 30 . Higher education (higher ed.) refers to more than 2 years in addition to 12 years of primary and secondary education. Standard t-tests of differences in means are conducted for determining the difference between men from low and higher income backgrounds. Significance: ** $p < 0.01$ * $p < 0.05$, [†] $p < 0.10$.

4 Econometric approach

To estimate the causal effect of higher education on body weight we exploit the exogenous variation generated by the changes in the incentives to enrol in higher education brought about by the reform. The effect of a higher education on body weight is estimated using the following two equations:

$$BW_{ic} = \alpha_1 + EDU_{ic}\beta + X_{ic}\gamma + d_c + \varepsilon_{ic} \quad (1)$$

$$EDU_{ic} = \alpha_2 + reform1988_{ic}\lambda + X_{ic}\vartheta + d_c + \eta_i \quad (2)$$

In (1) BW_{ic} is a body weight measure, i.e. Body Mass Index (BMI) or an indicator for being overweight (BMI >25) for individual i born in year c . The variable EDU equals ‘1’ if the individual has been enrolled in higher education and ‘0’ if they have not, X is a vector of variables that affect body weight (in the empirical model X includes marital status,

parental income, income when BMI is measured and income at age 20-28), d is year-of-birth-dummies, and ε is the residual.¹⁰ Thus β is the parameter of interest, indicating the effect of a higher education on body weight. The probability of a higher education is estimated in (2). X is the same vector of variables that affects body weight, and *reform1988* is a variable measuring how the 1988 Reform affected the respondents' decision to begin a higher education.

We estimate (1) and (2) using ordinary least squares (OLS) and instrumental variable (IV) estimation. Thus we assume linearity for education and overweight. However, as both our dependent variables are bivariate when we estimate the probability of being overweight we also tested the results using a bivariate probit model. We include year-of-birth dummies to control for trends in BMI across cohort (Lochner, 2011).

Given that men choose to enroll into higher education at different stages in life and with different budget restrictions, we constructed a continuous instrument. We assigned a value between zero and four to all men who had not yet completed or been enrolled in higher education in 1988 and who were less than 22 years old. These values indicate how the student grant scheme might have had an effect up until the age of 22, the age at which most students, who eventually completed a higher education, were enrolled. According to the OECD (1996), the median age of enrollment in Denmark was 21.2 in 1996. We assigned men not enrolled in higher education at age 18 (and younger), 19, 20 and 21 in 1988 a value of 4, 3, 2 and 1, respectively. The maximum value of 4 corresponds to the average number of years of completed education above 12 years of education for the youngest men in the sample. We assigned men already enrolled in higher education in 1988 a value corresponding to their expected number of years of education (>12 years of education) minus the years they had already completed and men who had already completed a higher education in 1988 a value of 0, as we assumed that they would not be affected by the 1988 Reform.

As the grant increase had a direct positive effect on income, it could have affected the cost of living and thereby the amount and type of food that the students consumed, which in turn could have affected body weight. However, in absolute terms the income increase from the grant was not large. Furthermore, as the grant increase also reduced the number of hours worked during the years spent studying significantly, see Arendt (2012), the grant may only have had a minor effect on the living cost. The reform could also have influenced the extent of parental aid, though few students in Denmark are dependent on parental aid during their studies (SU-styrelsen 1997). To validate our exclusion restriction we controlled for total income at age 20-28, the most common age-range among college students.¹¹

¹⁰ To avoid the problem of bad controls (Angrist and Pischke, 2009), we estimated models both including and excluding variables measured at the same time as BMI, i.e. income and marital status.

¹¹ Furthermore, as income might be a "bad control", we followed Pei et al. (2017) and conducted a balancing test with income, during studies, on the left side. In the full sample there was a small negative but significant relationship between the instrument and income. In the sample of men coming from low-income families, this relationship was no longer significant. These results indicate that consumption possibilities were not affected by the reform.

5 Results

5.1 Regression-based results

The results of the OLS estimations indicate that, among all men, a higher education reduced BMI by 0.8 units and reduced the probability of being overweight by 12 percentage points.¹² Furthermore, being married and having a father with a higher education significantly influenced BMI and the probability of being overweight. While parental income is significantly associated with BMI and the probability of being overweight, income at age 20-28, i.e., consumption possibilities during study years, is not significantly associated with these outcomes. This last result indicates that those with higher consumption possibilities at younger ages are neither more nor less likely to be overweight later.

Table 2: Body weight and higher education among all men. OLS and IV estimates. Parameter estimates and standard errors in parentheses.

	Probability of being overweight (OLS) (1)	Probability of being overweight (IV) (2)	BMI (OLS) (3)	BMI (IV) (4)
Higher education	-0.116 (0.022)**	-0.260 (0.100)**	-0.786 (0.139)**	-1.793 (0.651)**
Low income (0/1)	0.044 (0.025) [†]	0.037 (0.025)	0.413 (0.161)*	0.365 (0.165)*
Married (0/1)	0.076 (0.021)**	0.079 (0.021)**	0.315 (0.135)*	0.334 (0.137)*
ln(Income when BMI was measured (10,000 DKK))	0.021 (0.021)	0.042 (0.025) [†]	0.204 (0.134)	0.351 (0.164)*
ln(average yearly income age 20–28 (1,000 DKK))	0.013 (0.019)	-0.011 (0.025)	-0.073 (0.125)	-0.239 (0.164)
Mother, higher ed. (0/1)	-0.041 (0.028)	-0.021 (0.031)	-0.543 (0.181)**	-0.404 (0.203)*
Father, higher ed. (0/1)	-0.078 (0.027)**	-0.050 (0.033)	-0.341 (0.171)*	-0.146 (0.212)
Constant	0.245 (0.108)*	0.326 (0.122)**	24.389 (0.696)**	24.955 (0.788)**
Controlled for age cohort	x	x	x	X
R ²	0.04	0.03	0.04	0.02
Observations	3,007	3,007	3,007	3,007

The sample consists of men 15–35 years old in 1988. Higher education refers to more than 2 years in addition to 12 years of primary and secondary education. Standard errors are clustered on observation number as there are some observations included in both the sample from 1995 and 2000. Significance: **p<0.01 *p<0.05, [†]p<0.10.

¹² Among women, the probability of being overweight is reduced by nearly 10 percentage points (see appendix table A1).

5.2 Validation of the instrument

Table 3, column 1, shows that the 1988 Reform significantly increased the probability of completing a higher education, as anticipated by Figure 1. The F statistic for the exclusion of the 1988 Reform from the first-stage regressions is 145. This F statistics far exceeds the minimum F statistics of 10 suggested by Staiger and Stock (1997), and thus indicates that the instrument is relevant.

As the continuous instrument could be criticized as merely being a complicated age distribution variable and therefore correlated with taking a higher education we tested the relevance of the instrument by replacing the continuous reform variable with a dummy variable for 1988, the year of the reform, and found that the probability of a higher education increased significantly, by approx. 60 percentage points (table 3, column 4). Furthermore, to test whether the instrument just captures a time trend of enrolments in higher education, we tested the relationship between several placebo years and higher education. Columns 5 and 6 (table 3) show the results for the years 1982 and 1992. Compared to the parameter estimate on the instrument (table 3, column 1) the parameter estimates on the placebo reform years are small and not statistically significant. Thus the instrument in column 1 does not seem to capture a pure time trend.

Table 3: Test of the instrument. First stage results for higher education and reduced form results for overweight and BMI among all men.

	First stage higher Education (OLS)	Reduced form Overweight (OLS)	Reduced form BMI (OLS)	First stage Higher Education (OLS)	First stage Higher Education (OLS)	First stage Higher Education (OLS)
	(1)	(2)	(3)	(4)	(5)	(6)
Reform 1988	0.208 (0.017)**	-0.054 (0.021)**	-0.373 (0.135)**			
Reform 1988 dummy				0.618 (0.038)**		
Placebo Reform 1982					0.067 (0.063)	
Placebo Reform 1992						-0.034 (0.042)
R ²	0.15	0.03	0.03	0.18	0.11	0.11
Observations	3,007					

The sample consists of men 15–35 years old in 1988. Higher education refers to more than 2 years in addition to 12 years of primary and secondary education. Standard errors are clustered on observation number as there are some observations included in both the sample from 1995 and 2000. Significance: **p<0.01, *p<0.05, †p<0.10. The following control variables are included but not shown: marital status, income at age 20-28 and when BMI was measured, parental education and income, and birth cohort dummies.

Given that the grant scheme might have affected weight through multiple channels (e.g., income, education and decreased working hours), we show the reduced-form regressions of body weight on the reform in Table 3, columns 2 and 3. For both BMI and the probability of being overweight the parameter estimate on the reform variable is negative and significant. As the reduced-form estimate is proportional to the causal effect of interest,

a significant result in both the first-stage and the reduced-form regressions points to a valid IV estimate.¹³ Furthermore, the Durbin and Wu-Hausman test suggests that higher education cannot be treated as exogenous our structural model.¹⁴

5.3 The causal effect of higher education on body weight

The IV results in Table 2, columns 2 and 4, suggest a 26 percentage point reduction in the probability of being overweight and a 1.8 unit reduction in BMI of a higher education. These results correspond to a reduction in the risk of overweight of 53 percent and a reduction in BMI of about seven percent.¹⁵ In Table A1, the IV estimate for women for the probability of being overweight is -0.27 and thus of almost of the same size as the IV estimate for men.

At a first glance, the IV estimates seem relatively high compared to the OLS the results found in previous literature. For example, Kemptner et al. (2011) found a 3-4 percentage point reduction in the risk of becoming overweight for an additional year of compulsory schooling. Two factors explain our relatively large IV estimates. First, while previous studies on body weight have estimated effects of one more year of lower levels of education (typically secondary school), we estimated the effect of a higher education, i.e., an effect of at least two additional years to 12 years of schooling. Second, in cases where response to treatment varies across individuals the IV model provides an estimate of treatment of the treated only for those affected by the instrument (compliers). The group of compliers might differ depending on, for instance, the instrument, sample and the context (countries) and the effect is likely not to be the same as the average treatment for the treated. We have followed Angrist and Pischke (2009) and characterized the compliers by estimating the ratio of the first stage for men with low income background to the overall first stage. In the full sample model, we found that compliers are much more likely than others to come from a low income background (ratio 1.6).¹⁶

As one could claim that different individuals face different health returns from higher education, we present the effect of higher education on body weight by parental income background in Table 4. For both men from low and higher income backgrounds, the IV estimates are negative. Furthermore, the parameter estimates for men from low income backgrounds are generally higher compared to men from higher income backgrounds.¹⁷

¹³ Furthermore, the Wald estimator (see Angrist and Pischke 2009) is -0.79, when the outcome is overweight.

¹⁴ In the Durbin and Wu-Hausman test the residuals in the regression of higher education are added to the regression of body weight. If the parameter estimate on the residuals is significantly different from zero the parameter estimate on education is not consistent.

¹⁵ Calculation for all men where mean BMI is 25.33 and 48.85 percent is overweight.

¹⁶ Another possible explanation for the large estimate is that the IV estimates are ratios between two estimates (the reduced form over the first stage), and that small changes in one of them could inflate the ratio.

¹⁷ We also tested the results by parental (highest) occupational status (white collar/blue collar worker), instead of income. No significant difference was found in the relationship between education and overweight, when men with white-collar parents and men with blue-collar parents were compared. In addition, we tested the different cut-off points for parental income. The results were not significantly different around the threshold (i.e. 60% of the average median income).

Table 4: IV estimates for the effect on body weight of having a higher education among men by parental income background.

	Low income		higher income	
	Probability of being overweight (IV)	BMI (IV)	Probability of being overweight (IV)	BMI (IV)
	(1)	(2)	(3)	(4)
Higher education	-0.364 (0.208) [†]	-2.033 (1.425)	-0.231 (0.114)*	-1.513 (0.731)*
R ²	0.06	0.09	0.03	0.03
F statistics for instrument	38.28	38.28	109.64	109.64
Observations	471		2,536	

The sample consists of men 15–35 years old in 1988. Higher education refers to more than 2 years in addition to 12 years of primary and secondary education. Standard errors are clustered on observation number as there are some observations included in both the sample from 1995 and 2000. Significance: **p<0.01, *p<0.05, [†]p<0.10. The following control variables are included but not shown: marital status, income at age 20-28 and when BMI was measured, parental education and birth cohort dummies.

5.4 Sensitivity analysis

Testing the empirical model

One might surmise that if the grant increase had a direct effect on income it could have affected the living cost and thereby the amount and types of food that the students consumed. As this might invalidate our exclusion restriction, we controlled for yearly income at age 20-28 in the estimated models. However, controlling for income both during study years and when BMI is measured may bias the parameter estimate on education, as these variables are potentially affected by education. This is called the bad control problem in Angrist and Pischke (2009). To test this possible bias in the parameter estimate of higher education, we estimated a model including only variables measuring higher education, age cohort dummies and parental education and a model including all other control variables but excluding the income variables. Table 5, columns 1 and 2, shows that the parameter estimate on higher education is virtually the same (-0.24 and -0.26) when the “bad controls” are excluded.

As both our dependent variables are bivariate, we tested our results using a bivariate probit model, when we estimated the probability of being overweight (See table 5, column 2). Although the parameter estimate in the bivariate probit model shows the average treatment effect and the IV estimate shows a LATE, we found that the parameter estimate on higher education is similar in the two models. As the IV estimates have the advantage of easily interpreted coefficients, we rely on these estimates.

Table 5: Sensitivity analyses

	Probability of being overweight including only higher education and income background (IV)	Probability of being overweight excluding income variables (IV)	Probability of being overweight among men 15-29 years in 1988 (IV)	Probability of being overweight Biprobit model, marginal effect)	Probability of being obese (IV)	Probability of smoking (IV)
	(1)	(2)	(3)	(4)	(5)	(6)
Higher education	-0.258 (0.086)**	-0.239 (0.090)**	-0.253 (0.116)*	-0.250 (0.072)**	-0.161 (0.056)**	-0.411 (0.100)**
Control variables		x	x	x	x	x
R ²	0.02	0.03	0.03	0.03	0.02	0.03
Observations	3,007	3,007	2,374	3,007	3,007	3,007

The sample consists of men 15–35 years old in 1988 except for column (3). Higher education refers to more than 2 years in addition to 12 years of primary and secondary education. Standard errors are clustered on observation number as there are some observations included in both the sample from 1995 and 2000. Significance: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$. Control variables include: marital status, income at age 20-28 and when BMI was measured, parental education and income, and birth cohort dummies.

Testing the sample

In our main results, we selected a sample of 15-35 year old men in 1988. As this age range is may include men who are too old to be affected by the reform we estimated the model on a smaller sample including only 15-29 year old men. The parameter estimate for higher education on being overweight, shown in Table 5, column 3, is virtually the same (-0.25) as the parameter estimate in the main model (see table 2, column 2).

Other outcomes

As being obese is correlated with many more diseases compared to being overweight, we estimated the effect of a higher education on being obese ($BMI \geq 30$). The IV estimates in Table 5, column 5, shows that higher education reduces the probability of being obese among men by 16 percentage points. However, due to small sample sizes and few observations in the obese category, further research on larger datasets is necessary before any further conclusions from this parameter estimate can be drawn.

To test whether the effect of a higher education also exists for other health behavior outcomes we estimated the effect of a higher education on smoking. The result in Table 5, column 6, shows that a higher education significantly reduces smoking. This result is in line with previous literature (Lochner 2011).

6 Summary and conclusions

We contribute to the existing literature on the relationship between education and body weight by estimating the effect of higher education, i.e., more than two years in addition to

12 years of primary and secondary education, on body weight, and by taking parental income background into account. To identify the IV model, we exploit a reform of the Danish student's grant scheme, which involved a grant increase of approximately 60%. We find large negative (-0.26) and significant effect of higher education on the probability of being overweight on men. We characterize the group for whom the IV parameter is estimated and find that men coming from low income families are overrepresented in the group. When we analyzed the effect of higher education by subgroup of parental income background our IV results were significantly different from zero among both groups, and the parameter estimate was larger among men coming from a low income background compared to men coming from a higher income background. Various sensitivity test shows that the results were robust to the choice of empirical model and sample.

Our analysis and results focus on the policy-relevant group of men from low income parental backgrounds. Although cognitive abilities and health knowledge are factors related to enrolling in higher education for all socio-economic groups, we expected people from low income backgrounds to differ from their higher income background peers because of the social environment in which they were raised. Thus significantly increasing the number of years in school for people from economically disadvantaged backgrounds might change their health behavior more than among people from non-low income backgrounds. As educated people generally eat more healthily, exercise more and are less likely to be overweight and obese, people from disadvantaged families might be motivated by their educated peers to adopt the social norm for a healthy lifestyle.

Whereas the previous literature primarily studied the effect of other educational categories, such as completion of high school, or a further year of compulsory education, we extended the literature by focusing on enrolling in a higher education, i.e., two-to-five years beyond the usual 12 years of primary and secondary education. Our results show that a higher education has a negative and significant effect on body weight among men coming from low income families. This result suggests that while there might be a limited effect of fewer years of education, e.g., one extra year of compulsory education, on being overweight the effect is significant at higher levels of education. Furthermore, this effect differs according to socio-economic background.

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Appendix**Table A1: Body weight and higher education among all women and by parental income background. OLS and IV estimates.**

	All	All
	Probability of being overweight (OLS)	Probability of being overweight (IV)
	(1)	(2)
Higher education (0/1)	-0.096 (0.020)**	-0.272 (0.085)**
Low income (0/1)	-0.005 (0.027)	-0.023 (0.028)
Married (0/1)	0.028 (0.021)	0.019 (0.022)
ln(Income when BMI was measured (10,000 DKK))	-0.033 (0.019)*	-0.016 (0.021)
ln(Average yearly income age 20-28 (1,000 DKK))	-0.023 (0.012)*	-0.030 (0.013)*
Mother, higher ed. (0/1)	0.003 (0.027)	0.034 (0.031)
Father, higher ed. (0/1)	-0.092 (0.026)**	-0.061 (0.030)*
Constant	0.532 (0.082)**	0.566 (0.084)**
Controlled for age cohort	x	X
R ²	0.04	0.01
F statistics for instrument	147.08	147.08
Observations	2,468	2,468

The sample consists of women 15–35 years old in 1988. Higher education refers to more than 2 years in addition to 12 years of primary and secondary education. Standard errors are clustered on observation number as there are some observations included in both the sample from 1995 and 2000. Significance: **p<0.01; *p<0.05.