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Citation for published version (APA):
Leuven, E., Oosterbeek, H., & de Wolf, I. F. (2007). The effects of health education on health outcomes: Evidence from a natural randomized experiment. Amsterdam: Faculteit Economie en Bedrijfskunde.

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Download date: 22 May 2019

The effects of health education on health outcomes: Evidence from admission lotteries*

Edwin Leuven Hessel Oosterbeek Inge de Wolf

Abstract

This paper estimates the effects of attending medical school on health behavior and health status by exploiting that admission to medical school in the Netherlands is determined by a lottery. We instrument actual attendance with the result of the first lottery because lottery losers are allowed to re-apply in subsequent years. Our results show that health education reduces alcohol consumption and being underweight (and some indication that it might reduce smoking). It has, however, no impact on being overweight or obese, nor on self-reported health status. The effect on the frequency of physical exercise is negative. We interpret these mixed results as evidence that the content of education programs is unlikely to explain the education gradient for health. We do find however a large impact on the probability of being registered for donations of organs, suggesting that information provision can be an effective channel to raise the supply of organs.

1 Introduction

[IMPORTANT: point out that IV estimates are often much larger than OLS (e.g. lleras-muney 2005) whereas one would expect that OLS overestimates the effect of education on health. Interestingly we do not see this. We should present this as one of our main results...]

Kenkel et al. (2006)Cowell (2006)Farrell and Fuchs (1982)Berger and Leigh (1989)Sander (1995)

Many studies document a positive correlation between education and health. In a recent survey of this literature, Cutler and Lleras-Muney (2006) argue that the available

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evidence suggests that at least part of this correlation can be attributed to a causal effect running from education to health. This evidence is based on quasi-experimental studies that exploit exogenous variation in years of schooling due to changes in compulsory schooling laws (see Lleras-Muney, 2005; Oreopoulos, 2003; Arendt, 2005).[1] Since compulsory schooling laws usually generate variation in education around the completion of high school, studies exploiting these reforms recover local estimates, and it is not clear whether these effect estimates can be extrapolated to changes in education at higher levels. [REF] suggest that the effect of education on health does not diminish as one moves up the education ladder, and might even be stronger at higher education levels. This observation is however based on correlational analysis, and the current paper is to our knowledge the first study to present causal estimates of education on health status and health behavior at the high end of the education distribution.

A second contribution of our paper is that we try to disentangle the channels through which education affects health. As Cutler and Lleras-Muney (2006) point out, most studies focus on the effects of the quantity of schooling on health. This is however a reduced form effect since education may not only have a direct (preference) effect on health status, but may also change other factors that can affect health outcomes such as income, occupation and information. Cutler and Lleras-Muney (2006) also note that there is "no causal evidence on whether the content of education matters for health" (p.13), and that studies addressing this question are lacking.

In addition to considering health outcomes and health behavior we also consider the impact on a form of altruistic health behavior, namely registering as an organ donor. Like in other countries the demand for organs exceeds supply by large margin in the Netherlands where cadaveric organ procurement operates since 1998 under informed consent. Under this regime organs can only be extracted if the donor gives explicit permission before death. The deceased's family can however, and often does, object to donation (about 75 percent of the time, in the Netherlands, Koene, 2002). Dutch citizens aged 18 and over can register whether and how they wish to donate their organs after their

[1] Grossman (2006) provides an extensive overview, including early studies that used less convincing identification strategies.

death. In 2007 about 40.6 percent registered their wishes: 23.2 percent indicated that they wanted to donate their organs (4.0 percent with restrictions[2]), 12.4 percent did not give permission and the remaining 5.1 percent indicated that they left this decision to their relatives. Registered individuals are more often women than men (54.1 vs 45.9 percent). (http://www.donorregister.nl).

Economists have proposed bartering schemes (Roth et al., 2004), or opening up the market for organs (e.g. Becker and Elias, 2007) to reduce the gap between demand and supply. Bartering schemes improved allocative efficiency, but have not been able to generate a substantial increase in the supply of organs (Howard, 2007), and reform of organ procurement laws which would be necessary to introduce markets or change "opt-in" to "op-out" systems (see for example Abadie and Gay, 2006) has proven to be prohibitive (Roth, 2007). Some have argued that a more promising route is to increasing supply is through increasing efficiency in the current procurement chain, which would mainly imply recruiting more donors or lowering the rejection rates of family members. It is important to know in this context what factors increase individuals' propensity to become an organ donor. Education is one potential channel.

In our analysis we exploit the fact that admission to medical schools in the Netherlands is determined by a (weighted) lottery. This gives us a unique opportunity to estimate causal effects of health education on health status and health behavior because admission in a given year is determined by a random device. We also argue that if it is the content of education that matters for improving health, then one is most likely to find this mechanism for medical studies. Going to medical school not only provides those attending with

[3]

We do not find a clear-cut impact of health education on health behavior and health

[2]Donors can indicate which organs and tissue they wish to exclude from donation. About a quarter of these restrictions concerned organs, where the heart is the most commonly excluded organ. Three quarters of the restrictions concern tissue where skin and the cornea are excluded most often.

[3]This paper is also related to studies that address doctors' health. According to Baldwin et al. (1997) there is a concern about the health care of doctors. They are not taking sick leave when ill and do not seek/receive proper medical treatment when needed. The authors supplement anecdotal accounts of this phenomenon with results from a longitudinal study of a class of young doctors. They report some health problems among these young doctors, but since the study does not include a proper comparison group it is difficult to give a causal interpretation to the findings.

status. Health education reduces alcohol consumption and, for women, the probability to be underweight. Our results also suggest that health education may reduce the incidence of smoking although the estimates lack precision. We find, however, no impact on being overweight or obese, nor on respondents' self-reported health status. We even find a negative impact of health education on the frequency of physical exercise.

This mixed evidence makes it unlikely that the content of education programs explains the education gradient for health. [rewrite]

One strong and robust empirical finding in this paper is that attending medical school has a substantial effect on the probability that someone registers as a donor of organs. This suggests that provision of more information can be a channel to increase the supply of organs, which is important in the light of the structural under-supply of organs (e.g. Roth (2007)).

The remainder of this paper is organized as follows. The next section provides further details on the lottery and the institutional context. Section 3 describes the sources of data used in this paper. Section 4 outlines the estimation procedures and discusses identification issues. Section 6 presents and discusses the results. Section 6.4 examines the robustness of our findings and probes alternative explanations for our findings. Section 7 summarizes and concludes.

2 The lottery and institutional context

University education in the Netherlands is provided by 13 universities. These universities are all publicly funded, offer programs of very similar contents and quality, and charge uniform tuition fees that are set by the government. Eight of these universities offer programs in medical education. Medical studies at the university level consist of a basic track of 4 years of pre-clinical training, followed by 2 years of clinical clerkships in hospitals. Graduates from this 6 years program get a first medical qualification (comparable with Doctor of Medicine) with which they can enter the labor market. After obtaining this degree students can also choose to continue their medical training. To become a general practitioner requires 3 extra years of training, whereas medical specializations like ophthalmology, radiotherapy or urology require 4 to 6 additional years. These specialization tracks are mainly on-the-job and those who partake in them have a work contract and receive a salary. About 80 percent of the specialization for general practitioner for example is on-the job,

Normally, all graduates from the pre-university track in secondary education can enroll in university in the field of their wish provided that their subject specialization in secondary school matches the chosen field of study. Only a limited number of university studies, medical studies being the most prominent one, have a fixed number of places available.[4] This leads to a shortage if the number of qualified applicants exceeds this fixed number. For all other fields of study, supply is supposed to accommodate demand.

With excess demand for a certain study program, available places will in most countries be assigned through some form of selection based on merit. Instead of this, highly demanded seats in Dutch medical schools are assigned through a weighted lottery. While one may criticize this allocation system for ethical reasons or an alleged lack of efficiency, from a research perspective it has the advantage of creating a design that provides the opportunity to assess the effects of health education on health outcomes.

Before the actual lottery takes place, applicants to medical studies in the Netherlands are assigned to lottery categories. The categories differ by the probability to be awarded a place (to win the lottery). For regular applicants with a Dutch pre-university diploma, six categories are distinguished. These categories are indicated by letters A to F and differ in the grade point average (GPA) applicants obtained for their final exams in secondary school. These exams are nation-wide and externally graded. Grades in Dutch secondary school are given on a scale from 1 to 10, where 6 and above indicate a pass. Non-passes in some subjects are allowed given sufficient compensation (above 6) on other subjects. The classification for categories A to F is as follows:

- A if GPA$\geq$8.5
- B if 8.0$\leq$GPA$<$8.5

[4] Besides medical studies, fixed numbers of places are also present for dentistry, veterinary medicine and (in some years) technical business studies.

Table 1. Fraction admitted and number of applicants by year and lottery group, Cohorts 1989-1993

		A	B	C	D	E	F	Total
1988	Pr(In)	1.00	1.00	0.89	0.75	0.62	0.54	0.67
	In/Out	*29/0*	*96/0*	*160/19*	*373/123*	*333/205*	*401/347*	*1,393/694*
1989	Pr(In)	1.00	1.00	0.96	0.80	0.66	0.58	0.71
	In/Out	*30/0*	*84/0*	*151/7*	*344/86*	*349/182*	*405/292*	*1,363/567*
1990	Pr(In)	1.00	1.00	0.87	0.71	0.59	0.51	0.64
	In/Out	*36/0*	*111/0*	*168/26*	*334/134*	*337/234*	*379/367*	*1,365/761*
1991	Pr(In)	1.00	0.88	0.76	0.63	0.50	0.43	0.55
	In/Out	*41/0*	*115/15*	*153/48*	*342/205*	*326/323*	*361/500*	*1,358/1,091*
1992	Pr(In)	1.00	0.84	0.71	0.59	0.48	0.42	0.52
	In/Out	*51/0*	*95/18*	*168/67*	*353/247*	*330/359*	*432/604*	*1,429/1,295*
1993	Pr(In)	0.93	0.72	0.62	0.51	0.41	0.36	0.45
	In/Out	*41/3*	*120/47*	*150/91*	*355/347*	*346/501*	*466/833*	*1,478/1,822*

- C if $7.5 \leq \text{GPA} < 8.0$
- D if $7.0 \leq \text{GPA} < 7.5$
- E if $6.5 \leq \text{GPA} < 7.0$
- F if $6 \leq \text{GPA} < 6.5$

The ordering from A to F reflects differences in ability (probably including motivation). Because ability may have an independent effect on health outcomes, it is important that the analysis takes into account that assignment to medical school is only random conditional on lottery group.

Table 1 shows for each of the year cohorts included in our analysis, the proportions that have been admitted from each of the groups and the numbers of applicants per group. In each year around 85% of the applicants belongs to one of the groups D, E and F. Groups A and B are quite small. The probability to be admitted is close to 1 for applicants in category A, close to 0.90 for applicants in category B, and diminishes monotonically when going to C, D, E and F. In group F the odds are around 0.50. Hence, the probability to be admitted depends positively on GPA in the pre-university track. The year-to-year variation in fractions of admitted applicants (per group) depends on the numbers of applicants and the total number of available slots. The small numbers

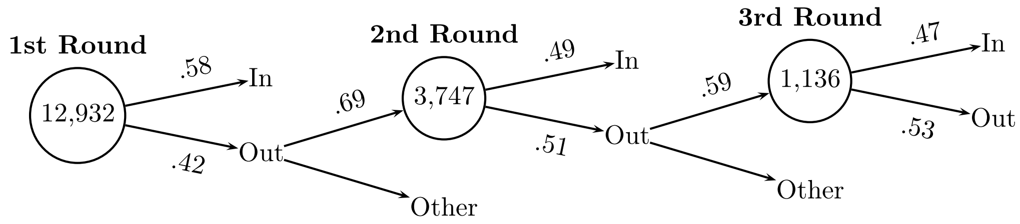

Figure 1. Repeated participation, Cohorts 1989-1993

of applicants in groups A and B in combination with the high fractions admitted cause that only very few applicants in these groups are not admitted (3 and 80 respectively in a period of 6 years). Because of this, these categories are excluded from the subsequent analyses.

Applicants who are not admitted in a given year, have the opportunity to re-apply the next year. For the cohorts included in our analysis, there was no restriction on the total number of times someone could apply, and many indeed re-applied.[5] The repeated participation is illustrated in Figure 1 which shows for 3 rounds lottery participation for the individuals in our dataset. Of the 12,932 individuals we observe participating for the first time, 58 percent gets immediately admitted to medical school. Of the the 5,430 applicants who do not get admitted in the first round, 69 percent re-applies the following year. We observe 3,747 individual participating for the second time and the acceptance rate is now 49 percent. After an unsuccessful second round there is again a substantial fraction, 59 percent, that participates in the admission lotteries for a third time. Rejection rates go up because the pool of applicants consists increasingly of individuals from lower lottery categories. Re-application rates go down because the opportunity cost of waiting one year to re-apply increase.

As a consequence of these repeated applications, admission to medical school is no longer completely random (conditional on lottery category). Motivated applicants who are rejected the first time are more likely to re-apply than applicants who are less motivated. We will therefore make use of an instrumental variable approach where we use the lottery result of the first application as an instrument for attendance to medical school (see section 4 for details).

[5]Recently the number of (re-)applications has been restricted to three.

3 Data

The data used in this paper come from two sources. The first source is the administration of the agency that conducts the lottery. Starting in 1987, this source provides for each year, information about who applies for a medical study together with the lottery group and the outcome of the lottery. The same agency also registers enrollment in Dutch higher education, which informs us about the actual study choices of those who won the lottery as well as of those who lost the lottery. Information of study progress is available in the form of whether or not students successfully completed certain stages.

The second source is a survey that we designed and sent out in 2007 to all persons who applied for a medical study for the first time in the years 1988-1993. We start in 1988 rather than in 1987 because we want to make sure that we have administrative information about the results from the first lottery that someone participated in. For persons who applied in 1987, we cannot rule out that they applied but were not admitted in 1986. Because a medical study takes in total 6 to 12 years, we did not sample more recent cohorts, as many of these applicants will still be students.

A letter inviting people to participate in our research was sent to 12,932 applicants. Respondents could choose between completing the paper version of the questionnaire and return that to us by regular mail, or they could log in on a special Internet site and answer the questions through this medium. In both cases, it was communicated to respondents that responses to the survey would be merged to the administrative data. 4602 people responded through Internet; 2456 people returned a paper version of the questionnaire. Combined this gives a response rate of 0.55. We consider this a high response rate for a questionnaire that is not anonymous. The response rate is slightly lower among applicants who were not immediately admitted than among applicants who were immediately admitted, 0.52 versus 0.55.

The questionnaire includes questions about behavior related to health and about health status. Regarding health behavior, respondents were asked whether they smoked or not (and if so how much), how many alcoholic drinks they consume on average per week, and how frequently they do some physical exercise (sports). On the basis of this we created dummy variables for smoking and having more than 14 alcoholic drinks per week, continuous variables for the number of alcoholic drinks per week and the number of cigarettes per day, and an ordinal variable for frequency of physical exercise (never; sometimes but less than once a week; once a week; 2 to 3 times a week; at least 4 times a week). From questions about respondents' weight and height we constructed their body mass index (BMI) and use dummies for overweight (BMI>25), obesity (BMI>30) and underweight (BMI<18) as indicators of health status. In addition we asked respondents how they regard their own health situation in general on a 5 points scale: very poor, poor, neither good nor poor, good, excellent. This subjective information has been shown to be strongly correlated with objective health measures (Idler and Benyamini, 1997).

We also asked respondents whether they are officially registered as an organ donor. While this variable is not directly related to health behavior or health status, we will also analyze the effects of health education on this variable. The hypothesis is that health education increases people's awareness of the importance of organ donations.

Table 2 presents descriptive statistics for the health variables and for some other variables that will be used as control variables. A large share of the respondents report good or excellent health, leading to the high average level of health status in both groups. An important factor explaining this is the low average age among respondents. According to the self-reported information on height and weight, 21% of the respondents are overweight, 1% underweight, and 3% obese. These percentages overweight and obese are low compared to fractions for the Dutch adult population in which 45% is overweight and 10% is obese. The median (modal) respondent has some physical exercise once (two or three times) per week. The average weekly intake of alcoholic beverages is 3 to 4 units; 4 percent of the respondents report to drink more than 14 units per week. Slightly more than 9 percent of the respondents report to smoke. In the Dutch population this percentage equals 28.

Applicants who did not attend medical school are scattered over many different fields of study. 19% of the non-attending applicants attend a study in a professional school rather than at the university level; 3% of that group opts for the study most closely related to

Table 2. Descriptive Statistics

	Mean	Std. Dev.
Age at interview	33.3	2.4
Female	0.61	0.49
Single	0.15	0.36
Children	0.62	1.15
Lottery weight	4.46	1.34
Health status		
- Self-reported	4.31	0.64
Health behavior		
- BMI	23.07	3.02
- Overweight	0.21	0.40
- Obese	0.03	0.16
- Underweight	0.01	0.10
- Sport	2.80	1.10
- Drinks per week	3.48	5.66
- Drinks>14 per week	0.04	0.21
- Smoker	0.09	0.29
- Number of cigarettes per day	9.0	6.9
- Donor	0.70	0.46

medical school, namely physiotherapy. 10% of the non-attending applicants decide not to study at all. Among the remaining 70% the most popular alternative university studies are psychology (9%) and law (6%). [have table?]

4 Estimation

The estimation procedure applied in this paper is straightforward. We are interested in the effect (δ) of having attended medical school (s_i) on health (y_i). We postulate a linear relationship:

$$y_i = \delta s_i + x_i'\beta + \epsilon_i \tag{1}$$

where β is a (vector of) parameters to be estimated, ϵ_i a disturbance term, and x_i is a vector of control variables including an intercept, dummies for birth year, gender, lottery weight, year of first lottery. Because the lotteries are random conditional on lottery category we also include full interactions of lottery category and year of first lottery.

Estimation of δ using OLS with a random sample from the population (of higher educated people) may give a biased estimate of δ if medical school attendance (s_i) correlates with unobserved determinants of health outcomes (ϵ_i). Endogeneity bias arises for instance when students who are more concerned about their health are also more inclined to attend medical school. Although in our sample this problem is probably greatly reduced because of the admission lotteries, estimation of δ by OLS may still give biased estimates. As mentioned above, the complicating factor is that applicants who were rejected the first time can re-apply the following year. Some of the rejected applicants decide to do so, while others do not to. As a consequence applicants who are admitted after their second application are no longer a random sample of the group of all applicants, and if the decision to re-apply correlates with ϵ_i we might still end up with omitted variable bias.

To address this potential bias, we use the result of the first lottery (z_i) as instrumental variable for attending medical school. The result of the first lottery is a dummy that takes the value one for winners and equals zero for losers. The identifying assumption is that conditional on x_i, the result of the first lottery is mean independent of ϵ which is clearly fulfilled in case of the first lottery since at this point selective re-application has not taken place yet.

The approach adopted in this paper allows us to identify a local average treatment effect (LATE, Imbens and Angrist 1994). If the effect on applicants is homogeneous, this will be equal to the average treatment effect on the treated. In that case we are able to answer the question what the health outcomes of those who attended medical school would have been if they had not attended medical school. If treatment effects are heterogeneous, the effect that we estimate is the effect on the compliers, which is the group of people that attend medical school when they win the first lottery but that would not have attended medical school if they would have lost the first lottery [there is a group of compliers in every round, and the effect we estimate is an average of the LATE in every round].

The research design does not inform us about the average effect of attending medical school for a random sample from the entire population. The reason is that the population of applicants for medical school is not a random draw from the population.

In addition to instrumental variable estimates of equation (1) we will also present naive OLS estimates of this relation as well as estimates of first stage relations where attending (or completing) medical school is the dependent variable and the result of the first lottery the explanatory variable of interest. Moreover, we will present results from reduced form equations in which the health outcomes are the dependent variables and in which again the result of the first lottery is the explanatory variable of interest.

A possible concern with our design is that lottery losers attend another study that is closely related to the study offered by medical schools. Although - as we mentioned - many do not do so, Section 6.4 presents results from an analysis in which the treatment variable is redefined as "attending any health related study". The results from this analysis are very similar to the results presented in the next section.

A concern with the interpretation of our findings is that enrolling in medical school changes other things than only the contents of the education attended. Examples of such variables include: marital status, the number of children and the number of actual working hours per week. Some of the effects of attending medical school may operate through these channels rather than through the effect of the contents of the education program. To examine this, Section 6.4 presents results from an analysis in which we add various, potentially endogenous, controls to our specifications. This leads only to minor changes of the results presented in the next section.

5 First stage

For the first stage regressions we consider two different measures for exposure to health education: attending medical school and completion of the first stage (of 6 years) of the medical school program. Because the correlation between these variables equals 0.83, it is not surprising that the results of the first stage regressions are very similar. The top panel of Table 3 reports the first stage result based in the group of applicants that responded to our questionnaire; the bottom part uses information from all applicants in the period 1988-1993.

Winning the first lottery increases the likelihood that an applicant attends medical

Table 3. First Stage Regressions

	Dependent variable	
	Attended	Completed
A. Sample: Respondents to questionnaire		
Result first lottery	0.463***	0.405***
	(0.011)	(0.012)
No of observations	6,493	6,493
R-squared	0.312	0.234
F-test instrument	1815.8***	1151.0***
B. Sample: All applicants in period 1988-1993		
Result first lottery	0.483***	0.399***
	(0.008)	(0.009)
No of observations	11,536	11,536
R-squared	0.306	0.220
F-test instrument	4052.1***	2122.1***

Note: Regressions include controls for year of birth, gender, lottery weight, year of first lottery and interactions of lottery weight and year of first lottery. Standard errors are heteroscedasticity robust. *** indicates significance at the 1%-level.

school by almost 50 percentage points. This is below the 100 percentage points that would result if the outcome of the first lottery would be the sole determinant of attendance. Of the 2,058 winners of the first lottery, 132 decided not to attend medical school. Of the 1,459 persons drawing a zero on the first lottery, 651 have been admitted after participating in lotteries of subsequent years. But although compliance is not perfect, the first stage relations are very strong. This is indicated by the high F-values for the tests on restrictions that the result of the first lottery has no effect.

The effect of the result of the first lottery on completion of medical school is a bit smaller than the effect on attending medical school. This is because not everyone who attends also completes medical school, and dropping out is unevenly distributed across winners of the first lottery and later attendants. In an extreme scenario in which all winners of the first lottery attend and complete, and in which all losers of the first lottery who attend (after a subsequent lottery) drop out, we would find a first stage effect on completion equal to 1. The fact that the first stage effect on completion is somewhat smaller than the first stage effect on attendance, indicates that those who lost the first lottery but yet attend medical school are a bit more likely to complete than those who won their first lottery.

6 Health outcomes and health related behavior

6.1 OLS

Before we turn to the 2SLS estimates of the effect of attending medical school on health outcomes, we first discuss the naive OLS estimates. These results show us what we would conclude if we ignore that re-applications may give rise to selection bias. Columns (2) and (3) of Table 4 report the results from regressions of the health outcomes on a dummy variable for attending medical school and control variables. In column (2) we restrict the sample to observations that participated in only one lottery, while column (3) presents OLS-estimates using the entire sample.

For the group of "marginals" in column (2) we see significant associations between attending medical school and self-reported health status (+), drinking (-), heavy drinking (-), smoking (-), physical exercise (-) and being a donor of organs (+). In the entire sample these associations are somewhat weaker but provide the same picture.

The OLS estimates in Table 4 are already purged from selection due to differences between people who did apply to medical school and people who did not. To get an impression of the size of the bias that is taken away by this, we also estimated OLS regressions using higher educated people who did not apply to medical school as the comparison group. Data come from 5 waves of a Dutch survey known as POLS (Ongoing Survey on Living Conditions), which asks questions about some health related variables (self-reported health status, smoking and sports). It contains information from a representative sample of the adult population. We restricted the sample to observations in the age range of 30 to 40 with a higher education degree, leaving us with almost 5,000 observations.

We regressed the health variables on an indicator of attending medical school, including controls for gender and age (and year of interview). For self-reported health status the coefficient of attending medical school equals 0.031 (s.e. 0.029). For smoking as the outcome variable, the coefficient equals -0.114 (s.e. 0.020), and for sporting as outcome variable it is -0.479 (s.e. 0.072). Hence, for self-reported health the estimate is comparable to the one reported in Table 4, whereas for smoking and sporting the estimates are much larger in absolute size. Those who attended medical school are much less likely to be a smoker and engage in physical exercise less frequently than the average higher educated person in the same age bracket in the population.

6.2 Reduced Form estimates

This subsection reports results from reduced form equations that estimate the effects of the outcome of the first lottery (the instrument) on the various health outcomes. These are the effects of the Dutch allocation system of places in medical school through a lottery on the health outcomes of lottery winners. Results are reported in column (1) of Table 4.

In all cases we estimated linear models controlling for age and gender and for dummies of lottery categories, dummies for year of first lottery and their interactions. Results from (ordered) probit models are very similar.

Looking first to health status we find that for self-reported health status, overweight and underweight the effects of winning the first lottery have the expected signs. For obese the sign is, however, in the unexpected (positive) direction. With the exception of being underweight, in all cases, however, the point estimates are (much) smaller than their standard errors. Effects are not insignificant due to a lack of precision. If we add/subtract two standard errors to/of the point estimate in the direction of positive health effects of winning the lottery, we can still exclude substantial effects. With 95% probability, the effect of winning the lottery on self-reported health status is less than 7% of a standard deviation of the self-reported health status variable; and with the same probability the effects of winning the lottery on overweight and obese are less than 3% and 11% of their respective standard deviations.

The pattern is somewhat different when we consider the effects of winning the lottery on health behavior. Winners are significantly less likely to drink (heavily) and are also significantly less likely to engage frequently in sports activities than lottery losers. For

Table 4. OLS, Reduced Form, and 2SLS estimates

	OLS							
	All (1)		Marginals (2)		Reduced Form (3)		2SLS (4)	
Health status								
- Self-reported	0.038	(0.018)**	0.054	(0.024)**	0.011	(0.017)	0.024	(0.037)
Health behavior								
- Overweight	-0.007	(0.012)	-0.026	(0.016)	-0.002	(0.011)	-0.004	(0.024)
- Obese	0.003	(0.005)	0.003	(0.006)	0.003	(0.004)	0.007	(0.009)
- Underweight	-0.002	(0.003)	-0.001	(0.004)	-0.005	(0.003)*	-0.011	(0.007)*
- Drinks	-0.260	(0.154)*	-0.373	(0.199)*	-0.265	(0.147)*	-0.573	(0.318)*
- Drinks>14	-0.005	(0.006)	-0.012	(0.008)***	-0.010	(0.006)*	-0.021	(0.012)*
- Smoker	-0.002	(0.008)	-0.019	(0.011)*	-0.010	(0.007)	-0.021	(0.016)
- # Cigarettes	-1.462	(0.768)*	-1.590	(0.984)	-0.111	(0.696)	-0.221	(1.382)
- Sport	-0.146	(0.032)***	-0.174	(0.042)***	-0.057	(0.030)*	-0.124	(0.064)*
- Donor	0.129	(0.014)***	0.148	(0.019)***	0.053	(0.013)***	0.115	(0.028)***

Note: All coefficients come from separate regressions. These regressions include controls for year of birth, gender, lottery weight, year of first lottery and interactions of lottery weight and year of first lottery. Standard errors are heteroscedasticity robust. ***/**/* indicates significance at the 1%/5%/10%-level.

smoking no effects are found of winning the lottery. Drinking less can be considered as healthier, while sporting less often can be considered as less healthy. The two significant effects thus give a mixed picture of the effects of winning the lottery on health behavior.

While health status and behavior towards own health are not affected by winning the lottery in an unambiguous way, we do find a substantial and statistically significant effect of winning the lottery on the probability of being registered as donor of organs. This probability is 5 percentage points higher, relative to a base of 62% which is the fraction of registered donors in the group that lost their first lottery.

6.3 2SLS

Due to possible endogeneity of attendance of medical school, the associations in columns (2) and (3) should not be given a causal interpretation. The results in column (4), however, can be interpreted as such. The point estimates in this column are equal to those in column (1) divided by the first stage effects of winning the lottery on attendance in Table 3 (0.463). This leads to more than a doubling of the reduced form estimates. The standard errors in column (4) are also more than doubled in magnitude compared to those in column (1). Column (4) shows that those who attended medical school are less likely to be underweight, drink significantly less and engage in sport activities less frequently than those who did not attend medical school. Those who attended medical school are also significantly more likely to be registered as a donor of organs. Effects sizes on drinking and sporting are a bit over 10% of the respective standard deviations. The effect on the probability to be registered as organ donor, equals more than 11 percentage points.

Table 5 reports separate 2SLS-estimates for men and women. Gender differences in the health effects of attending medical school are never significantly different from zero. Notice, however, that for all outcome variables the effects estimates are larger (in absolute size) for men than for women. The difference is largest for the effect on being registered as organ donor; the effect for men is double that of women.

We also tested for differences by ability (not reported here), but did not find a sys-

Table 5. Gender Differences

	Men (1)		Women (2)		Difference (1) - (2)	
Health status						
- Self-reported	0.028	(0.060)	0.021	(0.047)	0.007	(0.076)
Health behavior						
- Overweight	-0.052	(0.044)	0.026	(0.027)	-0.078	(0.052)
- Obese	0.013	(0.015)	0.004	(0.012)	0.009	(0.019)
- Underweight	-0.002	(0.004)	-0.017	(0.010)	0.015	(0.011)
- Drinks	-0.897	(0.700)	-0.433	(0.281)	-0.464	(0.754)
- Drinks>14	-0.039	(0.029)	-0.014	(0.009)	-0.025	(0.030)
- Smoker	-0.034	(0.032)	-0.016	(0.017)	-0.018	(0.036)
- # Cigarettes	-1.948	(2.103)	0.918	(1.988)	-1.030	(2.754)
- Sport	-0.136	(0.106)	-0.118	(0.080)	-0.018	(0.132)
- Donor	0.169	(0.046)***	0.078	(0.035)**	0.091	(0.058)

Note: Coefficients in the first two columns come from separate regressions. These regressions include controls for year of birth, lottery weight, year of first lottery and interactions of lottery weight and year of first lottery. Standard errors are heteroscedasticity robust. ***/** indicates significance at the 1%/5%-level.

tematic pattern between ability levels and the size of the impact of health education on health outcomes. Only for being a smoker we saw a monotonic pattern with the effect of attending medical school being more beneficial for applicants of lower ability. The standard errors on the estimates were however too large for these differential effects to be statistically significant.

6.4 Robustness/alternative explanations

We interpret the findings presented in the previous section as the effects of the contents of medical education on health outcomes. Concerns with this interpretation are that (1) students who do not attend medical school might still attend some other health related study, and (2) attending medical school may affect other things than knowledge alone.

To address the first concern we redefine the treatment and measure it as having attended any type of health related studies. Health related studies other than medical school include such studies as physiotherapy, speech therapy and dietetics. Table 6 reports the results. The first column repeats the findings from the last column in Table 4, the second column shows the results for the redefined treatment variable. The point estimates in the

Table 6. Redefine Treatment

	Medical		All health	
Health status				
- Self-reported	0.024	(0.037)	0.034	(0.053)
Health behavior				
- Overweight	−0.004	(0.024)	−0.005	(0.034)
- Obese	0.007	(0.009)	0.010	(0.014)
- Underweight	−0.011	(0.007)*	−0.016	(0.010)*
- Drinks	−0.573	(0.318)*	−0.826	(0.458)*
- Drinks>14	−0.021	(0.012)*	−0.031	(0.018)*
- Smoker	−0.021	(0.016)	−0.031	(0.023)
- # Cigarettes	−0.221	(1.382)	−0.337	(2.102)
- Sport	−0.124	(0.064)*	−0.179	(0.092)*
- Donor	0.115	(0.028)***	0.165	(0.040)***

Note: All coefficients come from separate regressions. These regressions include controls for year of birth, gender, lottery weight, year of first lottery and interactions of lottery weight and year of first lottery. Standard errors are heteroscedasticity robust. ***/* indicates significance at the 1%/10%-level.

second column are somewhat larger (in absolute terms) than those in the first, but the differences are small and never significant.

To address the concern that attendance of medical school affects other things than knowledge alone we present estimates from a specification in which we have added (potentially) endogenous covariates. These additional controls are: a dummy for being single, the number of children, the logarithm of the number of weekly actual hours per work, a dummy for working at least 60 hours per week, the logarithm of the wage rate, the number of months that respondents' have been unemployed since their graduation (plus its square) and the amount of potential work experience (plus its square). This last variable also captures the effect of differences in actual study duration.

Inclusion of the endogenous controls changes the estimates somewhat. Because standard errors are somewhat larger not all effects that are significant in the last column in Table 4 are significant in Table 7. But the differences between the two sets of estimates are never significant. This suggests that the effects of attending medical school can be attributed to the health knowledge acquired in medical school.

Table 7. Adding extra (endogenous) controls

	(1)		(2)	
Health status				
- Self-reported	0.024	(0.037)	0.008	(0.041)
Health behavior				
- Overweight	−0.004	(0.024)	−0.013	(0.027)
- Obese	0.007	(0.009)	0.005	(0.011)
- Underweight	−0.011	(0.007)∗	−0.012	(0.007)
- Drinks	−0.573	(0.318)∗	−0.716	(0.366)∗
- Drinks>14	−0.021	(0.012)∗	−0.026	(0.015)∗
- Smoker	−0.021	(0.016)	−0.023	(0.018)
- # Cigarettes	−0.221	(1.382)	1.058	(1.563)
- Sport	−0.124	(0.064)∗	−0.113	(0.072)
- Donor	0.115	(0.028)∗∗∗	0.111	(0.032)∗∗∗
Controls				
Family			✓	
Work			✓	
Income			✓	

Note: All coefficients come from separate regressions. These regressions include controls for year of birth, gender, lottery weight, year of first lottery and interactions of lottery weight and year of first lottery. Endogenous controls are a dummy for being single, the number of children, the logarithm of the number of weekly actual hours per work, a dummy for working at least 60 hours per week, the logarithm of the wage rate, the number of months that respondents' have been unemployed since their graduation (plus its square) and the amount of potential work experience (plus its square). Standard errors are heteroscedasticity robust. ***/* indicates significance at the 1%/10%-level.

7 Conclusion

Recent studies suggest a causal impact of education on health. The underlying mechanisms have not been identified yet. We find that health education reduces moderate and excessive alcohol consumption and the likelihood of being underweight, and seems to reduce smoking. It has, however, no impact on being overweight or obese, or on self-reported health status. The effect on the frequency of physical exercise is even negative. This mixed evidence makes it unlikely that the content of education programs explains the education gradient for health. Attending medical school is the most intensive exposure to health education one can imagine. Yet, people exposed to this treatment have the same health status and very similar health behavior as people who were denied this treatment. Because assigned to treatment was partly determined by a lottery, we are confident that the reported results can be interpreted as causal effects.

The results also cast doubt on the explanation put forward by Glied and Lleras-Muney (2003) for the education gradient of health. They hypothesize that more educated people are better able to take advantage of technological advances in medicine than less educated people. A natural extension of this hypothesis is to assume that people that attended medical school are better able to take advantage of technological advances in medicine than people who did not attend medical school. Our results provide no support for this.

It has been claimed that young doctors are not taking sick leave when ill and do not seek/receive proper care when needed. Our results indicate that this is not due to being a doctor. There are no (unambiguous) differences in health behavior and health status between young doctors and their peers who wanted to become a doctor but did not. Hence, occupational characteristics cannot be held responsible for the alleged poor health (behavior) of doctors.

Interestingly, going to medical school does have a significant and substantial impact on the probability that a person is registered as donor of organs. This suggests that health education may after all have a positive impact on a nation's health status, not by means of a direct effect on the health behavior or status of the recipients but from the spillover effects in the form of organ donations (and of course through the graduates from medical schools working as medical professionals) .

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A Derivation of adding endogenous controls

consider the following reduced form regression

$$y = \delta z + \epsilon$$

where $E[z\epsilon] = 0$. Now suppose that z can also affects x

$$x = \alpha_0 + \alpha_1 z + \upsilon$$

and $E[\epsilon \upsilon] \neq 0$