

The effects of health education on health outcomes: Evidence from a natural randomized experiment*

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Abstract

This paper estimates the effects of attending medical school on health behavior and health status exploiting that admission to medical school in the Netherlands is determined by a lottery. Because lottery losers are permitted to re-apply, we use the result of the first lottery in which someone participates as instrumental variable. Our results show that health education reduces alcohol intake and being underweight, and seems to reduce smoking. It has, however, no impact on being overweight or obese, or on subjective 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. Health education has a large impact on the probability of being registered for donations of organs, suggesting that information provision is a possible channel to raise the supply of organs.

1 Introduction

Many studies document a positive correlation between education and health. In a survey of this literature, Cutler and Lleras-Muney (2006) argue that the available 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 school laws (see Lleras-Muney, 2005; Oreopoulos, 2003;

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Arendt, 2005). Grossman (2006) gives more references including some to early studies that used less convincing instruments.

Cutler and Lleras-Muney (2006) point out that all of these quasi-experiments focus on the effects of the quantity of schooling on health and mention that there is “no causal evidence on whether the content of education matters for health” (p.13).¹ The current paper attempts to fill this gap by estimating the effects of health education on health behavior and health status. To achieve this, we exploit the fact that admission to medical schools in the Netherlands is determined by a (weighted) lottery.

The results of this paper are 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 comparison group it is difficult to assess how these problems should be judged. In the absence of a proper control group it is impossible to give a causal interpretation to the findings.

The main finding of the current paper is that health education has no clear-cut impact on the health behavior or the health status of those who went to medical school in the Netherlands. Health education reduces alcohol consumption and the probability to be underweight, and it may reduce the incidence of smoking. We find, however, no impact of health education on being overweight or obese, or on respondents’ subjective 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.

One strong and robust empirical finding in this paper is that attending medical school has a quite 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.

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 5 presents and discusses the results. Section

¹To be sure: they say this because no previous study has addressed this question and not because none of the studies that deal with this issue find a positive effect.

6 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 6 years including 2 to 3 years of co-ships. Graduates from this 6 years program are qualified as “basisarts”. This is a qualification with which they can enter the labor market. But, they can also choose for further education. 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.

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. This leads to a shortage if the number of qualified applicants exceeds this fixed number. Besides medical studies, fixed numbers of places are also present for dentistry, veterinary medicine and (in some years) technical business studies. 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 this system of allocation can be criticized 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 $\text{GPA} \geq 8.5$
- B if $8.0 \leq \text{GPA} < 8.5$
- 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 $\text{GPA} < 6.5$

The ordering from A to F is assumed to reflect 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.² 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 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 particular 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.³ Of the 5,430 applicants that during our period of observation lost the first time they participated in the lottery, 69% re-applied for at least one subsequent lottery.

²We motivate the choice of cohorts in Section 3.

³Recently the number of (re-)applications has been restricted to three.

Table 1: Fraction admitted and number of applicants by year and lottery group

Group	1988	1989	1990	1991	1992	1993	Total
A	1.00	1.00	1.00	1.00	1.00	0.93	0.99
	29	30	36	41	51	44	231
B	1.00	1.00	1.00	0.89	0.84	0.72	0.89
	96	84	111	130	113	167	701
C	0.89	0.96	0.87	0.76	0.72	0.62	0.79
	179	158	194	201	235	241	1,208
D	0.75	0.8	0.71	0.63	0.59	0.51	0.65
	496	430	468	547	600	702	3,243
E	0.62	0.66	0.59	0.5	0.48	0.41	0.53
	538	531	571	649	689	847	3,825
F	0.54	0.58	0.51	0.43	0.42	0.36	0.46
	749	697	746	881	1,036	1,299	5,408
Total	0.67	0.71	0.64	0.56	0.53	0.45	0.57
	2,087	1,930	2,126	2,449	2,724	3,300	14,616

As a consequence of repeated applications, admission to medical school is no longer random (conditional on category). Highly 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 in which the lottery result of the first application is used as instrument for attendance to medical school (see section 4 for details).

3 Data

The data used in this paper come from two sources. The first source is the administrative records 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 that was 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).

Health status is measured in two ways. From questions about respondents' weight and height we constructed their body mass index (BMI) and use dummies for overweight ($BMI > 25$), obese ($BMI > 30$) 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. Also related to health, we asked respondents whether they are officially registered as a donor of organs. 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.⁴

Table 2 presents descriptive statistics for the health variables and for some other variables that will be used as control variables, separately for those who attended medical school and those who did not. A large share of the respondents report

⁴Although an anecdote told by a seminar participant hints at a negative relation. Someone decided to undo her registration as a donor because after she started working as a nurse she got the impression that medical specialists spend less effort on patients who are registered as donors.

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, 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 populations this percentage equals 28.

For some variables the responses are significantly different between respondents who attended medical school and those who did not. The most substantial but least surprising difference occurs for the weight category in the lottery for admission to medical school. Attenders have a significantly higher subjective health (although the size of the difference is minor), they sport significantly less often, a higher fraction is registered as organ donor, and if they smoke they smoke fewer cigarettes per day. In the remainder of the paper we will examine whether the differences in outcomes remain when covariates (including lottery weights) are included and when we correct for self-selection through re-applications.

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 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%).

4 Estimation

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

$$Y_i = \alpha + \delta S_i + X_i \beta + \epsilon_i \tag{1}$$

Where X is a vector of control variables including dummies for birth year, gender, lottery weight, year of first lottery, and interactions of lottery weight and year of first lottery. α and β are (vectors of) parameters to be estimated, and ϵ a disturbance term.

Estimation of δ using a random sample from the population (of higher educated

Table 2: Descriptive Statistics

	Scale	Attenders		Non-attenders		p-value
		Mean	S.D.	Mean	S.D.	
Age at interview	Years	33.3	2.4	33.6	2.8	0.000
Female	Dummy	0.61	0.49	0.63	0.48	0.102
Single	Dummy	0.15	0.36	0.18	0.38	0.024
Children	Continuous	0.62	1.15	0.67	1.13	0.146
Lottery weight	1 (highest)-6 (lowest)	4.46	1.34	5.12	1.05	0.000
<i>Health status</i>						
- Subjective health	1 (very poor)-5 (excellent)	4.31	0.64	4.27	0.61	0.000
- BMI	Continuous	23.07	3.02	23.22	3.16	0.084
- Overweight	Dummy	0.21	0.40	0.23	0.42	0.020
- Obese	Dummy	0.03	0.16	0.03	0.17	0.581
- Underweight	Dummy	0.01	0.10	0.01	0.11	0.441
<i>Health behavior</i>						
- Sport	1(never)-5(>3 times p/w)	2.80	1.10	2.96	1.07	0.000
- Drinks per week	Continuous	3.48	5.66	3.72	5.37	0.134
- Drinks >14 per week	Dummy	0.04	0.21	0.05	0.22	0.430
- Smoker	Dummy	0.09	0.29	0.10	0.30	0.351
- Number of cigarettes per day	Continuous	9.0	6.9	10.4	7.5	0.049
- Donor	Dummy	0.70	0.46	0.55	0.50	0.000

people) may be biased due to a correlation between S and ϵ . Endogeneity bias arises for instance when students who are more concerned about their health are also more inclined to attend medical school. But even for our sample of people who applied for medical school and who were assigned on the basis of a lottery, estimation of δ by OLS may be biased. The complicating factor is that applicants that were rejected the first time may choose to re-apply the next year. Some of the rejected applicants opt to do so, while others choose not to. Hence, applicants who are admitted after their second application are no longer a random sample of the group of all applicants.

To address this potential bias, we use the result of the first lottery (Z) 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 , the result of the first lottery is mean independent of ϵ . This assumption is by definition fulfilled in case of a lottery.

The approach adopted in this paper allows us to identify a local average treatment effect. 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 and that do not attend medical school when they lose the first lottery.

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 naïve 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 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 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 Results

5.1 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 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

Table 3: First Stage Regressions

	Dependent variable	
	Attended	Completed
A. Sample: respondents to questionnaire		
Result first lottery	0.463*** (0.011)	0.405*** (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*** (0.008)	0.399*** (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.

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.

5.2 Reduced form

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 subjective health, overweight and underweight the effects of winning the first lottery have the expected signs. For obese the sign is, however, in de 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.

Table 4: Reduced form, OLS and IV estimates

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

Note: All coefficients come from different 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.

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 subjective health is less than 7% of a standard deviation of the subjective health 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 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.

5.3 OLS

Before we turn to the IV estimates of the effect of attending medical school on health outcomes, we first discuss the naïve 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 subjective health (+), 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.

5.4 IV

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

Table 5: Gender Differences

	Men	Women	Difference
Health	0.028 (0.060)	0.021 (0.047)	0.007 (0.076)
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)
# Cigs	-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 different 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.

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 IV-estimates for men and women and table 6 does this for different ability groups (defined by lottery category). 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 find no systematic pattern between ability levels and the size of the impact of health education on health outcomes. Only for being a smoker we find a monotonic pattern with the effect of attending medical school being more beneficial for applicants of lower ability. The standard errors on the estimates are however too large to make these differential effects significant.

Table 6: Effects by Ability

	[6,6,5]	[6,5,7]	[7,7,5]	[7,5,10]
Health	0.030(0.051)	-0.016(0.070)	0.098(0.094)	-0.060(0.151)
Overweight	0.025(0.034)	-0.086(0.044)*	0.009(0.058)	0.114(0.085)
Obese	0.005(0.014)	0.015(0.019)	-0.001(0.020)	-0.001(0.029)
Underweight	-0.008(0.008)	-0.009(0.012)	0.001(0.019)	-0.069(0.041)*
Drinks	-0.700(0.410)*	-0.976(0.669)	-0.206(0.793)	1.599(1.156)
Drinks>14	-0.001(0.017)	-0.039(0.022)*	-0.051(0.034)	0.014(0.053)
Smoker	-0.034(0.024)	-0.031(0.030)	-0.024(0.039)	0.080(0.057)
# Cigs	-0.985(1.657)	1.193(2.806)	1.439(5.152)	-7.424(7.263)
Sport	-0.118(0.087)	-0.108(0.117)	-0.173(0.167)	-0.075(0.287)
Donor	0.136(0.039)***	0.134(0.051)***	0.012(0.071)	0.171(0.116)

Note: All coefficients come from different regressions. These regressions include controls for year of birth, gender and year of first lottery. ***/* indicates significance at the 1%/10%-level.

Table 7: Redefine Treatment

	Medical	All health
Health	0.024 (0.037)	0.034 (0.053)
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)
# Cigs	-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 different 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.

6 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 7 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 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

Table 8: Adding extra (endogenous) controls

Health	0.024 (0.037)	0.008 (0.041)
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)
# Cigs	-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)***

Endogenous controls	No	Yes
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Note: All coefficients come from different 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.

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 8. 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.

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 subjective 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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