DISCUSSION PAPER SERIES

DP14061

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PUBLIC ECONOMICS

ISSN 0265-8003

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Discussion Paper DP14061
Published 17 October 2019
Submitted 16 October 2019

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www.cepr.org

This Discussion Paper is issued under the auspices of the Centre's research programmes:

- Public Economics

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JEL Classification: D83, H51, I11, I12, I14, I26

Keywords: Mortality, Medical information, Health care use, Health inequality, Intergenerational transmission, Higher education

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Acknowledgements
We gratefully acknowledge valuable comments from seminar and workshop participants in Amsterdam, Florence, Odense, The Hague and Vienna. The non-public micro data used in this paper are available via remote access to the Microdata services of Statistics Netherlands (CBS). Van der Klaauw acknowledges financial support from a Vici-grant from the Dutch Science Foundation (NWO).

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Elisabeth Artmann Hessel Oosterbeek Bas van der Klaauw*

Abstract

To assess the importance of limited access to medical expertise, we exploit admission lotteries to medical school in the Netherlands to estimate the causal effects of having a child who is a doctor on parents' health outcomes. We use data on health care use and mortality of parents of 22,000 lottery participants. Results reject that health outcomes of doctors' parents differ from those of non-doctors' parents. This suggests that easy, informal access to medical expertise is not an important driver of differences in health care use and mortality. This is consistent with institutions that provide equal health care for all.

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1 Introduction

Many policy makers aim at equal access to health care for all. Even in countries with universal health insurance coverage and (almost) free health care, health care use may, however, differ between people for reasons unrelated to their health. These reasons include: i) information limitations about e.g. health risks, adequate preventive behavior or treatment options, ii) patients' inability to communicate with their health care providers, and iii) providers treating patients of different backgrounds differently. A recent literature examines the combined effect of these reasons by comparing outcomes of doctors and their relatives to those of a control group (Chen et al., 2019; Chou et al., 2006; Frakes et al., 2019; Grytten et al., 2011; Johnson and Rehavi, 2016; Leuven et al., 2013). The idea in these studies is that doctors and their relatives have full access to medical services so that their health care use and outcomes are not affected by any of these reasons.

The main challenge in this literature is to isolate the effects of doctors' expertise from other factors that cause outcomes of doctors and their relatives to differ from those of other people. Doctors have a profession that comes with irregular working hours and is physically more demanding and more stressful than most other professions. Moreover, doctors select themselves into their profession which may be related to their initial health condition or their attitudes towards health. Similar concerns pertain to the relatives of doctors. Doctors typically come from more educated families, and doctors choose different partners and have different fertility patterns than non-doctors (e.g. Artmann et al., 2018). To deal with these issues, most existing studies use an extensive set of control variables, including risk factors and baseline health, and focus on specific health conditions.[1]

We contribute to this literature by using admission lotteries to medical school in the Netherlands to study how health outcomes of parents are affected by having a child who is a doctor. We compare outcomes of the parents whose child won the admission lottery to medical school and became a doctor to the outcomes of parents whose child lost this lottery and did not become a doctor. We consider this the cleanest possible design. By looking at parents of doctors instead of doctors themselves, our results are not contaminated by the impact that working conditions may have on doctors' own health. Because we study the parents of doctors who were admitted to medical school on the basis of lotteries, these parents are on average similar to the parents of applicants who lost the admission lottery, thereby eliminating selection bias. By looking at parents instead of other relatives, our results are not contaminated by doctors' partner choices and fertility decisions, or by endogenous study choices of siblings. Because children are more likely to care for aging parents than for aging uncles and aunts, parents are the relatives for whom it is most likely to find a treatment effect.

[1] Chou et al. (2006) and Johnson and Rehavi (2016) find a lower incidence of C-sections among doctors and their relatives than among other women in Taiwan and the US. Grytten et al. (2011) find that doctors and their relatives are more likely to have a C-section than other women in Norway. These different results can in part be explained by the different financial incentives in hospitals between the countries. Frakes et al. (2019) find that military doctors in the US do only slightly better than other military officers. Chen et al. (2019) use two alternative designs, one of which is close to ours. We discuss this study in more detail below and in Subsection 4.3.

It is a priori not clear how parents' health care use and outcomes are affected by having a child who is a doctor. Various forces are at work. Doctors may provide information about preventive behavior. This reduces parents' demand for care if they behave more healthy, but may also increase demand for care through, for example, regular screenings and flu-shots. Doctors may also convince parents to take prescribed medication and to complete treatments. This need not change the amount of formal care, but would increase the quality of care and thus improve parents' health outcomes. Furthermore, doctors may be better in recognizing symptoms in an early stage. This may lead to earlier diagnosis, which increases health care use in the short run, but may reduce it in the longer run. Finally, doctors may use their knowledge and network to obtain treatment for their parents. They could try to direct them immediately to a specialist rather than first going to the GP. Or they may provide additional information to the GP and/or specialist to help them make a better diagnosis and decision about providing subsequent treatments. This changes the type of health care and may also affect the costs of health care.[2] It is an empirical question whether the combined effect of these forces increases or decreases health care use of doctors' parents. In our analysis we consider total health care costs, different types of health care use and various hospital diagnoses and medication use. This provides a detailed picture of how doctors affect the health care of their parents. Our key health outcome is, however, mortality. All forces operate in the direction of lowering the mortality of doctors' parents.

We use rich data from different registers that are available at Statistics Netherlands and that can be linked at the individual level and the parent-child level. We combine the registers on admission lotteries for medical school, on educational attainment, on health care professionals, on mortality, and on health care use, covering the full population. The health care use comprises health care costs, specialist and GP visits, prescription medicine use and hospitalization records.

When we consider the full population independent of children's level of education, we find strong associations between children having a medical degree and parental outcomes. Fathers and mothers of doctors live longer, have lower health care costs and are less likely to visit a GP, to be hospitalized and to take any prescription medication, but are slightly more likely to be treated by a specialist. These associations are weaker, but still hold when we restrict the sample to parents of children with a college degree. Next, we exploit the randomization of the admission lotteries to medical school to control for selection into the medical profession. We use the result of the first admission lottery as instrumental variable for practicing as a doctor. The estimation results show causal effects which are close to zero and not statistically significant. This implies that there is no evidence that having access to medical expertise through a child who is a doctor affects parental health care use and health outcomes in the Netherlands.

Our results contrast sharply with those of Chen et al. (2019), who also exploit admission lotteries to medical school and also study a setting (Sweden) with equal formal access to health

[2]We ignore that becoming a doctor has substantial earnings returns (Ketel et al., 2016), which could increase health investments for parents. Furthermore, being a doctor may change labor supply and the amount of leisure available to meet parents. Both channels are probably of second order importance in a small country like the Netherlands with extensive universal health insurance.

care services. The contrasting findings warrant further exploration. A limitation of the Swedish admission lottery data is that the number of lottery participants is quite small and it only covers outcomes up to eight years after the admission lotteries. Chen et al. (2019) therefore complement the admission lottery results with results from an event study design that compares the health of doctors' relatives with that of lawyers' relatives. In Subsection 4.3, we compare our results with theirs and show that in our data a similar event study design does not eliminate selection bias.[3]

In addition to the literature on the effects of access to expert medical knowledge, our paper is related to three other literatures. First, to the literature on inequity in access to health care, which tends to conclude that access is biased towards high SES groups.[4] Second, to the literature on the effect of education on health outcomes, which shows mixed findings about the causal impact of education on health.[5] And third, to the recent literature on the relationship between adult children's education and parents' longevity, where studies find a positive association and sometimes a positive causal impact.[6]

The remainder of the paper is structured as follows. Section 2 provides details on the health care system in the Netherlands and the admission lotteries and Section 3 describes the data. Section 4 first discusses the association between having a child who is a doctor and parental health outcomes, then it introduces the empirical approach and presents our instrumental variables estimates of the causal effect of children having a medical degree on parental health. We complete this section by comparing our results to those obtained by Chen et al. (2019). Section 5 summarizes and concludes.

2 Institutional background

This section first gives a brief overview of the Dutch health care system focusing on the affordability of high quality health care for all inhabitants of the country. Next, it describes the admission lotteries to medical school, and the study program to become a doctor.

[3]We wish to point out that our paper is not written to replicate or criticize Chen et al. (2019). We requested the data for this project from Statistics Netherlands in September 2017, long before we saw a first draft of the Chen et al-paper in January 2019.

[4]See Van Doorslaer et al. (2006) and Van Doorslaer et al. (2004). Individuals with higher education and/or income have better access to primary care (Angerer et al., forthcoming; Olah et al., 2013), to certain health services after a stroke (Kapral et al., 2002) or to specialized cardiac services (Alter et al., 1999) and have shorter waiting times for non-emergency hospital treatment (Monstad et al., 2014; Moscelli et al., 2018; Siciliani and Verzulli, 2009).

[5]Higher educated individuals live longer and are in better health throughout the lifespan. The evidence on a causal link is, however, mixed. Lleras-Muney (2005), Oreopoulos (2006) and Van Kippersluis et al. (2011) find that more education improves health outcomes, but Clark and Royer (2013), Meghir et al. (2018) and Malamud et al. (2017) find no support for this. See Galama et al. (2018) and Eide and Showalter (2011) for reviews.

[6]See Friedman and Mare (2014), Torssander (2013, 2014) and Zimmer et al. (2007) for correlational studies. Lundborg and Majlesi (2018) and De Neve and Fink (2018) apply instrumental variable approaches to estimate causal impacts. Fadlon and Nielsen (2019) analyze how health behaviors and investments are shaped through intra- and intergenerational family spillovers. They find that spouses and adult children immediately increase their health investments and improve their health behaviors in response to family health shocks.

2.1 Health care system in the Netherlands

Since the implementation of the Health Insurance Act in January 2006, all Dutch residents are legally obliged to purchase a basic health insurance package from private insurers.[7] Private insurers cannot reject applicants and are not allowed to charge different prices for the same package. In 2019, adults pay an annual community-rated premium of about 1200 euro. The government pays the premium for children under 18 years old and subsidizes individuals whose income is too low to afford the premium. The government collects an almost equal amount from general taxation which can be considered an income-dependent premium. These tax revenues are distributed among the private insurers on a risk-adjusted basis for their insured population (Kroneman et al., 2016).

The central government defines the content of the basic package. This covers medical care, including care provided by GPs, hospitals, specialists and midwives, and prescription drugs.[8] Every insured person over age 18 pays an annual deductible of 385 euro (in 2019) for health-care costs, including costs for hospital admission, medical transportation and prescription drugs but excluding costs for GP consultations, maternity care, home nursing care and care for children under the age of 18.[9] Voluntary supplemental health insurance is available for services not included in the basic health insurance package. In 2017, about 84 percent of all individuals had some form of supplemental health insurance, the most popular services being dental care, physiotherapy, glasses and contact lenses (Wammes et al., 2014).

The Netherlands spent 10 percent of its GDP on health care in 2017, which is similar to most other OECD countries but considerably lower than the health care expenditure of the US which in the same year amounted to 17 percent of its GDP. Primary care is foremost provided by GPs who act as gatekeepers for access to hospital and specialist care. Only seven percent of contacts with a GP result in a referral to secondary care (Kroneman et al., 2016). With 3.3 doctors per 1000 inhabitants, the density of doctors in the Netherlands is similar to that in other OECD countries.

2.2 The admission lotteries

Students who completed the academic track in secondary school in the Netherlands are eligible to enroll in all study programs at all Dutch universities.[10] Some study programs require that students have followed specific subjects at secondary schools, but programs are not allowed to

[7] The discussion in this subsection relies on Wammes et al. (2014).

[8] In addition, the basic care package covers dental care until age 18 (coverage after age 18 is confined to specialist dental care and dentures); medical aids and devices; maternity care; ambulance and patient transport services; paramedical care (limited physical/remedial therapy, speech therapy, occupational therapy, and dietary advice); basic ambulatory mental health care for mild to moderate mental disorders; and specialized outpatient and inpatient mental care for complicated and severe mental disorders.

[9] In addition to the deductible, individuals need to share some costs for selected services such as medical transportation via co-payments, coinsurance or direct payments for services that are subsidized to a certain limit. A reimbursement limit is set for drugs in groups of equivalent drugs such that excess costs above this limit are not reimbursed.

[10] The information in this subsection largely follows Ketel et al. (2016).

Table 1: Lottery categories

Category	GPA	Weight	Share
A	$8.5 \leq$ GPA ≤ 10	2.00	1.7%
B	$8.0 \leq$ GPA < 8.5	1.50	5.4%
C	$7.5 \leq$ GPA < 8.0	1.25	8.6%
D	$7.0 \leq$ GPA < 7.5	1.00	20.8%
E	$6.5 \leq$ GPA < 7.0	0.80	22.1%
F	$6.0 \leq$ GPA < 6.5	0.67	29.9%
Other	–	1.00	11.5%

Note: GPA describes the average of the student's final exam grades at secondary school. In the Netherlands, grades are between 1 and 10, with 5.5 and higher means passing. Weight is the weight in the admission lottery and Share describes the fraction of the applying students in each lottery category.

select students based on grades or other student characteristics.[11] Some study programs have quotas that limit the number of students that can be admitted. For medical school the quota was introduced in response to the drastically increasing number of potential students at the end of the 1960s which exceeded the number of study places available.[12]

Until 1999, students who applied to medical school (and any other study program with a quota) were admitted on the basis of the results from a nationwide centralized lottery.[13] The lottery first determines which students can enroll in medical school and next distributes these students over the eight medical schools in the Netherlands. Based on their GPA on the secondary school exam, students are divided into categories, which determine students' weights in the admission lottery. Table 1 shows that students with a GPA exceeding 8.5 are in category A and they receive a weight of 2.00, while students with a GPA between 6 and 6.5 are assigned to category F with a weight of 0.67.[14] The category "Other" includes students who did not take the Dutch secondary school exams, e.g. foreign students, who will be excluded from our empirical analysis.

Rejected applicants are allowed to reapply in the next year, and until 1999 they could do this as often as they wanted. We observe that many but not all rejected first-time applicants reapplied at least once. This implies that admission to medical school is not only determined by lottery results. In our empirical analysis we will therefore use the result of the first lottery in which someone participated as instrumental variable for becoming a doctor.

[11] Graduating from secondary school requires an exam in seven subjects including Dutch and English. Applicants for medical school should also have passed biology, chemistry, physics and math. Once the exam is passed it cannot be retaken.

[12] See Goudappel (1999) for details on the reasons for introducing quotas.

[13] From 2000 onward, studies with quotas are allowed to admit (initially) at most 50 percent of the students using their own criteria. Universities have made increasing use of this and by now, the admission lotteries have been eliminated. Selection is often based on motivation and previous experience. For this reason we restrict our analysis to students who first applied for medical school before this change.

[14] The number of available places per lottery category is determined such that for the total number of available places divided by the number of applicants in a category, the weights hold.

2.3 The study program

During our observation period, the study program at medical school consisted of three phases (Ketel et al., 2016). First, students followed four years of mainly theoretical education in order to receive their undergraduate diploma. Second, two more years of on-the-job training qualifies students for the basic degree, which is necessary to be included in the Dutch registry of health care professionals. This registration is required to enter the labor market for medical professionals. Medical studies are, as university education in the Netherlands in general, largely publicly funded, so that students pay the regular tuition fee (at that time about 1000 Euros per year). Furthermore, medical school students are entitled to the same study allowance that all Dutch students receive. In the third phase, students could either seek employment as *basisarts*, pursue a PhD or enroll in a specialization track. Although not mandatory, to be hired for the latter it is common to first obtain a PhD degree. The specialization tracks vary in duration ranging from three years for e.g. general practitioners to six years for, for example, surgeons and neurologists. There are no tuition fees during this phase, and students receive a formal employment contract and a salary. In total, the complete medical study program could take between 6 and 15 years.

3 Data

This section describes the data used in the empirical analysis and provides summary statistics of the data.

3.1 Data sources and sample

We use administrative data from different registers available at Statistics Netherlands which can be linked at the individual level and at the parent-child level. The registers that we use are the register on admission lotteries, the register of health care professionals, the mortality register, and registers of health care use and health care costs.

The register on admission lotteries contains information on all applicants for medical school, their lottery category and the results in all lotteries. Lottery information is available for the years 1987 to 2004. To make sure that we observe first-time applicants, we exclude applicants who participated in 1987 since we have no information about possible participation in 1986, and we exclude applicants older than 20 when we observe them applying for the first time. Because the lottery system was gradually abandoned after 1999, we exclude individuals applying for the first time after that year.[15]

From the lottery register we exclude applicants of whom at least one parent is registered as doctor in the register of health care professionals, because for these parents having a child who is a doctor adds relatively little medical expertise. This eliminates about 12.5 percent of the first-time applicants. The register of health care professionals was established in 1994 and mandated

[15] We also drop applicants from lottery category A because almost no one from this category lost the lottery.

every health care professional to be registered in order to practice in the Netherlands.[16] We have information on actual study choices of all applicants and their study progress. For the lottery applicants we observe who enters the register and thus becomes a doctor.

About 90 percent of the fathers of the lottery applicants are born between 1934 and 1952, and 90 percent of the mothers were born between 1938 and 1954.[17] The mortality register contains all deaths from 1995 onwards, so the oldest parents were in their late fifties when the mortality register started.

Data availability on health care use and health care costs varies because different data are owned by different institutions. This affects the observation period of these data. We have access to health care costs that are reimbursed by the basic health insurance package (available from 2009 to 2016), specialist visits and treatment costs (2013-2017) and prescription medicine use coded according to the 4-digit Anatomical Therapeutic Chemical (ATC4) classification (2006-2017). The register on prescription drugs covers medicine that is (partially) reimbursed by the statutory health insurance, but excludes drugs provided in hospitals and nursing homes.[18] We also use hospitalization records (1995-2016) which comprise information on all hospital visits including those without overnight stay, main diagnosis according to the International Classification of Diseases (ICD9 and ICD10-classification) and some characteristics of the admitting hospital.[19]

In addition to the sample of lottery participants, we construct from the general population a sample containing all individuals born between 1967 and 1982 and their parents. We refer to this sample as the "full population". This sample considers the same birth years as the lottery participants. From this "full population" we construct a sample of college graduates and their parents. We refer to this sample as the "college graduates".[20] The "full population" and "college graduates" are used to determine associations between having a child who is a doctor and parental health outcomes.

3.2 Summary statistics

The upper panel in Table 2 reports summary statistics on study enrollment and completion by the result of the first lottery. Almost 94 percent of the applicants admitted to medical school in their first lottery actually enroll in the program. About 45 percent of the first-time lottery losers enroll in medical school after having won a subsequent lottery. Almost all lottery winners

[16] We cannot identify parents with a medical degree who were never registered because they stopped working as health care professional before 1994. However, the oldest children were born in 1967 and if the parents worked until (early) retirement, then we might only miss parents who were in their very late thirties at the birth of their child. In robustness checks, we also exclude individuals where either parent is registered as nurse. This does not alter the results (results available upon request).

[17] For 6.3 percent of the lottery applicants in our sample we can not link a father and for 3.0 percent the mother cannot be linked.

[18] The records do not contain information on the quantity prescribed so that we only observe whether drugs from a specific ATC4 category were used in a year.

[19] Statistics Netherlands does not have outpatient records so that we can only identify parents having a specific disease or condition if the diagnosis was made in the hospital.

[20] In the Netherlands, individuals can obtain a degree from either a research university ("Wetenschappelijk Onderwijs", WO) or a professional college ("Hoger Beroepsonderwijs", HBO).

enroll in a study program in the Netherlands, while about 96 percent of the losers do so. The share of lottery winners who complete medical school amounts to 82 percent, while the share among lottery losers is almost 41 percent. About 96 percent of lottery winners and 93 percent of lottery losers complete any study program in the Netherlands.

Table 2: Sample description by outcome of the first lottery

	Winners	Losers
Enrollment in medical school	93.8%	45.0%
Completion of medical school	82.4%	40.7%
Enrollment in a study program in NL	99.4%	96.3%
Completion of a study program in NL	96.0%	92.8%
Registration as doctor	80.8%	42.2%
Registered as GP	28.9%	30.7%
Registered as specialist	53.4%	49.5%
Registered without specialization	17.7%	19.8%
N	10,212	12,003

The bottom panel shows that almost all lottery winners that complete medical school also register as doctor. For lottery losers the fraction of licensed doctors is larger than the medical school completion rate. Some lottery losers complete medical school abroad (most likely Belgium) and then practice in the Netherlands. The lottery losers who complete medical school distribute themselves similarly as the lottery winners over the different types of doctors. About 30 percent of the doctors become GPs, about 50 percent register as specialist and slightly less than 20 percent either do not specialize or work as social doctor.[21]

Tables A1 and A2 in Appendix A.1 show balancing of the applicants and their parents in terms of pre-treatment characteristics of winners and losers of the first lottery for medical school. With the exception of the one percentage point difference in the shares of parents being married or cohabiting in the pre-lottery year, these characteristics do not differ between (parents of) lottery winners and losers.

Table 3 lists the fields of study that are most often chosen by lottery losers who pursue another field of study. Some lottery losers enroll in programs that have some health component, but that yield considerably less medical knowledge than medical school and do not allow to practice medicine. Examples are biomedical science, movement science, therapeutics and rehabilitation. Other commonly chosen fields are science, mathematics and computing, psychology and business.

Table 4 shows descriptives of the main outcome variables for the fathers and mothers of the full population, college graduates and the lottery applicants separately. About 23 percent of the fathers in the full population have died by the end of 2018. This fraction is 19 percent

[21] Social doctors comprise, for instance, occupational health doctors, doctors for mentally disabled, community doctors, etc.

Table 3: Most popular study fields of lottery losers

Field	Share
Biomedical science, Movement science, Therapeutics, Rehabilitation	18.2%
Science, Mathematics and Computing	10.8%
Psychology	10.1%
Business	9.3%
Law	8.0%
Pharmacy	7.7%
Education	7.3%
Health	6.8%
Engineering, Manufacturing and Construction	6.6%

Table 4: Summary statistics of the main outcome variables

	Fathers			Mothers		
	Full pop.	College	Lottery	Full pop.	College	Lottery
Mortality rate (by 31.12.2018)	22.7%	19.3%	16.7%	12.4%	10.4%	9.4%
Age survivors (31.12.2018)	72.1	72.7	72.8	70.0	70.9	71.2
Total annual costs (in €)	4137	3771	3680	3469	3030	2994
Annual GP visit (0/1)	79.3%	80.1%	79.2%	84.2%	84.5%	83.7%
Annual GP costs (in €)	122	113	106	127	115	110
Any medication use (0/1)	80.0%	79.7%	79.2%	83.6%	82.7%	82.9%
Annual pharmacy costs (in €)	581	522	508	529	445	445
Hospitalization - inpatient (0/1)	13.1%	12.3%	13.8%	12.4%	11.3%	12.5%
Annual hospital costs (in €)	2699	2485	2453	2083	1863	1855
Specialist visit (0/1)	57.7%	58.6%	59.4%	55.9%	56.2%	57.9%
Specialist treatment costs (in €)	2122	1993	1982	1660	1502	1520
N	3,147,979	989,859	21,103	3,283,379	1,019,391	21,693

Note: Observations in columns 1, 2, 4 and 5 are weighted to mirror the age distribution of medical school applicants. All costs are converted to euros in 2015. Total annual costs in row 3 comprise all health care costs covered by basic health insurance, which includes GP costs, pharmacy costs, hospital costs, and costs for paramedical care, mental health care, geriatric rehabilitation care, home care, patient transports, oral care, health care provided abroad and some other health care. Annual hospital costs describe both inpatient and outpatient costs made in hospital. Total annual costs, annual GP costs, annual pharmacy costs and annual hospital costs are from the data on reimbursements of the basic health insurance package (2009-2016), annual GP visit is also based on these data and equals one if there were positive GP consultation costs within a year. Medication use is from the register of prescription use (2006-2017). Hospitalization comes from the hospital records (1995-2016). Specialists visits and specialists treatment costs are from the records of diagnosis treatment combinations (2013-2017), most specialists costs are also included in hospital costs of the basic health insurance package.

among college graduates and 17 percent in the sample of lottery applicants' fathers. Mortality rates among mothers are roughly 10 percentage points lower in the full population, but exhibit a similar decreasing pattern when moving to the lottery sample.

The total annual health care costs (converted to euros in 2015) are for both fathers and mothers highest in the full population. The difference is mainly due to hospital costs and to a

smaller extent due to pharmacy costs.[22] The higher costs within the full population are not due to a higher incidence of using the different types of care. Differences in care use and costs are small between parents of college graduates and parents of lottery participants. For all samples, health care costs of fathers are higher than those of mothers. Fathers are more likely to visit a hospital or a specialist, while mothers are more likely to go to the GP or take medication. The differences between fathers and mothers may reflect differences in care use between older men and women, but also that fathers are on average two years older.

The data allow to distinguish between different types of specialist visits, reasons for hospital visits and types of medication use. Summary statistics on these more detailed outcomes are provided in Appendix A.2. Parents of the lottery applicants are slightly more likely to visit a specialist, but parents in the full population are more often treated by surgeons and cardiologists, which may suggest more serious health conditions (Table A3). While mothers and fathers of lottery applicants less often need an acute admission, they are more likely to be treated in a university medical center or top clinical hospital instead of in a general hospital (Table A4). The incidences of specific diagnoses are often highest among the parents of the full population. This does not hold for every diagnosis, e.g. the probability of being diagnosed with any type of cancer is highest among the parents of lottery applicants. Recall that differences between samples in the probability of taking any medication are small. But parents of the full population and of college graduates are more likely to be prescribed most types of medication than the parents of lottery applicants (Table A5). This suggests that the former more often have multiple diseases or conditions, and take a higher number of different types of medication at the same time.

4 Results

This section first reports OLS-estimates of the correlation of having a child who is a doctor and parental outcomes in our three samples. Next, we exploit the admission lotteries for medical school in order to eliminate selection bias into the medical profession. This allows us to determine the causal effects of having a child who is a doctor on parents' mortality and various measures of their health care use. Our main finding is that while the correlations are substantial, the causal effects are close to zero and not statistically significant. In the final part, we follow Chen et al. (2019) and conduct an event study comparing the parents of doctors to those of graduates from law school. The results from this analysis point to significant differences between the two groups. We interpret this as evidence that the event study design does not fully eliminate selection bias.

[22] Hospital costs include almost all specialists costs as well.

4.1 Association of having a child who is a doctor with parental health outcomes

We first regress within the full population the different health outcomes of parents on whether their child is registered as doctor. In the OLS regressions, we control for gender and ethnicity of the child, fixed effects for the birth years of child and parent, and fixed effects for the years in which the outcome is observed. The sample is restricted to parents with children born between 1967 and 1982. We cluster standard errors at the level of the parent. The estimation results presented in the upper panel in Table 5 show that almost all health outcomes are more favorable for parents of doctors, and differences are always significant. The magnitudes of the estimated coefficients are very similar for fathers and mothers. Because it is very unlikely that we control for all relevant heterogeneity between parents of doctors and parents of non-doctors, the estimates should be interpreted as associations rather than causal effects.

Fathers of doctors are 6.6 percentage points less likely to have died by the end of 2018 compared to fathers of children not practicing as doctor, and this difference is 4.3 percentage points for mothers. The annual health care costs of parents of doctors are about 500 euros lower. These lower costs are caused by lower costs for GP consultations, pharmaceuticals, hospital admissions and treatment by a specialist. The parents of doctors are less likely to visit a GP, to be prescribed any type of medication and to be hospitalized. The fathers and mothers of doctors are on average 1.1 and 1.4 percentage points more likely to visit a specialist, respectively.

The middle panel of Table 5 shows results when we restrict the sample to the parents of college graduates. The coefficients have the same sign as in the full sample, indicating that parents of doctors have more favorable outcomes than parents of other college graduates. However, the magnitudes of the estimates are smaller than in the full sample and some estimates become statistically insignificant, particularly for mothers. The negative association of the child being a doctor with fathers' (mothers') mortality reduces to 2.7 (1.4) percentage points. The estimate for the difference in total health care costs declines to about 100 euros. These smaller coefficients when restricting the sample to parents of college graduates confirm the usual gradient between education and own health (Cutler and Lleras-Muney, 2008; O'Donnell et al., 2015; Van Kippersluis et al., 2010).

The bottom panel of Table 5 shows results when we restrict the sample to parents of lottery participants. Because there is substantial noncompliance with the outcome of the first lottery, these results have no causal interpretation. The resulting OLS-estimates show that the differences in outcomes between parents of doctors and non-doctors decrease substantially compared to the results in both other panels and many of the estimates become insignificant. The negative association with parental mortality reduces further in magnitude compared to the estimates in the upper and middle panels. For GP costs we find that both fathers and mothers of doctors have significantly lower costs, but the effects are of economically negligible size. The change in results compared to the sample of college graduates shows that parents of lottery applicants differ from parents of other college graduates.

Table 5: Association of child being a doctor with parental mortality and health care access, use and costs

	Fathers		Mothers	
	$\hat{\beta}$	s.e.	$\hat{\beta}$	s.e.
I. Full population				
Mortality (by 31.12.2018)	−0.066***	(0.003)	−0.043***	(0.002)
Total costs	−506.27***	(41.57)	−495.05***	(34.09)
GP visit (0/1)	−0.014***	(0.002)	−0.012***	(0.002)
GP costs	−19.11***	(0.62)	−19.85***	(0.62)
Any medication	−0.014***	(0.002)	−0.010***	(0.002)
Pharmacy costs	−86.04***	(10.50)	−87.27***	(9.11)
Hospitalization (0/1)	−0.012***	(0.001)	−0.009***	(0.001)
Hospital costs	−260.12***	(31.88)	−222.83***	(23.17)
Specialist visit (0/1)	0.011***	(0.003)	0.014***	(0.003)
Specialist treatment costs	−661.16***	(140.10)	−154.46***	(30.44)
II. College graduates				
Mortality (by 31.12.2018)	−0.027***	(0.003)	−0.014***	(0.002)
Total costs	−133.17***	(42.00)	−88.27**	(34.55)
GP visit	−0.015***	(0.002)	−0.012***	(0.002)
GP costs	−9.66***	(0.63)	−8.54***	(0.63)
Any medication	−0.004*	(0.002)	0.001	(0.002)
Pharmacy costs	−24.07**	(10.63)	−8.28	(9.31)
Hospitalization (0/1)	−0.002**	(0.001)	0.002	(0.001)
Hospital costs	−45.76	(32.17)	−21.22	(23.50)
Specialist visit (0/1)	0.012***	(0.003)	0.016***	(0.003)
Specialist treatment costs	−71.00	(141.65)	0.21	(30.59)
III. Medicine lottery participants				
Mortality (by 31.12.2018)	−0.010*	(0.005)	−0.008*	(0.004)
Total costs	−42.87	(79.15)	−49.58	(63.79)
GP visit	−0.008**	(0.004)	−0.002	(0.003)
GP costs	−4.89***	(1.17)	−5.37***	(1.16)
Any medication	0.009**	(0.004)	0.012***	(0.004)
Pharmacy costs	−17.91	(22.32)	4.52	(16.43)
Hospitalization (0/1)	0.002	(0.002)	0.002	(0.002)
Hospital costs	3.20	(60.03)	−17.88	(44.20)
Specialist visit (0/1)	0.018***	(0.005)	0.006	(0.005)
Specialist treatment costs	26.85	(264.78)	37.27	(47.36)

Note: Cluster-robust standard errors in parentheses. All regressions include controls for gender and ethnicity of the child, fixed effects for the child's and parent's year of birth, and fixed effects for the year the outcome is observed. Levels of statistical significance: * p<0.10, ** p<0.05, *** p<0.01

4.2 Causal evidence from admission lotteries

Within the full population, parents of doctors have more favorable health outcomes than parents of non-doctors. A substantial part of this difference is due to selection. Reducing differences in socioeconomic background by restricting the control group to parents of non-doctors who are more similar to the doctors causes that differences in health outcomes become small and often insignificant. Still, even in the sample of lottery participants doctors are not a random sub-

sample due to noncompliance with the outcome of the first admission lottery. In this subsection, we use an instrumental variables approach to deal with this noncompliance and recover causal effects of the child being a doctor on various measures of parental health care.

Empirical approach and first-stage results

We are interested in the effects of being a doctor on parental mortality, health care use and costs. We assume a linear relationship between outcome variable Y in year t of individual i's parent (Y_{it}), and being a doctor (D_i):

$$Y_{it} = \alpha_t + \delta D_i + X_i\beta + LC_i + U_{it} \tag{1}$$

The effect of being a doctor on outcomes is captured by δ, the parameter of interest. The vector of controls X_i includes applicant's age at first lottery participation, a gender dummy, an indicator for non-western origin and fixed effects for the birth years of child and parent. The interaction term between the lottery category and year of first participation, LC_i, controls for the fact that individuals' chances of being admitted are only identical conditional on lottery year and category. Lastly, α_t are fixed effects for the year in which the outcome is observed and U_{it} is an individual-specific error term.

Compliance with the result of the first admission lottery is imperfect (see Subsection 3.2). Not all winners of the first lottery enrolled in medical school, and some dropped out before completing their degree and being registered as a doctor. A substantial fraction of lottery losers reapplied in subsequent years and eventually become a doctor. To deal with the endogeneity of becoming a doctor, we use the result of the first admission lottery in which the applicant participated (LR_{1i}) as instrumental variable:

$$D_i = \kappa + \lambda LR_{1i} + X_i\theta + LC_i + V_i \tag{2}$$

All applicants to medical school participate at least once in an admission lottery, so there is no sample selection when considering the outcome of the first admission lottery. Conditional on the lottery category interacted with the year of the first application, the outcome of the first lottery is random. This ensures that the independence assumption underlying the instrumental variable approach is satisfied: $E[U_{it}|X_i, LC_i, LR_{1i}] = E[U_{it}|X_i, LC_i]$. This is supported by the balancing results reported in Appendix A.1. The parameter λ describes the fraction of compliers in the sample. In our setting compliers are individuals for whom the result of the first lottery determines whether they ever become a doctor. The treatment effect δ in equation (1) should be interpreted as Local Average Treatment Effect (LATE).

We run the first-stage regressions separately for fathers and mothers. The estimates for λ are in Table 6 and show that the outcome of the first admission lottery is a strong instrument. The F-statistics are above 3100. Winning the first lottery increases the probability to become a doctor by 36 percentage points.

Table 6: First-stage estimates

	$\hat{\lambda}$	s.e.	F-statistic	N
I. Fathers	0.361***	(0.007)	3110.7	21,103
II. Mothers	0.362***	(0.006)	3208.0	21,693

Note: All specifications include controls for gender, ethnicity, age at the first lottery application (in days), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery. Levels of statistical significance: * p<0.10, ** p<0.05, *** p<0.01.

Parental mortality

Table 7 reports the estimated causal effects of having a child who is a doctor on fathers' and mothers' probability of having died by the end of 2018. The estimates are close to zero and statistically insignificant, implying that a child who is a doctor does not prolong parents' life. This result is confirmed when restricting the sample to parents born before 1944 and defining mortality by age 75 as the outcome variable.

Table 7: Instrumental variable estimates for child being a doctor on parental mortality

	Mortality by 31.12.2018			Parents born before 1944		
	$\hat{\delta}_{IV}$	s.e.	p-value	$\hat{\delta}_{IV}$	s.e.	p-value
I. Fathers	0.0001	(0.0146)	0.993	0.0139	(0.0274)	0.611
II. Mothers	0.0066	(0.0116)	0.573	0.0092	(0.0268)	0.733

Note: All specifications include controls for gender, ethnicity, age at the first lottery application (in days), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery. Levels of statistical significance: * p<0.10, ** p<0.05, *** p<0.01

Rather than having died at a given moment in time or before a particular age, we can consider the age of dying using duration models. For this purpose, we use a Cox proportional hazard model on the reduced form, i.e. we use the result of the first lottery as regressor rather than being a doctor.[23] The hazard rate model includes the same regressors and fixed effects as the linear regression model discussed above. Table 8 presents the marginal effects. It shows estimates on the full sample and on the restricted sample of parents born before 1944 (potentially reaching at least age 75 during the observation period). The effects are small and not statistically significant.

Finally, we conduct Wilcoxon rank-sum tests for equality of the survivor functions between the parents of the lottery losers and the parents of the lottery winners to investigate whether there are differences at other points in the distribution. In these rank-sum tests we control for the lottery category interacted with the year of the first lottery. As shown in Table 9, in no case can we reject the null hypothesis of equality of the survivor functions of lottery winners' and losers' parents. So all three tests show that whether or not the child is a doctor does not affect the longevity of parents.

[23] Instrumental variable approaches do not combine easily with (non-linear) hazard rate models.

Table 8: Marginal effects of winning the first admission lottery on parental mortality from a Cox proportional hazard rate model

	Full sample			Parents born before 1944		
	$\hat{\beta}_{Cox}$	s.e.	p-value	$\hat{\beta}_{Cox}$	s.e.	p-value
I. Fathers	0.0153	(0.0353)	0.665	0.0442	(0.0613)	0.471
II. Mothers	0.0345	(0.0478)	0.471	0.0545	(0.1008)	0.589

Note: All specifications include controls for gender, ethnicity, age at the first lottery application (in days), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery. Levels of statistical significance: * p<0.10, ** p<0.05, *** p<0.01

Table 9: Rank-sum test for equality of survivor functions of lottery losers and lottery winners

	Full sample			Parents born before 1944		
	χ^2	p-val.	N	χ^2	p-val.	N
I. Fathers	0.07	0.796	20,827	2.32	0.128	7189
II. Mothers	0.40	0.527	21,542	0.09	0.765	4734

Note: The tests control for differences in admission probabilities by lottery categories in the different years.

Parental health care use and costs

Table 10 shows the instrumental variables estimates on health care costs and health care use. The results in the first row show no significant differences in total health care costs. The estimated effect is close to zero for fathers and somewhat larger for mothers. The point estimate of 278 euros for mothers corresponds to about 9 percent of the mean total annual health care costs of almost 3000 euros in the lottery sample.

When looking at separate cost components, none of the effects for GP consultation costs, specialist treatment costs, pharmaceutical spending and hospitalizations are statistically significant. Because we consider many outcomes, we also report significance levels that correct for multiple hypotheses testing. We follow the approach suggested by Anderson (2008) and compute false-discovery-rate adjusted p-values referred to as FDR q-values. Anderson (2008) shows that the FDR q-values are less conservative than the Bonferroni correction for multiple hypotheses testing. We compute the FDR q-values for two groups separately, i.e. the cost factors (GP costs, specialist treatment costs, pharmacy costs and hospital costs) and the health care use indicators (GP visit, specialist visit, any medication and hospitalization). The estimates on health care use show that both parents are less likely to go to the GP and more likely to go to the hospital and visit a specialist if their child is a doctor. However, only the estimate for GP visits of fathers is significant and the significance disappears when computing the FDR q-value. Furthermore, the effects are relatively small, particularly for mothers.

Our results lend no support to the idea that having a child who is a doctor changes the health care use of parents. However, the estimates in Table 10 only consider broad categories of health care use. In Appendix A.3 we show estimates for less coarse measures of health care use. In particular, we consider the type of specialist visited by the parent (Table A6), the characteristics of the hospital visit (panel I in Table A7), the main diagnosis made in hospital

Table 10: IV-estimates of the effects of being a doctor on parental health care

	Fathers				Mothers			
	$\hat{\delta}$	s.e.	p-val.	FDR q-val.	$\hat{\delta}$	s.e.	p-val.	FDR q-val.
Total costs	1.97	(224.75)	0.993	-	277.71	(187.24)	0.138	-
GP visit	-0.0223	(0.0106)	0.036	0.145	-0.0065	(0.0093)	0.487	0.650
GP costs	-5.06	(3.32)	0.128	0.512	-3.04	(3.24)	0.348	0.373
Specialist visit (0/1)	0.0225	(0.0152)	0.138	0.185	0.0045	(0.0143)	0.753	0.753
Specialist treatment costs	154.68	(175.27)	0.377	0.755	168.12	(152.56)	0.271	0.373
Any medication	-0.0048	(0.0118)	0.686	0.687	0.0087	(0.0103)	0.399	0.650
Pharmacy costs	-20.52	(55.89)	0.713	0.894	45.35	(50.82)	0.372	0.373
Hospitalization (0/1)	0.0084	(0.0054)	0.116	0.185	0.0077	(0.0052)	0.139	0.556
Hospital costs	22.94	(170.70)	0.893	0.894	151.59	(131.93)	0.251	0.373

Note: FDR q-values are false-discovery-rate adjusted p-values following Anderson (2008). The FDR q-values are computed separately for two groups, use indicators (GP visit, specialist visit, any medication, hospitalization) and cost factors (GP costs, specialists treatment costs, pharmacy costs, hospital costs). All specifications include controls for gender, ethnicity, age at the first lottery application (in days), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery.

(panel II in Table A7), and the type of medication use (Table A8).[24] We do not find effects on the characteristics of the hospital visit (duration, acute admission, top clinical or university medical center), but there are a few significant effects for the type of treating specialist, hospital diagnosis and type of medication. When we adjust for multiple hypotheses testing, the only estimate that remains significant is that mothers of doctors are more likely to be diagnosed with a heart failure. There are no significant effects on the different types of treating specialist or medication use. Overall, our estimates do not indicate that doctors have a substantial effect on the health care use of their parents, or that it changes their health outcomes.

We performed two sensitivity analyses. First, we split the sample of lottery applicants by gender. The results in Table A9 do not point to heterogeneous effects by gender of the child. The estimated effects are also not consistent with hypotheses that either male or female doctors take better care of their parents or take more care of the same-sex or the opposite-sex parent. Second, we consider the living distance between the parents and the child. We split the sample in more or less than 40km travel distance. The results in Table A10 do not show larger effects if the living distance between the parent and the child is shorter.

4.3 Comparison of results with Chen et al. (2019)

Our main finding that parents' health care use and health outcomes are not affected by their child being a doctor, contrasts with the results from the recent study by Chen et al. (2019), who also exploit data from admission lotteries to medical school and who also study health care use and outcomes in a setting without differences in formal access to health care (Sweden). This apparent contradiction warrants a closer inspection.

Admission to medical school in Sweden is normally based on students' high-school GPA. Due to grade inflation, the number of applicants with the highest possible GPA score exceeded the number of available places in the years from 2002 to 2010. In those years, 188 applicants were

[24] We also follow Malamud et al. (2017) and Meghir et al. (2018) to classify diseases according to the epidemiological literature as treatable and preventable.

admitted to medical school on the basis of a lottery, while 555 applicants were rejected. Health outcomes for the relatives of these applicants are observed for up to eight years after enrollment in medical school or after the first lottery application.

To increase statistical power, Chen et al. (2019) consider a wider range of relatives, including grandparents, parents, siblings, children, cousins, and in-laws.[25] The estimates based on this design suggest economically large health improvements for relatives even while the future doctors are still in medical school. More specifically, for older relatives there are significant and rather large reductions in the probabilities to experience a heart attack or heart failure, and there is higher adherence to preventive drugs use (e.g. blood thinners, diabetes drugs).[26] For younger relatives, there is a reduction in the number of inpatient days, a higher degree of HPV vaccination and reduced use of hormonal contraceptives. Due to the small sample, many of the estimates are not statistically significant. This includes the estimates of the impacts on lung cancer, type II diabetes, adherence to beta blockers, asthma drugs, preventable hospitalizations and addiction.

To study impacts beyond the first eight years after enrollment, Chen et al. (2019) complement the results based on admission lotteries with an event study that compares the health outcomes of doctors' relatives with those of relatives of graduates from law school. Law school graduates are chosen as comparison group because they are supposedly similar on dimensions such as income, years of education, secondary school GPA, prestige of the study program and working hours. There may, however, also be dimensions in which they differ, such as interest in study subjects (law vs health), (health-related) lifestyle, partner choice, fertility, etc. Chen et al. (2019) show that in the event study, pre-trends of health outcomes are mostly similar and differences arise around six years after enrolling in medical school. Twenty-five years after starting the study, doctors' relatives have 2 percentage points lower mortality rates than relatives of law school graduates.

To assess whether the differences in findings from the admission lottery design between Chen et al's study and ours, carry over to the event study design, we also conducted an event study comparing health care use and mortality of the parents of doctors to those of the parents of law school graduates. We focus on the parents of registered doctors born after 1967 and construct a control group of parents of law school graduates born in the same years. For all outcomes, we normalize the coefficient to zero when the child is 19 years old, which corresponds with matriculation into medical school and law school.

Figure 1 shows the event study results for mortality of the father and mother up to 26 years after matriculation. The results show that after the child started to study, mortality is always significantly lower among the fathers of doctors than among the fathers of law school

[25]This is potentially problematic as some of these relatives entered the circle of relatives after the applicants' admission to medical school. Using the Dutch admission lotteries for medical school, Artmann et al. (2018) show that male lottery winners are more likely to have a partner, to have a partner with a university degree and to have more children than male lottery losers. Both male and female lottery winners are more likely to have a partner who also has a medical degree.

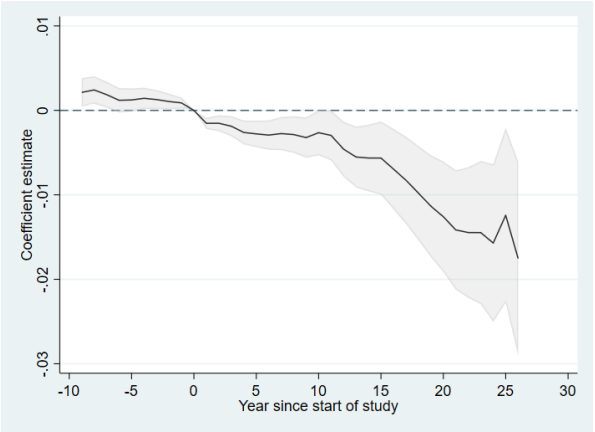
[26]Note, however, that adherence to preventive drugs is measured conditional on these drugs being prescribed – which in itself is an outcome.

graduates. Mortality is lower among the mothers of doctors than among the mothers of law school graduates 11 years after starting the study. These results are very different from the results based on the admission lotteries where we found no effect on parental mortality.

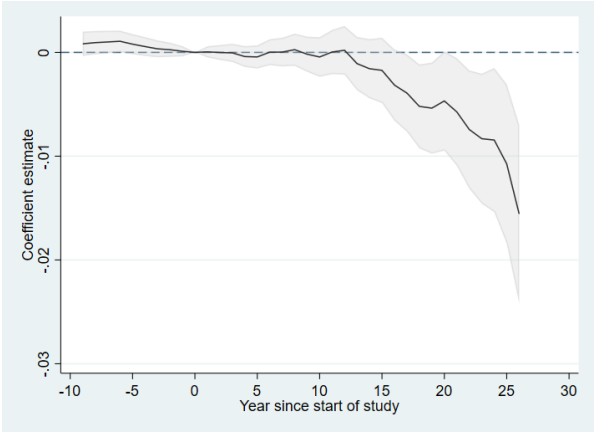
Next, we present similar graphs for total health care costs (Figure 2), hospitalization (Figure 3) and use of medication (Figure 4). The event study does not show significant effects for total health care costs and for the probability to be hospitalized, which is in line with the results from the admission lotteries. For medication use, the event study shows significantly positive effects both for fathers and mothers. These findings are again in contrast to the ones we found in Tables 10 and A8 which show no significant differences. We interpret the differences between the admission lottery results and the event study results as evidence that an event study approach comparing parents of doctors and law school graduates does not fully eliminate selection bias.

Figure 1: Parents' mortality by year since start study of their child - event study

(a) Fathers



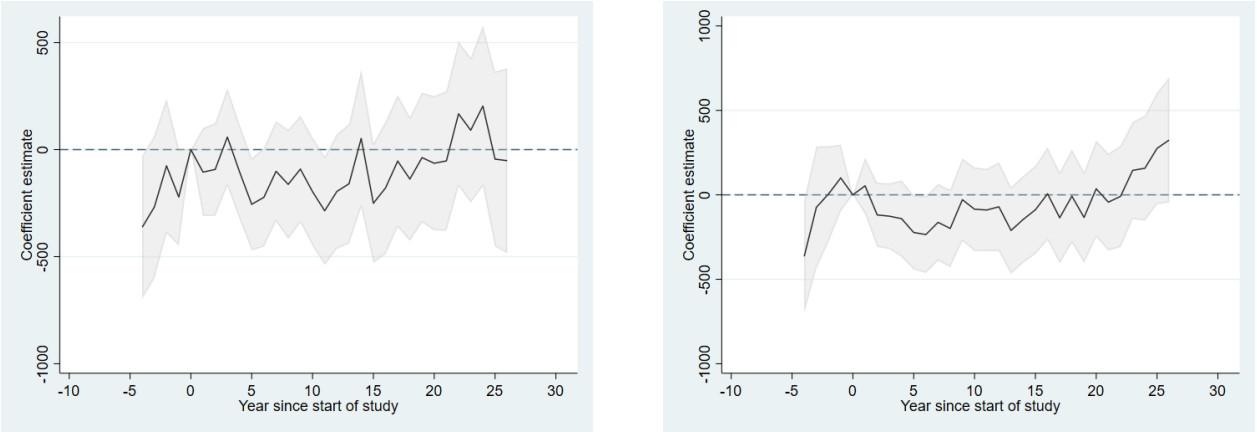
(b) Mothers



Note: Estimates (with confidence intervals) from an event study comparing the parents of doctors and law school graduates. Based on regressions that include controls for gender and ethnicity of the child, fixed effects for the child's and parent's year of birth, fixed effects for year since start of the study, and fixed effects for the year the outcome is observed.

Figure 2: Parents' total health care costs by year since start study of their child - event study

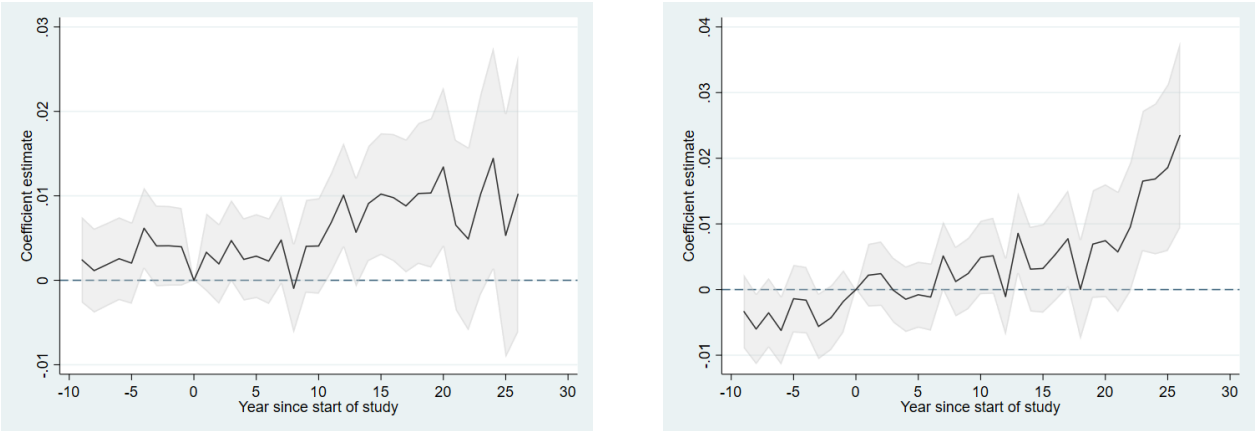
(a) Fathers **(b)** Mothers



Note: Estimates (with confidence intervals) from an event study comparing the parents of doctors and law school graduates. Based on regressions that include controls for gender and ethnicity of the child, fixed effects for the child's and parent's year of birth, fixed effects for year since start of the study, and fixed effects for the year the outcome is observed.

Figure 3: Parents' hospitalization by year since start study of their child - event study

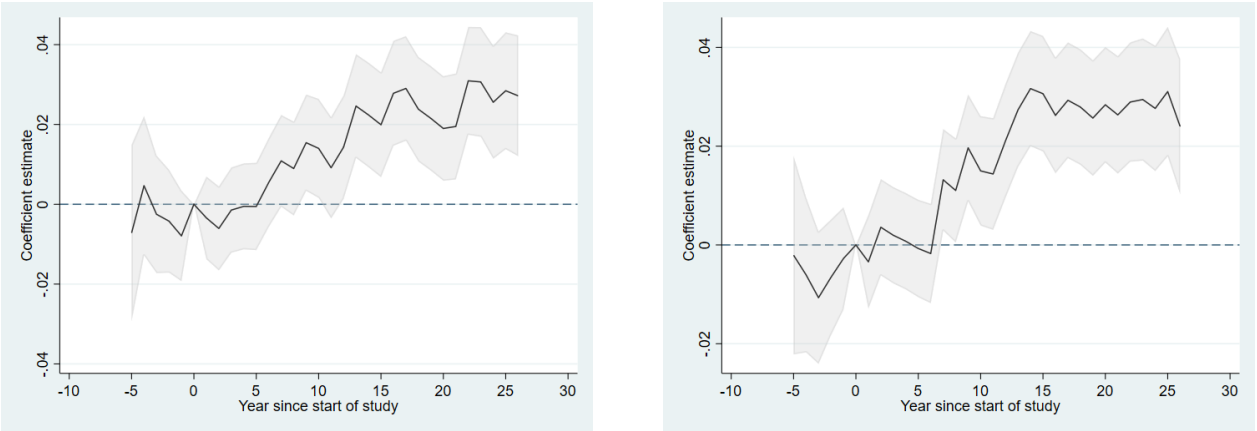
(a) Fathers **(b)** Mothers



Note: Estimates (with confidence intervals) from an event study comparing the parents of doctors and law school graduates. Based on regressions that include controls for gender and ethnicity of the child, fixed effects for the child's and parent's year of birth, fixed effects for year since start of the study, and fixed effects for the year the outcome is observed.

Figure 4: Parents' medication use by year since start study of their child - event study

(a) Fathers **(b)** Mothers



Note: Estimates (with confidence intervals) from an event study comparing the parents of doctors and law school graduates. Based on regressions that include controls for gender and ethnicity of the child, fixed effects for the child's and parent's year of birth, fixed effects for year since start of the study, and fixed effects for the year the outcome is observed.

5 Conclusion

A large literature shows that even in the presence of universal health insurance coverage there remains inequality in access to health care. It is often argued that information limitations about health conditions and the health care system and differences in the capability to communicate with medical professionals are relevant drivers of this inequality. We test the importance of these mechanisms by investigating if the health outcomes and health care use of parents is affected by whether or not their child is a doctor.

We document that parents have lower mortality rates and lower health care costs when their child is a doctor. When restricting the population to parents of college graduates, differences become smaller, but remain significant. Because doctors are not a random sub-sample of all college graduates, these differences are likely to suffer from selection bias. To estimate causal effects, we exploit admission lotteries to medical school that took place between 1988 and 1999 in the Netherlands.

Our data contain a large range of variables describing health care use and health outcomes. During our observation period, the majority of the parents of the lottery applicants were between 65 and 80 years old and thus in a phase in which health care use is substantial and mortality not negligible. Our findings show that having a child who is a doctor has no impact on parents' longevity or on various measures of their health care use. The results do not change when splitting the sample by gender of the child or by living distance between parent and child. The associations we find for the general population and the population of college graduates are thus driven by selection.

Our results imply that there are no important spillovers from the medical expertise from doctors to their parents. This suggests that the health care system provides high-quality health care and information to all parents. We should stress, however, that our results apply to parents of individuals who applied for medical school, so these parents have relatively high-educated children. Therefore, our results are not conclusive about equality of health care access in general in the Netherlands. Furthermore, our findings pertain to a country with universal health insurance coverage and an explicit policy goal of ensuring equal access to health care.

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A Appendix

A.1 Balancing tests

Table A1: Balancing of applicants' characteristics by outcome of the first medical school lottery application

	Lottery winners		Lottery losers	p-value
Lottery category B				
Female	60.0%		62.3%	0.32
Age at first application	18.0		17.9	0.59
Non-Western immigrant	5.3%		4.6%	0.83
N		1543		
Lottery category C				
Female	63.1%		64.1%	0.40
Age at first application	18.0		18.0	0.11
Non-Western immigrant	4.3%		4.3%	0.65
N		2359		
Lottery category D				
Female	60.0%		61.4%	0.32
Age at first application	18.2		18.2	0.89
Non-Western immigrant	5.8%		5.9%	0.75
N		5316		
Lottery category E				
Female	58.7%		60.4%	0.20
Age at first application	18.4		18.3	0.18
Non-Western immigrant	8.2%		7.8%	0.23
N		5604		
Lottery category F				
Female	56.9%		57.3%	0.59
Age at first application	18.6		18.5	0.07
Non-Western immigrant	11.7%		11.2%	0.20
N		7393		

Note: The p-values in the final column are weighted by the admittance probabilities for students in different years of lottery application.

Table A2: Balancing of parental characteristics by outcome of the first medical school lottery application

	Lottery winners	Lottery losers	p-value
Fathers' annual income in 1999	56742	57112	0.53
Mothers' annual income in 1999	14781	14776	0.99
Annual parental income in 1999	67590	68330	0.37
Fathers' average annual income 1999-2003	53763	53966	0.67
Mothers' average annual income 1999-2003	15184	15236	0.82
Average annual parental income 1999-2003	64909	65635	0.35
Parents married/cohabiting pre-lottery year	82.6%	83.7%	0.05
Fathers' number of children	2.71	2.69	0.39
Mothers' number of children	2.71	2.69	0.42
Fathers' age at birth of applicant	30.49	30.51	0.59
Mothers' age at birth of applicant	28.28	28.27	0.83
Father cannot be linked in data	6.6%	6.0%	0.14
Mother cannot be linked in data	3.4%	2.9%	0.02

Note: Observations are weighted by the inverse probability of winning the lottery for each lottery category-lottery year combination to account for compositional differences between the two groups. The p-values in the final column are weighted by the admittance probabilities for students in different years of lottery application.

A.2 Summary statistics

Table A3: Summary statistics - parental specialist visits

	Fathers			Mothers		
	Full pop.	College	Lottery	Full pop.	College	Lottery
Ophthalmology	14.12%	14.53%	15.02%	14.73%	15.19%	16.11%
Surgery	10.60%	9.91%	9.55%	12.24%	11.87%	11.76%
Neurosurgery	0.96%	0.89%	1.01%	0.92%	0.82%	0.83%
Dermatology	8.57%	10.03%	11.36%	8.81%	10.21%	11.68%
Internal medicine	12.87%	11.93%	11.73%	12.35%	11.25%	11.62%
Cardiology	18.71%	18.26%	18.16%	11.68%	10.84%	11.06%
Neurology	8.37%	8.13%	8.11%	7.52%	6.97%	7.26%
Rheumatology	2.59%	2.42%	2.28%	3.62%	3.44%	3.61%
Geriatrics	1.47%	1.36%	1.30%	1.09%	0.98%	0.94%
Ear, nose & throat	6.78%	6.90%	6.92%	5.57%	5.66%	5.99%
Orthopedics	6.85%	6.71%	6.64%	9.88%	9.66%	10.04%
Gastroenterology	5.59%	5.45%	5.58%	5.21%	5.07%	5.55%
Lung specialist	7.86%	6.62%	6.11%	5.99%	4.83%	4.83%

Note: Observations in columns 1, 2, 4 and 5 are weighted to mirror the age distribution of medical school applicants.

Table A4: Summary statistics - parental hospitalizations

	Fathers			Mothers		
	Full pop.	College	Lottery	Full pop.	College	Lottery
I. Hospital stay						
Duration hospitalization	0.0032	0.0028	0.0029	0.0026	0.0021	0.0021
Acute admission	5.16%	4.43%	4.84%	3.68%	2.96%	3.23%
Top clinical	4.99%	4.78%	5.99%	4.49%	4.17%	5.12%
University medical center	1.84%	1.81%	2.60%	1.38%	1.32%	1.93%
II. Main diagnosis						
Treatable diseases	2.02%	1.82%	1.93%	1.33%	1.02%	1.06%
Preventable diseases	0.94%	0.78%	0.80%	0.71%	0.59%	0.61%
Respiratory diseases	0.82%	0.66%	0.69%	0.60%	0.42%	0.43%
Abdominal hernia	0.57%	0.60%	0.68%	0.13%	0.11%	0.12%
Cholelthiasis & cholecystitis	0.16%	0.14%	0.15%	0.26%	0.21%	0.21%
Lung cancer	0.30%	0.22%	0.24%	0.14%	0.10%	0.11%
Breast cancer	–	–	–	0.34%	0.36%	0.35%
Prostate cancer	0.17%	0.20%	0.25%	–	–	–
Cancers	1.68%	1.61%	1.89%	1.70%	1.68%	1.77%
Liver cirrhosis	0.04%	0.03%	0.04%	0.03%	0.02%	0.02%
Circulatory diseases	3.09%	2.76%	3.04%	1.62%	1.37%	1.43%
Hypert. & cerebrovasc. dis.	0.44%	0.38%	0.38%	0.28%	0.22%	0.23%
Heart failure	0.22%	0.16%	0.18%	0.10%	0.06%	0.05%
Heart attack	0.42%	0.35%	0.34%	0.11%	0.08%	0.07%
Other ischemic heart dis.	0.92%	0.80%	0.86%	0.31%	0.23%	0.28%

Note: Observations in columns 1, 2, 4 and 5 are weighted to mirror the age distribution of medical school applicants.

Table A5: Summary statistics - parental medicine use

	Fathers			Mothers		
	Full pop.	College	Lottery	Full pop.	College	Lottery
Peptic ulcer med.	25.12%	21.74%	21.16%	27.21%	23.02%	23.45%
Diabetes medication	12.70%	9.59%	8.60%	9.89%	6.37%	5.32%
Antithrombotic agents	28.87%	27.02%	26.68%	15.77%	13.50%	14.06%
Diuretics	14.13%	12.44%	11.35%	15.95%	13.27%	12.25%
Beta-blocking agents	23.34%	21.39%	19.98%	20.70%	18.26%	17.20%
Lipid-modifying agents	32.17%	29.43%	28.63%	22.83%	19.38%	18.65%
Corticosteroids	14.80%	14.68%	14.41%	16.36%	15.76%	15.38%
Penicillins	13.71%	13.14%	13.53%	13.88%	12.90%	13.66%
Anti-inflamm./anti-rheum. med.	19.94%	17.84%	16.58%	24.41%	21.44%	20.75%
Opioids	8.04%	6.39%	5.91%	9.99%	7.57%	7.42%
Psycholeptics	7.10%	6.10%	6.01%	10.25%	8.67%	8.99%
Antidepressants	5.86%	5.20%	5.02%	10.73%	9.21%	8.80%
Dementia medication	0.40%	0.43%	0.49%	0.28%	0.28%	0.30%
Nasal preparations	7.61%	8.10%	8.78%	9.41%	9.61%	10.50%
Obstructive airway disease med.	11.92%	9.65%	8.83%	13.26%	10.31%	10.00%
Antihistamines	5.01%	4.94%	5.28%	8.25%	7.82%	8.56%
Anti-infectives	4.03%	3.94%	4.05%	4.46%	4.60%	5.21%

Note: Observations in columns 1, 2, 4 and 5 are weighted to mirror the age distribution of medical school applicants.

A.3 IV-estimates for specific types of health care use

Table A6: IV-estimates of the effects of being a doctor on parental specialist visits

	Fathers				Mothers			
	$\hat{\delta}$	*s.e.*	*p*-val.	FDR *q*-val.	$\hat{\delta}$	*s.e.*	*p*-val.	FDR *q*-val.
Ophthalmology	−0.0133	(0.0109)	0.222	0.482	0.0160	(0.0106)	0.132	0.858
Surgery	0.0097	(0.0079)	0.219	0.482	−0.0041	(0.0086)	0.630	0.896
Neurosurgery	0.0046	(0.0027)	0.085	0.368	0.0006	(0.0023)	0.804	0.896
Dermatology	0.0216	(0.0101)	0.033	0.368	0.0109	(0.0093)	0.241	0.896
Internal medicine	−0.0044	(0.0104)	0.675	0.911	0.0092	(0.0099)	0.354	0.896
Cardiology	0.0114	(0.0130)	0.380	0.617	0.0070	(0.0093)	0.450	0.896
Neurology	0.0022	(0.0075)	0.771	0.911	−0.0037	(0.0066)	0.578	0.896
Rheumatology	0.0018	(0.0052)	0.725	0.911	0.0042	(0.0061)	0.497	0.896
Geriatrics	0.0049	(0.0027)	0.069	0.368	0.0006	(0.0020)	0.752	0.896
Ear, nose & throat	0.0007	(0.0068)	0.917	0.974	0.0039	(0.0060)	0.518	0.896
Orthopedics	0.0090	(0.0068)	0.186	0.482	−0.0010	(0.0080)	0.895	0.896
Gastroenterology	0.0002	(0.0061)	0.974	0.974	0.0124	(0.0060)	0.040	0.516
Lung specialist	0.0081	(0.0075)	0.281	0.523	−0.0010	(0.0065)	0.878	0.896

Note: FDR *q*-values are false-discovery-rate adjusted *p*-values following Anderson (2008). All specifications include controls for gender, ethnicity, age at the first lottery application (in months), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery.

Table A7: IV-estimates of the effects of being a doctor on parental hospitalizations

	Fathers				Mothers			
	$\hat{\delta}$	*s.e.*	*p*-val.	FDR *q*-val.	$\hat{\delta}$	*s.e.*	*p*-val.	FDR *q*-val.
I. Hospital stay								
Duration hospitalization	−0.0000	(0.0002)	0.891	0.892	0.0003	(0.0002)	0.054	0.217
Acute admission	0.0019	(0.0028)	0.499	0.666	0.0031	(0.0023)	0.168	0.336
Top clinical	0.0063	(0.0039)	0.111	0.317	0.0027	(0.0035)	0.436	0.582
University medical center	0.0035	(0.0025)	0.158	0.317	−0.0000	(0.0021)	0.995	0.995
II. Main diagnosis								
Treatable diseases	−0.0004	(0.0016)	0.784	0.976	−0.0015	(0.0012)	0.229	0.459
Preventable diseases	−0.0003	(0.0009)	0.723	0.976	−0.0017	(0.0009)	0.048	0.339
Respiratory diseases	0.0000	(0.0011)	0.975	0.976	−0.0002	(0.0008)	0.778	0.851
Abdominal hernia	−0.0008	(0.0009)	0.370	0.976	−0.0001	(0.0004)	0.778	0.851
Cholelthiasis & cholecystitis	−0.0001	(0.0004)	0.732	0.976	−0.0002	(0.0005)	0.605	0.847
Lung cancer	0.0000	(0.0005)	0.960	0.976	−0.0002	(0.0003)	0.434	0.732
Breast cancer	–	–	–	–	−0.0004	(0.0006)	0.470	0.732
Prostate cancer	0.0012	(0.0006)	0.045	0.212	–	–	–	–
Cancers	0.0039	(0.0016)	0.019	0.148	0.0000	(0.0015)	0.981	0.982
Liver cirrhosis	−0.0004	(0.0002)	0.021	0.148	0.0000	(0.0002)	0.790	0.851
Circulatory diseases	−0.0013	(0.0024)	0.590	0.976	0.0021	(0.0016)	0.183	0.446
Hypert. & cerebrovasc. dis.	0.0004	(0.0007)	0.556	0.976	−0.0007	(0.0005)	0.191	0.383
Heart failure	0.0001	(0.0004)	0.896	0.976	0.0009	(0.0003)	0.001	0.012
Heart attack	−0.0001	(0.0006)	0.837	0.976	0.0004	(0.0003)	0.115	0.446
Other ischemic heart dis.	−0.0007	(0.0012)	0.555	0.976	0.0009	(0.0007)	0.187	0.446

Note: FDR *q*-values are false-discovery-rate adjusted *p*-values following Anderson (2008) We follow Malamud et al. (2017) and Meghir et al. (2018) and classify diseases according to the epidemiological literature as treatable and preventable. Treatable diseases: Tuberculosis (ICD10-codes: A15-A19, B90), Malignant neoplasm of cervix uteri (C53), Chronic rheumatic heart disease (I05-I09), All respiratory diseases (J00-J99), Asthma (J45, J46), Appendicitis (K35-K38), Abdominal hernia (K40-K46), Hypertensive and cerebrovascular disease (I10-I15, I60-I69), Chollelthiasis and cholecystitis (K80-K81). Preventable diseases: Lung cancer (C33-C34), Cirrhosis of liver (K70, K74.3-K74.6) and diseases due to external causes (V, W, X, Y). All specifications include controls for gender, ethnicity, age at the first lottery application (in months), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery.

Table A8: IV-estimates of the effects of being a doctor on parental medicine use

	Fathers				Mothers			
	$\hat{\delta}$	*s.e.*	*p*-val.	FDR *q*-val.	$\hat{\delta}$	*s.e.*	*p*-val.	FDR *q*-val.
Peptic ulcer med.	0.0215	(0.0127)	0.092	0.520	0.0224	(0.0127)	0.077	0.263
Diabetes medication	−0.0107	(0.0105)	0.312	0.787	0.0200	(0.0082)	0.015	0.126
Antithrombotic agents	0.0012	(0.0154)	0.936	0.955	0.0059	(0.0110)	0.593	0.772
Diuretics	−0.0068	(0.0103)	0.507	0.862	0.0116	(0.0107)	0.277	0.588
Beta-blocking agents	−0.0008	(0.0141)	0.954	0.955	−0.0068	(0.0131)	0.605	0.772
Lipid-modifying agents	−0.0026	(0.0166)	0.877	0.955	0.0153	(0.0134)	0.253	0.588
Corticosteroids	0.0079	(0.0089)	0.378	0.787	0.0061	(0.0084)	0.470	0.762
Penicillins	0.0012	(0.0062)	0.848	0.955	0.0045	(0.0063)	0.472	0.762
Anti-inflamm./anti-rheum. med.	0.0228	(0.0083)	0.006	0.101	0.0024	(0.0089)	0.792	0.896
Opioids	0.0082	(0.0045)	0.067	0.520	−0.0037	(0.0054)	0.493	0.762
Psycholeptics	0.0005	(0.0055)	0.921	0.955	0.0009	(0.0069)	0.895	0.896
Antidepressants	0.0035	(0.0072)	0.624	0.955	0.0016	(0.0096)	0.867	0.896
Dementia medication	−0.0022	(0.0017)	0.194	0.787	−0.0023	(0.0012)	0.064	0.263
Nasal preparations	−0.0072	(0.0085)	0.396	0.787	0.0187	(0.0087)	0.032	0.181
Obstructive airway disease med.	0.0078	(0.0096)	0.417	0.787	0.0242	(0.0098)	0.014	0.126
Antihistamines	0.0010	(0.0065)	0.873	0.955	0.0103	(0.0080)	0.197	0.559
Anti-infectives	−0.0031	(0.0035)	0.383	0.787	−0.0018	(0.0038)	0.636	0.772

Note: FDR *q*-values are false-discovery-rate adjusted *p*-values following Anderson (2008). All specifications include controls for gender, ethnicity, age at the first lottery application (in months), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery.

Table A9: IV-estimates of the effects of being a doctor on parental health care by gender of the child

	Sons				Daughters			
	$\hat{\delta}$	s.e.	p-val.	FDR q-val.	$\hat{\delta}$	s.e.	p-val.	FDR q-val.
I. Fathers								
Total costs	206.71	(365.51)	0.572	-	-151.98	(284.44)	0.593	-
GP visit	-0.0162	(0.0160)	0.312	0.975	-0.0266	(0.0141)	0.060	0.120
GP costs	-3.95	(5.04)	0.433	0.434	-6.17	(4.41)	0.162	0.650
Specialist visit (0/1)	0.0007	(0.0229)	0.974	0.975	0.0397	(0.0202)	0.050	0.120
Specialist treatment costs	582.75	(373.51)	0.119	0.434	-67.08	(201.16)	0.739	0.739
Any medication	-0.0007	(0.0176)	0.970	0.975	-0.0064	(0.0158)	0.689	0.689
Pharmacy costs	-93.26	(98.15)	0.342	0.434	38.64	(65.67)	0.556	0.739
Hospitalization (0/1)	0.0045	(0.0082)	0.578	0.975	0.0116	(0.0072)	0.106	0.142
Hospital costs	299.99	(280.61)	0.285	0.434	-176.23	(214.38)	0.411	0.739
II. Mothers								
Total costs	265.61	(291.53)	0.362	-	301.87	(246.66)	0.221	-
GP visit	-0.0310	(0.0143)	0.030	0.121	0.0115	(0.0123)	0.351	0.418
GP costs	-6.82	(5.05)	0.177	0.630	0.26	(4.33)	0.952	0.952
Specialist visit (0/1)	-0.0059	(0.0219)	0.786	0.827	0.0154	(0.0190)	0.417	0.418
Specialist treatment costs	-152.21	(172.48)	0.378	0.630	424.51	(242.19)	0.080	0.319
Any medication	-0.0083	(0.0154)	0.588	0.827	0.0216	(0.0139)	0.118	0.237
Pharmacy costs	30.32	(70.75)	0.668	0.669	59.22	(70.98)	0.404	0.539
Hospitalization (0/1)	0.0018	(0.0080)	0.827	0.827	0.0130	(0.0068)	0.056	0.226
Hospital costs	143.81	(199.87)	0.472	0.630	161.11	(177.19)	0.363	0.539

Note: FDR q-values are false-discovery-rate adjusted p-values following Anderson (2008). All specifications include controls for ethnicity, age at the first lottery application (in months), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery.

Table A10: IV-estimates of the effects of being a doctor on parental health care by living distance

	Distance $\leq$ 40km				Distance $>$ 40km			
	$\hat{\delta}$	s.e.	p-val.	FDR q-val.	$\hat{\delta}$	s.e.	p-val.	FDR q-val.
I. Fathers								
Total costs	-257.68	(329.92)	0.435	-	217.91	(289.05)	0.451	-
GP visit	-0.0017	(0.0133)	0.898	0.969	-0.038	(0.0156)	0.014	0.057
GP costs	-2.88	(4.66)	0.537	0.958	-6.73	(4.56)	0.140	0.489
Specialist visit (0/1)	0.0009	(0.0224)	0.969	0.969	0.0371	(0.0185)	0.045	0.090
Specialist treatment costs	-14.06	(264.52)	0.958	0.958	244.58	(216.20)	0.258	0.489
Any medication	0.0083	(0.0154)	0.589	0.969	-0.0119	(0.0157)	0.450	0.450
Pharmacy costs	-122.83	(85.81)	0.152	0.610	62.18	(68.89)	0.367	0.489
Hospitalization (0/1)	0.0074	(0.0076)	0.330	0.969	0.0093	(0.0071)	0.191	0.255
Hospital costs	-76.07	(258.47)	0.769	0.958	96.35	(214.65)	0.654	0.654
II. Mothers								
Total costs	177.57	(275.27)	0.520	-	348.65	(251.48)	0.166	-
GP visit	-0.0028	(0.0118)	0.813	0.824	-0.0107	(0.0139)	0.442	0.472
GP costs	-2.22	(4.40)	0.615	0.782	-3.45	(4.62)	0.456	0.456
Specialist visit (0/1)	-0.0177	(0.0205)	0.389	0.824	0.0174	(0.0177)	0.325	0.472
Specialist treatment costs	191.80	(185.08)	0.300	0.782	163.378	(212.822)	0.443	0.456
Any medication	0.0064	(0.0131)	0.624	0.824	0.0100	(0.0139)	0.472	0.472
Pharmacy costs	25.11	(90.73)	0.782	0.782	69.51	(54.44)	0.202	0.456
Hospitalization (0/1)	0.0016	(0.0071)	0.824	0.824	0.0133	(0.0070)	0.058	0.233
Hospital costs	92.99	(189.19)	0.623	0.782	193.92	(182.11)	0.287	0.456

Note: FDR q-values are false-discovery-rate adjusted p-values following Anderson (2008). All specifications include controls for gender, ethnicity, age at the first lottery application (in months), fixed effects of the birth year of the applicant and parent, and fixed effects for the lottery category interacted with the year of first lottery.

A.4 Classification of hospital diagnoses and prescription drug use

Table A11: ICD10-codes used to determine main diagnosis in case of hospitalization

Condition	ICD10-code
Respiratory diseases	J00-J99
Abdominal hernia	K40-K46
Hypertensive and cerebrovascular diseases	I10-I15, I60-I69
Chollelthiasis and cholecystitis	K80, K81
Lung cancer	C33, C34
Breast cancer	C50
Prostate cancer	C61
All cancers	C00-C97
Liver cirrhosis	K70, K74.3-K74.6
All circulatory diseases	I00-I99
Heart failure	I50
Heart attack	I21, I22
Other ischemic heart diseases	I20, I23, I24, I25

Table A12: ATC4-codes used to identify prescription drug use

Medication	ATC4-code
Drugs for peptic ulcer & gastro-oesophageal reflux disease	A02B
Diabetes medication	A10A, A10B, A10X
Antithrombotic agents	B01A
Diuretics	C03
Beta-blocking agents	C07
Lipid-modifying agents	C10A, C10B
Corticosteroids	D07A, D07B, D07C, D07X
Penicillins	J01C
Anti-inflammatory/anti-rheumatic medication	M01
Opioids	N02A
Psycholeptics	N05
Antidepressants	N06A
Dementia medication	N06D
Nasal preparations	R01A
Obstructive airway disease med.	R03
Antihistamines	R06A
Anti-infectives	S01A