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Do Doctors Improve the Health Care of Their Parents? Evidence from Admission Lotteries[†]

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To assess the importance of unequal access to medical expertise and services, we estimate the causal effects of having a child who is a doctor on parents' mortality and health care use. We use data from parents of almost 22,000 participants in admission lotteries to medical school in the Netherlands. Our findings indicate that informal access to medical expertise and services is not an important cause of differences in health care use and mortality. (*JEL* H51, I11, I12, I14, I18)

Many policymakers 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 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 (Chou et al. 2006; Johnson and Rehavi 2016; Grytten, Skau, and Sørensen 2011; Leuven, Oosterbeek, and de Wolf 2013; Chen, Persson, and Polyakova 2019; Frakes, Gruber, and Jena 2021). The idea in these studies is that doctors and their relatives have full access to medical expertise and 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 and access to services 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

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profession, which may be related to their initial health condition or their attitudes toward 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 nondoctors (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. 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. At the moment the child applies to medical school, parents have long completed their education and made their occupation choice and other major labor market decisions. Therefore, parents of students who were admitted to medical school on the basis of lotteries are on average similar to the parents of applicants who lost the admission lottery, which eliminates selection bias. Furthermore, 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.

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 healthily 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 does not need to 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 a general practitioner (GP). Or they may provide additional information to the GP 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] All forces operate in the direction of lowering the mortality of doctors' parents, which

[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 United States. Grytten, Skau, and Sørensen (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, Gruber, and Jena (2021) find that military doctors in the United States do only slightly better than other military officers. Using Swedish admission lotteries to medical school and an event study comparing doctors to lawyers, Chen, Persson, and Polyakova (2019) find that relatives of doctors have more favorable health outcomes.

[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

is our key outcome variable. 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.

We use data from different registers that are available at Statistics Netherlands and that can be linked at the individual level and at 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 and costs, covering the full population.

When we consider the full population independent of children's level of education, we find strong associations between children having a medical degree and parents' mortality and health care use. Fathers and mothers of doctors live longer, have lower health care costs, and are less likely to visit a GP, to be hospitalized, or to take any prescription medication. They are, however, 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 on mortality that are close to zero and not significantly different from zero. For health care use and costs, most estimates are not significantly different from zero, although for some outcome variables estimates are too imprecise to rule out substantial effects. Taken together, the results indicate that having access to medical expertise and services through a child who is a doctor is not an important cause of differences in parents' health care use and mortality.

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 toward high-SES groups.[3] Second, to the literature on the effect of education on health outcomes, which shows mixed findings about the causal impact of education on health.[4] 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.[5] Our paper is most closely related to Chen, Persson, and Polyakova (2019), who study the same research question using admission lotteries

available to meet parents. Both channels are probably of second-order importance in a small country like the Netherlands with extensive universal health insurance.

[3] See Van Doorslaer, Masseria, and Koolman (2006) and Van Doorslaer, Koolman, and Jones (2004). Individuals with higher education and/or income have better access to primary care (Angerer, Waibel, and Stummer 2019; Olah, Gaisano, and Hwang 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 nonemergency hospital treatment (Moscelli et al. 2018; Monstad, Engesæter, and Espehaug 2014; Siciliani and Verzulli 2009).

[4] Higher-educated individuals live longer and are in better health throughout the life-span. The evidence on a causal link is, however, mixed. Lleras-Muney (2005); Oreopoulos (2006); and Van Kippersluis, O'Donnell, and van Doorslaer (2011) find that more education improves health outcomes, but Clark and Royer (2013); Meghir, Palme, and Simeonova (2018); and Malamud, Mitrut, and Pop-Eleches (2021) find no support for this. See Galama, Lleras-Muney, and van Kippersluis (2018) and Eide and Showalter (2011) for reviews.

[5] 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

to medical school in Sweden and an event study comparing health outcomes of relatives of doctors and lawyers.[6] Their results differ from ours. After the presentation of our findings, we discuss possible reasons for these differences.

This paper proceeds as follows. Section I provides details on the health care system in the Netherlands and the admission lotteries. Section II describes the data. Section III first discusses the associations between having a child who is a doctor and parents' mortality and health care use, then it introduces the empirical approach and presents instrumental variables estimates of the causal effects. Section IV summarizes and concludes.

I. Institutional Background

This section first gives a brief overview of the Dutch health care system. Next, it describes the admission lotteries to medical school and the study program to become a doctor.

A. *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 €1,200. 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 (in 2019) for health care costs,[9] 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

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.

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

[7] The discussion in this subsection relies on Wammes, Jeurissen, and Westert (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, paramedic 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] People can reduce their insurance premium by taking additional deductibles up to €500 per year. These voluntary deductibles are not very popular and particularly not among older individuals. In our sample of parents of medical school applicants, less than 7 percent have some additional deductible, and there is no significant difference between parents of lottery winners and lottery losers.

the age of 18.[10] 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, Jeurissen, and Westert 2014).

The Netherlands spent 9.9 percent of its GDP on health care in 2018, which is similar to most other OECD countries but considerably lower than the health care expenditure of the United States, which in the same year amounted to 16.9 percent of its GDP (OECD 2020b). Primary care is foremost provided by GPs, who act as gatekeepers for access to hospital and specialist care. Only 7 percent of contacts with a GP result in a referral to secondary care (Kroneman et al. 2016). With 3.3 doctors per 1,000 inhabitants, the density of doctors in the Netherlands is similar to that in other OECD countries (OECD 2020a).

B. *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.[11] Some study programs require that students have followed specific subjects at secondary schools, but programs are not allowed to select students based on grades or other student characteristics.[12] A number of study programs have quotas that limit how many students can be admitted. For medical school, the quota was introduced in response to the drastically increasing number of applicants at the end of the 1960s, which exceeded the number of study places available.[13]

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.[14] 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.[15] The category Other includes students who did not take the

[10] In addition to the deductible, individuals need to share some costs for selected services such as medical transportation via copayments, 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.

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

[12] 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.

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

[14] 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.

[15] 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.

Table 1—Lottery Categories

Category	GPA	Weight	Share (percent)
A	$8.5 \leq \text{GPA} \leq 10$	2.00	1.7
B	$8.0 \leq \text{GPA} < 8.5$	1.50	5.4
C	$7.5 \leq \text{GPA} < 8.0$	1.25	8.6
D	$7.0 \leq \text{GPA} < 7.5$	1.00	20.8
E	$6.5 \leq \text{GPA} < 7.0$	0.80	22.1
F	$6.0 \leq \text{GPA} < 6.5$	0.67	29.9
Other	—	1.00	11.5

Notes: 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.

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.

C. *The Study Program*

During our observation period, the study program at medical school consisted of up to three phases (Ketel et al. 2016). In the first phase, students follow four years of full-time medical education to receive their undergraduate diploma.[16] In the second phase, students receive two more years of on-the-job training, which qualifies them 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. Less than 20 percent of those who enroll in medical school stop after the second phase and seek employment as *basisarts*. The vast majority continue to the third phase and enroll in a specialization track, which commonly includes obtaining 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.

II. Data

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

[16] Like in other European countries, the structure of university education in the Netherlands is different from that in the United States. Students immediately enter a specific field of study (such as medicine, law, or economics), and their entire curriculum is in that field.

A. *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.[17]

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 (Statistics Netherlands 2020p). 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.[18]

From the lottery register we exclude applicants of whom at least one parent is registered as a doctor in the register of health care professionals (Statistics Netherlands 2020c) because for these parents, having a child who is a doctor adds little medical expertise. This eliminates 12.9 percent of the applicants who won their first lottery and 12.2 percent of the applicants who lost their first lottery ($p = 0.083$). The register of health care professionals was established in 1994 and mandated every health care professional to be registered in order to practice in the Netherlands.[19] 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.[20] The mortality register contains all deaths from 1995 until 2019 (Statistics Netherlands 2020f), 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 provided by different institutions. We have access to health care costs that are reimbursed by the basic health insurance package (available from 2009 to 2017) (Statistics Netherlands 2020v), specialist visits and treatment costs (2013–2017) (Statistics Netherlands 2020r), and prescription medicine use coded according to the four-digit Anatomical Therapeutic Chemical (ATC4) classification (2006–2017) (Statistics Netherlands 2020q). The register on prescription drugs covers medicine that is (partially) reimbursed by the statutory health insurance but excludes

[17] Individual-level demographic variables stem from the person registry (Statistics Netherlands 2020g) and the household registry (Statistics Netherlands 2020e). Children and parents can be linked using Statistics Netherlands (2020m).

[18] We also drop applicants from lottery category A because only 68 applicants in this category lost the first lottery; 42 of them were admitted to medical school in the next year.

[19] We cannot identify parents with a medical degree who were never registered because they stopped working as health care professionals 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 a nurse. This does not alter the conclusions.

[20] For 5.9 percent of the lottery applicants in our sample, we cannot link a father, and for 3.0 percent, we cannot link a mother.

drugs provided in hospitals and nursing homes.[21] We use hospitalization records (1995–2017) (Statistics Netherlands 2020o, n), 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.[22]

Our measure of total annual costs comprises all health care costs covered by basic health insurance, which includes GP, pharmacy and hospital costs, costs for paramedic care, mental health care, geriatric rehabilitation, home care, patient transports, oral care, health care provided abroad, and some other health care. Annual hospital costs include both inpatient and outpatient costs. Annual total, GP, pharmacy and hospital costs are from the data on reimbursements of the basic health insurance package; annual GP visit is also based on these data and equals one if there were positive GP consultation costs within a year. Specialist visit and treatment costs are from the records of diagnosis treatment combinations. Most specialist costs are also included in hospital costs of the basic health insurance package. All costs are converted to euros in 2015 and describe the combined spendings borne by the insurer and the out-of-pocket payments of the patient. In the year that parents die, we consider unadjusted health care costs for that year.[23] Observations for the years after dying are ignored in the empirical analysis.

In addition to the sample of lottery participants, we also use the Statistics Netherlands register data to construct a sample from the general population containing all individuals born between 1967 and 1982 and their parents. We refer to this sample as the "full population." The children in this sample have 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."[24] The "full population" and "college graduates" are used to determine associations between having a child who is a doctor and parents' mortality and health care use.[25]

B. *Descriptive 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 winning a subsequent lottery.[26] Almost all lottery winners enroll in a study program in the

[21] 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.

[22] 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.

[23] Health care costs are highest just before dying, so annualizing costs for people who die early in the year would give extreme observations.

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

[25] Information on educational attainment for the lottery applicants and "college graduates" is drawn from Statistics Netherlands (2020j, i, k, l).

[26] The reapplication rate among first-time lottery losers in category B is 81 percent. This rate decreases with lottery category, i.e., with the weight individuals receive in the lottery, to 67 percent in category F.

Table 2—Sample Description by Outcome of the First Lottery

	Winners	Losers
Enrollment in medical school	93.8%	45.1%
Completion of medical school	82.4%	40.8%
Enrollment in a study program in NL	99.5%	96.3%
Completion of a study program in NL	96.1%	93.2%
Registration as doctor	80.6%	42.5%
Registered as GP	28.8%	30.9%
Registered as specialist	54.4%	51.9%
Registered without specialization	16.8%	17.2%
Observations	10,209	11,998

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 a study program in the Netherlands.

The bottom panel shows that almost all lottery winners who complete medical school also register as a 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 53 percent register as specialists, and about 17 percent either do not specialize or work as social doctors.[27]

Table 3 shows that pretreatment characteristics do not differ significantly between the parents of the winners and losers of the first lottery for medical school. The only exception is the 0.9 percentage point difference in the shares of parents being married or cohabiting in the pre-lottery year, which is significant at the 10 percent level.[28] Table A1 in online Appendix A.1 shows balancing of pretreatment characteristics of the applicants to medical school. None of the differences is significantly different from zero.

Table 4 lists the fields of study chosen by lottery losers who pursue another study in the Netherlands. The most popular alternative fields of study are within social sciences (Business and Economics, Psychology) and sciences (Science, Mathematics, and Computing). Some lottery losers enroll in programs that have some health component (Nursing and Dentistry), but these programs yield considerably less medical knowledge than medical school and do not allow to practice medicine.

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

[28] Information on marriages and registered partnerships is drawn from Statistics Netherlands (2020h), information on cohabitation from Statistics Netherlands (2020t). Annual earnings are computed as the sum of income from employment (Statistics Netherlands 2020b), income from self-employment (Statistics Netherlands 2020u), income from abroad (Statistics Netherlands 2020a,) and income from other sources (Statistics Netherlands 2020s).

Table 3—Balancing of Parental Characteristics by Outcome of the First Medical School Lottery Application

	Lottery winners	Lottery losers	*p*-value
Fathers' annual income in 1999	56,713	57,059	0.54
Mothers' annual income in 1999	14,785	14,775	0.99
Annual parental income in 1999	67,666	68,415	0.37
Fathers' average annual income 1999–2003	53,739	53,906	0.69
Mothers' average annual income 1999–2003	15,186	15,234	0.83
Average annual parental income 1999–2003	64,981	65,706	0.35
Parents married/cohabiting pre-lottery year	86.8%	87.7%	0.07
Fathers' number of children	2.75	2.72	0.32
Mothers' number of children	2.70	2.68	0.45
Fathers' age at birth of applicant	30.5	30.5	0.68
Mothers' age at birth of applicant	28.3	28.3	0.84

Notes: 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 based on regressing the characteristics on an indicator for winning the first lottery and fixed effects for the lottery category interacted with the year of first application.

Table 4—Study Fields of Lottery Losers (Enrolled)

Field	Share (percent)
Business and Economics	12.5
Science, Mathematics, and Computing	10.7
Psychology	10.0
Health (e.g., Nursing, Dentistry)	8.8
Law	8.3
Pharmacy	7.9
Health Science, Movement Science, and Health Care Management	7.8
Education	7.2
Medical Diagnostics and Treatment Techniques	6.7
Engineering, Manufacturing, and Construction	6.5
Humanities and Arts	4.5
Therapy and Rehabilitation	3.3
Others (Social Sciences, Agriculture and Veterinary, Services, Welfare)	5.8

III. Results

This section first reports OLS estimates of the correlation of having a child who is a doctor and parents' mortality and health care use in our three samples. Next, we exploit the admission lotteries for medical school 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 health care use. Our main finding is that while the correlations are substantial, the causal effects show no evidence of large effects of having a child who is a doctor on parents' health care use and mortality.

A. *Association of Having a Child Who Is a Doctor with Parental Health Outcomes*

We first regress within the full population the different outcome variables of parents on whether their child is registered as a 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 outcome variables 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 nondoctors, the estimates should be interpreted as associations rather than causal effects.

Fathers of doctors are 7 percentage points less likely to have died by the end of 2019 compared to fathers of children not practicing as doctors, and this difference is 4.5 percentage points for mothers. The annual health care costs of parents of doctors are over €500 lower. These lower costs are due to 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. They are, however, 0.8 to 1.0 percentage points more likely to visit a specialist.

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 are no longer significantly different from zero, particularly for mothers. The negative association of the child being a doctor with fathers' (mothers') mortality reduces to 2.8 (1.3) percentage points. The estimate for the difference in total health care costs declines to about €100.

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 nondoctors decrease substantially compared to the results in both other panels and many of the estimates are not significantly different from zero. 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.

B. *Causal Evidence from Admission Lotteries*

Within the full population, parents of doctors have lower mortality and lower health care use and costs than parents of nondoctors. A substantial part of this difference is due to selection. Restricting the control group to parents of nondoctors who are more similar to the doctors reduces the differences. Still, even in the sample of lottery participants, doctors are not a random subsample 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 parents' mortality and health care use and costs.

Table 5—Association of Child Being a Doctor with Parental Mortality and Health Care Access, Use, and Costs

	Fathers			Mothers		
	Mean	$\hat{\beta}$	SE	Mean	$\hat{\beta}$	SE
Panel A. Full population						
Mortality (by 12/31/2019)	0.248	−0.070	(0.003)	0.139	−0.045	(0.002)
Total costs	4,533	−547.64	(42.22)	3,711	−523.52	(34.74)
GP visit (0/1)	0.838	−0.014	(0.002)	0.870	−0.013	(0.002)
GP costs	139	−21.92	(0.67)	141	−22.33	(0.65)
Specialist visit (0/1)	0.598	0.008	(0.003)	0.568	0.010	(0.003)
Specialist treatment costs	2,228	−207.38	(36.12)	1,694	−170.59	(30.29)
Any medication	0.836	−0.017	(0.002)	0.860	−0.013	(0.002)
Pharmacy costs	624	−91.47	(10.55)	551	−92.01	(9.08)
Hospitalization (0/1)	0.139	−0.013	(0.001)	0.129	−0.010	(0.001)
Hospital costs	2,950	−274.18	(32.22)	2,218	−227.84	(23.25)
Observations		3,057,971			3,220,845	
Panel B. College graduates						
Mortality (by 12/31/2019)	0.212	−0.028	(0.003)	0.113	−0.013	(0.002)
Total costs	4,075	−132.25	(42.27)	3,209	−72.13	(34.88)
GP visit	0.837	−0.012	(0.002)	0.866	−0.010	(0.002)
GP costs	127	−10.57	(0.67)	126	−8.96	(0.65)
Specialist visit (0/1)	0.599	0.011	(0.003)	0.565	0.016	(0.003)
Specialist treatment costs	2,050	−35.84	(36.02)	1,517	−0.79	(30.14)
Any medication	0.823	−0.002	(0.002)	0.843	0.002	(0.002)
Pharmacy costs	553	−24.17	(10.58)	459	−8.09	(9.15)
Hospitalization (0/1)	0.129	−0.002	(0.001)	0.116	0.002	(0.001)
Hospital costs	2,680	−39.08	(32.26)	1,967	−11.44	(23.34)
Observations		950,881			985,496	
Panel C. Medicine lottery participants						
Mortality (by 12/31/2019)	0.191	−0.009	(0.005)	0.105	−0.010	(0.004)
Total costs	3,986	−52.18	(80.53)	3,173	−50.69	(64.71)
GP visit	0.830	−0.011	(0.003)	0.859	−0.005	(0.003)
GP costs	119	−6.00	(1.25)	120	−5.91	(1.23)
Specialist visit (0/1)	0.607	0.016	(0.005)	0.582	0.002	(0.005)
Specialist treatment costs	2,044	17.54	(63.76)	1,533	29.84	(47.50)
Any medication	0.822	0.006	(0.004)	0.845	0.010	(0.003)
Pharmacy costs	539	−24.14	(22.62)	459	2.39	(16.70)
Hospitalization (0/1)	0.127	0.002	(0.002)	0.116	0.002	(0.002)
Hospital costs	2,652	6.86	(60.87)	1,963	−25.45	(44.09)
Observations		20,900			21,547	

Notes: Cluster-robust standard errors are 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. All costs are converted to euros in 2015. The means in panels A and B are weighted to mirror the age distribution of medical school applicants.

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 a linear term for applicant's age at first lottery

participation,[29] 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.[30] When estimating the effect on mortality, Y is an indicator equal to one if the parent died before the end of the observation period and zero otherwise. Subscript t is then dropped, and α is an intercept rather than a fixed calendar time effect.[31]

Compliance with the result of the first admission lottery is imperfect (see Section IIB). Not all winners of the first lottery enroll in medical school, and some drop out before completing their degree and being registered as a doctor. A substantial fraction of lottery losers reapply 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: $E\left[U_{it}|X_i, LC_i, LR_{1i}\right] = E\left[U_{it}|X_i, LC_i\right]$. This is supported by the balancing shown in Table 3 and online Appendix Table A1. 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 panel A of Table 6 and show that the outcome of the first admission lottery is a strong instrument. The F-statistics are above 3,000. Winning the first lottery increases the probability to become a doctor by 36 percentage points. Because lottery losers may opt for other health-related fields of study or register as another type of health care professional, we consider two alternative first-stage regressions. Panel B shows that winning the first lottery increases the probability to enroll in any health-related field of study with 25 percentage points. Panel C shows

[29] Age is measured as a continuous variable in years based on exact birth dates.

[30] Less than 5 percent of the parents have more than one child participating in the lottery. In our main analysis, these parents appear twice, and we correct for this by clustering standard errors at the parent level. The alternative is to exclude families with siblings participating in the admission lottery or to only consider the oldest sibling we observe in our sample. In both cases, the general pattern is that p-values increase.

[31] Most outcome variables are available from 2006 or later onward (see Section IIA), which is at least six years after participation in the first lottery (recall that we limit the sample to parents of medical school applicants in the years 1988 to 1999). The exception are outcome variables retrieved from hospitalization records, which are available from 1995 onward. For analyses based on these records, we include parents in the sample from six years after the first lottery in which their child participated onward.

Table 6—First-Stage Estimates

	Mean	$\hat{\lambda}$	SE	*F*-statistic	Observations
Panel A. Child being a doctor					
Fathers	0.429	0.359	(0.007)	3,030.4	20,900
Mothers	0.428	0.359	(0.006)	3,128.8	21,547
Panel B. Child enrolled in a health field					
Fathers	0.622	0.253	(0.006)	1,847.2	20,900
Mothers	0.620	0.253	(0.006)	1,895.0	21,547
Panel C. Child registered as health care professional					
Fathers	0.521	0.296	(0.006)	2,168.0	20,900
Mothers	0.519	0.296	(0.006)	2,215.8	21,547

Notes: Cluster-robust standard errors are in parentheses. All specifications include controls for gender, ethnicity, age at the first lottery application, 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.

that the probability to be registered in the Dutch registry of health care professionals, which comprises doctors, nurses, dentists, pharmacists, midwives, physician assistants, and physiotherapists, increases with about 30 percentage points for both parents.[32] Both alternative first stages yield somewhat smaller estimates, but they remain sizable and highly significant.

Parental Mortality.—Panel A in 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 2019. The IV estimates are small and not significantly different from zero, implying that a child who is a doctor does not prolong parents' lives. The IV estimates are only around 5 percent of the earlier reported full population correlations. Taking the size of the standard errors into account, we can rule out with 95 percent probability effects on mortality larger than half the size of the conditional correlations found in the full population (cf. Table 5). The results are robust to restricting the sample to parents born before 1945 and considering mortality as having died before the age of 75.

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.[33] The hazard rate model includes the same regressors and fixed effects as the linear regression model discussed above. Panel B in Table 7 presents the marginal effects. It shows estimates on the full sample and on the restricted sample of parents born before 1945 (potentially reaching at least age 75 during the observation period), respectively. The effects are small and not significantly different from zero.

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

[32] The registry also includes psychologists and psychotherapists, which we do not consider as health professions, as they belong to the field of social science. Including these would slightly reduce the estimates to 0.279.

[33] Instrumental variable approaches do not combine easily with (nonlinear) hazard rate models.

Table 7—Effects on Parental Mortality

Panel A. Effect on parent died by 12/31/2019; IV estimates

	Complier mean	$\hat{\delta}_{IV}$	SE	*p*-value	Observations
Full sample					
Fathers	0.1708	−0.0042	(0.0151)	0.779	20,900
Mothers	0.0965	0.0004	(0.0122)	0.976	21,547
Parents born before 1945					
Fathers	0.1732	0.0115	(0.0251)	0.645	8,620
Mothers	0.1035	0.0020	(0.0252)	0.937	5,948

Panel B. Effect on hazard rate; Cox proportional hazard model

	Baseline hazard	$\hat{\beta}_{Cox}$	SE	*p*-value	Observations
Full sample					
Fathers	0.0149	0.0058	(0.0340)	0.864	20,900
Mothers	0.0083	0.0110	(0.0456)	0.809	21,547
Parents born before 1945					
Fathers	0.0193	0.0333	(0.0552)	0.547	8,620
Mothers	0.0108	0.0126	(0.0869)	0.885	5,948

Panel C. Equality of survivor functions; Wilcoxon rank-sum tests

	χ^2	*p*-value	Observations
Full sample			
Fathers	0.00	0.980	20,900
Mothers	0.45	0.504	21,547
Parents born before 1945			
Fathers	1.34	0.248	8,620
Mothers	0.02	0.894	5,948

Notes: Cluster-robust standard errors are in parentheses. All specifications include controls for gender, ethnicity, age at the first lottery application, 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. The rank-sum tests in panel C control for differences in admission probabilities by lottery categories in the different years.

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 panel C, 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.

Parental Health Care Use and Costs.—Table 8 shows the IV estimates on health care use and costs, separately for fathers (panel A) and mothers (panel B). For fathers, we find no significant effect on total health care costs, while for mothers, the effect on total health care costs is positive, equals €326 (11 percent of the control complier mean), and is significant at the 10 percent level. Taking the size of the standard errors into account, the IV estimates for total health care costs rule out with 95 percent probability effect sizes as large as 72 percent (for fathers) and 11 percent (for mothers) of the conditional correlations for the full population as reported in Table 5. Note that these correlations and the IV estimates have opposite signs.

When looking at separate components of health care use and costs, we see small but marginally significant positive effects on the probability to visit a specialist for fathers and on the probabilities of hospitalization for fathers and mothers. We find

no significant effects on any of the separate cost components. The estimates on specialist treatment and hospital costs are, however, not very precise, so that substantial effects cannot be ruled out. Again, the point estimates of the effects on the cost components have the opposite signs of the conditional correlations reported in Table 5.

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. 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 that were significantly different from 0 at the 10 percent level without a correction are no longer significantly different from 0 based on the FDR q-values.

The estimates in Table 8 consider broad categories of health care use and costs. In online Appendix A.2, we show estimates for finer measures of health care use. We consider the type of specialist visited by the parent (online Appendix Table A2), the characteristics of the hospital visit and the main diagnosis made in hospital (online Appendix Table A3), and the type of medication use (online Appendix Table A4). We do not find effects on the characteristics of the hospital visit (duration, acute admission, top clinical or university medical center) at the 5 percent level, 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 in the hospital, which is a rare event. Overall, the estimates do not indicate that doctors have a substantial effect on the health care use of their parents.

We performed three heterogeneity analyses. We find some evidence that the few significant effects in Table 8 are due to daughters and not to sons (see online Appendix Table A5). Second, we divide the applicant sample by lottery category. To get sufficient power, we group those in categories B, C, and D and those in categories E and F (see online Appendix Table A6). There are only minor differences in favor of categories E and F (students with lower high school GPA). Third, we consider the distance between the homes of the parent and the child.[34] We split the sample in more or less than 40 kilometers' travel distance. Effects are not larger if the distance is shorter (see online Appendix Table A7).

Our findings differ from those of Chen, Persson, and Polyakova (2019), who find favorable effects of being a doctor on health outcomes of relatives in Sweden. The authors use admission lotteries that were conducted when too many applicants had the maximum GPA from high school, which is normally used for admission. The results of the lottery-based analyses are complemented with results from an event-study design in which health outcomes of relatives of doctors are compared to health outcomes of relatives of lawyers.

[34] Individuals' addresses are obtained from Statistics Netherlands (2020d).

Table 8—IV Estimates of the Effects of Being a Doctor on Parental Health Care Use and Costs

	Complier mean	$\hat{\delta}$	SE	p-value	FDR q-value
Panel A. Fathers					
Total costs	3,832.01	64.23	(229.49)	0.780	—
GP visit	0.8299	−0.0137	(0.0091)	0.134	0.179
GP costs	118.86	−4.68	(3.58)	0.191	0.511
Specialist visit (0/1)	0.5809	0.0282	(0.0151)	0.061	0.123
Specialist treatment costs	1,851.58	203.16	(178.60)	0.255	0.511
Any medication	0.8151	0.0030	(0.0110)	0.783	0.783
Pharmacy costs	585.20	−25.75	(56.07)	0.646	0.647
Hospitalization (0/1)	0.1349	0.0108	(0.0054)	0.046	0.123
Hospital costs	2,464.35	95.14	(173.76)	0.584	0.647
Panel B. Mothers					
Total costs	2,922.94	326.45	(192.21)	0.089	—
GP visit	0.8592	−0.0023	(0.0084)	0.787	0.787
GP costs	119.33	−3.06	(3.46)	0.377	0.377
Specialist visit (0/1)	0.5745	0.0050	(0.0144)	0.727	0.787
Specialist treatment costs	1,458.67	172.39	(154.10)	0.263	0.377
Any medication	0.8373	0.0110	(0.0098)	0.264	0.529
Pharmacy costs	415.90	45.98	(51.68)	0.374	0.377
Hospitalization (0/1)	0.1255	0.0092	(0.0052)	0.079	0.317
Hospital costs	1,844.97	179.99	(133.05)	0.176	0.377

Notes: Cluster-robust standard errors are in parentheses. FDR q-values are false-discovery-rate adjusted p-values following Anderson (2008). The FDR q-values are computed separately for fathers and mothers, and for two groups, use indicators (GP visit, specialist visit, any medication, hospitalization) and cost factors (GP costs, specialist treatment costs, pharmacy costs, hospital costs). All specifications include controls for gender, ethnicity, age at the first lottery application, 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.

There are several possible explanations for the different findings in the two studies. First, lottery participants in Sweden are students with the maximum high school GPA, while our analysis excludes students with the highest GPAs because too few of them lost an admission lottery. Heterogeneous effects between top students and other students could then (partially) explain the different results.[35] Second, it may be that in the Netherlands a larger fraction of lottery losers ends up in a health-related study or profession than in Sweden. This would dampen the effect of a doctor in the family in the Netherlands more than in Sweden. Third, the Netherlands is a small and densely populated country where most people live close to a doctor or hospital. This may reduce the importance of a relative with medical knowledge compared to Sweden, which is much larger and more sparsely populated. While some of our results (no heterogeneous effects by grouped lottery categories or by distance between homes of parent and child, and sizable and significant first stages on health-related study or profession) lend no support to these explanations, we cannot rule them out entirely. Finally, the data from Sweden contain information that is not included in our data, such as diagnoses for specialist outpatient visits outside of primary care and more detailed drug prescription data (ATC5 classification instead of ATC4). This allows them to focus on drug prescription conditional on being diagnosed. We have mortality and health care costs as main outcomes, which

[35] As we mentioned in footnote 18, there are too few (complying) lottery losers in top category A to obtain meaningful estimates for this group.

are not considered by Chen, Persson, and Polyakova (2019) in their lottery-based analysis.

Following Chen, Persson, and Polyakova (2019), we also conducted an event-study analysis in which we compare mortality and health care use and costs between the parents of doctors and the parents of lawyers. Online Appendix B describes the analysis and reports the results. When considering the same outcomes as Chen, Persson, and Polyakova (2019), we obtain similar results. The results point to negative effects of having a child who is a doctor on parents' mortality and total health care costs, no significant effects on hospitalization, and positive effects on medication use of mothers. One interpretation of the different findings from the lottery-based analysis and the event-study analysis is that the latter does not fully eliminate selection bias in the Dutch setting. Alternatively, we can regard the estimates from the two designs as different causal effects. The lottery design identifies the effect of the child being a doctor versus the second-best profession, whereas the event-study design identifies the effect of the child being a doctor versus being a lawyer. It can be argued that both effects capture differences in access to the health care system but that the event-study estimates capture a larger gap in medical information than the lottery-based estimates.[36]

IV. 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 mortality and health care use of parents are 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 subsample 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 costs. 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, while effects on parents' health care use and costs are mostly not significantly different from zero. The results do not change when splitting the sample by gender of the child or by the distance between the homes of parent and child. The associations we find for the general population and the population of college graduates are thus driven by selection.

[36] We thank an anonymous referee for this suggestion.

Our results imply that there are no important spillovers from the medical expertise and connections 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 the Netherlands in general.

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