

Medical Occupation Preference under the Influence of the COVID-19 pandemic: The role of social and risk preference

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Abstract

Background: The COVID-19 pandemic has resulted in unprecedented demands on health care workers. This will likely have fundamental and lasting impacts on preferences to work in the medical profession. We examine the influence of the COVID-19 pandemic on medical occupation preferences, focusing on Wuhan. The outbreak of COVID-19 began in Wuhan and served as an exogenous shock on many people's lives, especially those with a career in the medical industry.

Methods: We conducted a survey of 5 686 respondents in China regarding the influence of the COVID-19 pandemic on medical occupation preference. The survey was conducted during March 2020 at a time when the pandemic in Wuhan has just passed its peak. This allows us to capture the most immediate effect from the pandemic. To test the robustness of our results we conducted a complimentary survey in the UK in May 2020 with 1 198 respondents. We also, in December 2020, conducted a field experiment with 428 first and second-year medical students in Wuhan. This allows us to compare students who enrolled before and after the COVID-19 pandemic in Wuhan.

Results: We find that a significant negative impact of the pandemic has on the willingness to let a loved one choose a medical occupation. Individuals who were heavily influenced by the pandemic, i.e. Wuhan residents especially medical workers, express significantly lower medical occupation preferences. Further analysis from Sobel-Goodman mediation tests reveal that around half of the total negative effect can be mediated by enhanced risk aversion and reduced pro-sociality. The UK survey and the field experiment among university medical school students in Wuhan reinforce these findings.

Conclusions: Our results suggest a fundamental change in medical occupation preferences. Medical workers' shift in risk- and social-preferences has caused a reduced medical occupation preference. Non-medical workers and students who are more pro-social and risk-seeking are more likely to choose a medical occupation. This change is already influencing the intake of students into medical school and so will have long term consequences.

Introduction

The novel coronavirus (COVID-19) has led to an unprecedented demand on health care systems in countries across the world. This shock has resulted in inevitable negative consequences for health care workers who had to endure high exposure to the virus, long working hours, high levels of work related stress and the death of colleagues [1-5]. The critical issue we explore in this paper is the consequences of the COVID-19 pandemic for recruitment and retention in health care [6, 7]. To shed light on this issue we focus in particular on medical workers in Wuhan, China, where COVID-19 first appeared.

The COVID-19 pandemic provided a severe shock to the medical system in Wuhan in late January and early February 2020 when tens of thousands of patients poured into poorly prepared local hospitals. Under such conditions, local medical workers suffered from an extremely challenging and stressful working environment [8-11]. It is widely evidenced that such a stressful environment can spillover to

patients, families and the health care system, with negative effects on patient care [12-14], the physical and mental health of medical professionals [15, 16], and, most importantly for our purposes, workers desire to continue in the profession [17-19].

While COVID-19 may negatively impact retention in the medical profession it may have a positive influence on recruitment into the profession. In particular, the COVID-19 pandemic has clearly demonstrated the invaluable role that health care workers play in society. This could lead to an increase in the number of people who want to train as medical workers. For instance, applications to a major medical school in China increased 30% in the year after the breakout of pandemic.ⁱ Similarly, according to the Association of American Medical College (AAMC) there is a 25% to 35% increase in medical college applications in the US, much higher than the average increase of 3% in the past decades [20]. The net effect of the pandemic, in the short, medium and long run, on preferences for working in the medical profession is, therefore, a crucial and fascinating question that is of high importance for public health policymakers.

In this project we offer unique insight on the impact the COVID-19 pandemic could have on the occupation preferences of health care workers and non-health care workers. We first conducted an incentivized online survey of 1 136 medical and 4 550 nonmedical workers in Wuhan and other regions of China between the 12th and 20th of March 2020. This allowed us to examine the immediate effect of the COVID-19 pandemic, during the stringent lockdown of Wuhan that lasted from 23 January to early March of 2020, on medical occupation preference and other related economic consequences such as individual risk-tolerance and pro-sociality. To reduce non-responses among medical workers, who have career development concerns, and non-medical workers, who currently have a job, we asked respondents about their occupational preference for their children (if the respondent was married), or for their partner (if the respondent was not married). We focused on the comparison between Wuhan and non-Wuhan respondents where non-Wuhan serve as a control for areas where the pandemic was less severe. It is assumed that before the pandemic, the occupational preference of residents in Wuhan had no systematic differences from those in other places of China.ⁱⁱ Therefore, the differences in occupational preference between Wuhan and non-Wuhan residents should be driven by the pandemic.

A first objective of the project was to compare the effect of the pandemic on medical workers' occupation preferences. We find that the pandemic has significantly influenced medical occupation preferences. In particular, individuals who suffered more negatively from the pandemic exhibit a reduced preference for a medical occupation. A second, and crucial objective of the project, was to explore the causal reasons why the pandemic is impacting occupational preference. We examined two potential channels that are motivated by the literature on behavior change after unexpected catastrophic events.

Specifically, it is well documented that systematic changes in prosociality and risk taking can occur after natural disasters [22-28]. We, therefore, explored the mediating effect of social- and risk-preferences on medical occupation preference, using the Sobel-Goodman mediation test [29]. Our results indicate that around a half of the total negative effect of the pandemic is mediated by changes in pro-sociality and risk

preference. In other words, people negatively affected by the pandemic become more risk-averse and less pro-social which then makes them less willing to choose a medical occupation (either for their children or a partner).

We test the robustness of this novel finding in two ways. First, we ran an additional field experiment in Wuhan on 428 first and second year medical students. First year students joined after the pandemic while second year students joined before the pandemic and, thus, we were able to test the effect of the pandemic on the social- and risk-preferences of incoming medical students. In the experiment we found consistent evidence of an effect of the pandemic on the social preferences of incoming medical students. In addition, we report the results from a survey conducted in the UK in May 2020 that mirrored the medical occupation preference questions in the Wuhan survey. The survey of 1 198 was a representative sample of the UK at the time it was emerging from its first COVID-19 lockdown. We again find a strong effect of social- and risk-preferences on medical occupation preferences.

ⁱ According to the Xinhua Net report, online applications to Tsinghua Medical College and Union Medical College have increased by nearly 30% compared with last year.

URL: http://www.xinhuanet.com/politics/2020-09/03/c_1126449016.htm

ⁱⁱ Wang et al. (2020) finds that Chinese medical doctors, German medical students and Chinese medical students are very similar in patient-regarding preferences even if they have different living standards in different countries. More evidences support this presupposition is discussed later in the Method section [21].

Methods

Study design

Data collection was performed in three stages. In March 2020 we collected data from 5 686 adults in China who completed an online survey. We used a two-by-two factorial design contrasting between (1) medical and non-medical workers, and (2) Wuhan and non-Wuhan residents. Our sample includes 1 136 medical workers many of whom participated in the front-line anti-pandemic activities.ⁱⁱⁱ As we discuss below, the survey elicited the respondents' willingness for a loved one to choose a medical profession. We use this as a measure for medical occupation preferences.

Our approach utilizes the fact that the COVID-19 pandemic and lockdown policy made Wuhan distinct from other areas of China. By March 12, 2020,^{iv} the total number of confirmed cases in Wuhan was 49 986, accounting for 61.9% of the total number of confirmed cases in China.^v The total number of deaths reached 3 869, accounting for 83.5% of 4 632 reported deaths. Of the 3 000 medical workers in China who had been infected with COVID-19, more than 85% were medical workers in Wuhan. Wuhan was the only city in China whose medical system was being overwhelmed by confirmed cases. Among our medical worker sample from Wuhan, 85.3% reported that their direct family members or friends had been

infected by the virus, which is much higher than the 52.5% of the non-medical sample from Wuhan and the 27.3% of the medical sample from other regions of China.

In May 2020 we collected data from 1 198 adults in the UK who completed an online survey. The survey contained questions mirroring those in the Chinese survey, thus, allowing a robustness check of our findings. By the 20th May the UK had experienced around 35 000 deaths due to Covid.^{vi} This is orders of magnitude more than in Wuhan or China. And extreme stresses on workers in the National Health Service (NHS) were apparent during the pandemic [30]. Morale in the NHS was, however, already low after a decade of real budget cuts [31]. Moreover, the lockdown was associated with strong public support for medical professionals with, for instance, a weekly “clap for carers” [32]. We expected, therefore, that the direct impact of the pandemic on medical occupation preference would be less pronounced in the UK compared to Wuhan. This allows a robustness test for the underlying role of social and risk preferences in medical occupation choice.

In December 2020 we conducted a field experiment with 428 first and second-year students in Wuhan. Second-year students enrolled before the COVID-19 pandemic began while first-year students enrolled after the pandemic. We collect data from both medical and non-medical students. This allows us to conduct a difference-in-difference analysis examining the causal effect from the exogenous shock of the pandemic on the social-preferences and risk-preferences of medical students. Again, this allows a robustness test for the underlying role of social and risk preferences in medical occupation choice.

Ethical approval for the data collected was provided by Wuhan University (China Survey and field experiment) and De Montfort university (UK Study).

Participants

To recruit respondents for our main survey we followed a “social network snowball” (SNS) sampling method. SNS sampling is an appropriate tool for researching “hard to reach” populations that are difficult to study through conventional survey methods [33-36], and it has been found to have no detectable impact on associations among variables [37]. We, therefore, used this approach to collect data from individuals with COVID-19 experiences, especially medical workers.

We shared the survey in multiple private WeChat groups and asked existing survey participants to share the survey among their own colleagues and acquaintances. To ensure that no individual could respond to the survey more than once, we screened responses based on their IP address and WeChat account number. To collect medical worker samples, we submitted the questionnaire to target hospital WeChat groups in Wuhan and other cities. The medical workers' samples included at least six out of the top ten hospitals with the highest number of infected medical workers in China.^{vii} Survey respondents were based in 32 of China's provincial regions (as shown in Figure A1 in the Supplementary Material). More than one in ten percent of respondents were from Wuhan, which is the provincial capital of Hubei Province. A descriptive summary of the survey sample is shown in Table 1.

Participants for the UK survey were recruited using Prolific. The sample was chosen to be representative of the UK population in terms of sex, age and ethnicity. Of the 1 198 participants, 75 (7.5%) were working in the healthcare sector, 28 of them involved in the front line treatment and care of people during the pandemic, and 184 (18.4%) had immediate family working in the health sector.

A total of 428 students from one of the top universities in Wuhan participated in the field experiment. The experiment is composed of four sub-samples varied by the year of study (Freshman n = 210 vs. Sophomore n = 218) and school of admission (non-medico n = 196 vs. medico n = 232).

Table 1 Descriptive Summary

	Wuhan		Non-Wuhan		
	Med	Nonmed	Med	Nonmed	Total
Preference for medical occupation (pooled across married and unmarried)					
WTM	2.5(1.5)	3.6(1.3)	3.9(1.5)	4.1(1.2)	4.0 (1.3)
Preference	0.7(0.7)	1.0(0.7)	1.2(0.8)	1.2(0.7)	1.2(0.7)
Panel a. Selected demographic variables					
Age (proxy)	39.5(10.3)	35.4(10.8)	33.6(10.3)	33.4(9.8)	33.8(10.0)
Male (%)	32.2(46.8)	39.0(48.8)	40.0(49.0)	40.4(49.1)	39.9(49.0)
High education, college or above (%)	97.2(16.7)	93.9(24.1)	84.4(36.3)	78.0(41.4)	80.8(39.4)
High income, 10w-30w or above (%)	56.4(49.7)	53.2(50.0)	34.7(47.6)	30.5(46.1)	33.7(47.3)
Married (%)	84.3(36.4)	61.5(48.7)	71.5(45.2)	64.1(48.0)	65.9(47.4)
No. of children (married)	1.1(0.5)	1.0(0.6)	1.3(0.6)	1.2(0.6)	1.2(0.6)
Panel b. Risk/social preference					
Risk taking	2.8(0.6)	3.0(0.6)	3.6(0.9)	3.3(0.8)	3.3(0.8)
Prosocial	2.9(0.6)	3.0(0.6)	3.6(0.9)	3.3(0.8)	3.3(0.8)
Prefer son (%)	33.2(47.2)	41.2(49.3)	37.7(48.5)	38.4(48.6)	38.3(48.6)
Panel c. Influences from COVID-19, 5-extremely positive, 1-extremely negative					
Family health	3.1(1.3)	2.9(1.1)	3.7(1.2)	3.5(1.2)	3.5(1.2)
Occupational development	3.3(1.3)	2.7(1.2)	3.7(1.3)	3.4(1.2)	3.4(1.3)
Financial status	2.8(1.1)	2.6(1.1)	3.5(1.3)	3.3(1.2)	3.2(1.2)
Mental health	3.1(1.1)	2.9(1.1)	3.8(1.2)	3.5(1.1)	3.5(1.2)
Panel d. COVID-19 experiences					
Participated (frontline anti-pandemic activities, %)	73.9(44.0)	1.6(12.6)	44.8(49.8)	5.1(21.9)	13.8(34.5)
Participated (volunteer work, %)	56.4(49.7)	31.0(46.3)	73.9(43.9)	37.7(48.5)	43.8(49.6)
Family member who is a medical worker (%)	55.0(49.9)	27.5(44.7)	68.9(46.3)	29.6(45.7)	36.8(48.2)

Direct family member was infected (%)	10.4(30.6)	4.5(20.9)	10.5(30.7)	1.0(9.9)	3.1(17.4)
Friend was infected (%)	74.9(43.5)	48.1(50.0)	16.8(37.4)	4.5(20.8)	12.0(32.5)
Sample Size	211	374	925	4 176	5 686

Notes. Expected value or proportion (in terms of %) for key variables. Standard deviations were reported in the last column of the table in the parenthesis. ¹ For post-pandemic expectations, responses of “no preference” were removed from the analysis. The proportion is a comparison between “more” and “less”. For a full analysis of the responses, see Table A3.

Procedures

We administered the main survey online between March 12 and March 20, 2020. Each survey respondent received a payment of 2 yuan for their completion of the survey. In addition, respondents were informed that by answering the survey they could help the research about the pandemic and medical industry. Respondents typically took approximately 5-15 minutes to complete the survey, and we excluded from the sample any respondents who took less than four minutes to complete the survey. This left a total of 5 686 complete survey responses. The survey included 66 questions in total (all survey questions are available in the Supplementary Material). Certain sections of the survey contained jump logic, so respondents only needed to answer a subset of the survey questions.

We constructed two measures of medical occupation preference. First is “individual’s willingness to let their children (or partner if the respondent was unmarried) choose a medical occupation”. This was measured on a 5-point Likert scale from 1 “Not willing at all” to 5 “Extremely willing” and will be denoted WTM. (See Q21 for married and Q31 for unmarried respondents, Supplementary Material). Second, we asked “preference for children’s (or partner’s if the respondent was unmarried) occupation after the COVID-19 outbreak”. This will be denoted Preference and is a direct measure of change in medical occupation intention under the influence of the COVID-19 pandemic. This was measured on a scale of 2 being “More willing to let my children/partner choose a medical job,” 1 being “No change” and 0 being “Less willing to let my children/partner choose a medical job”. (See Q25 for married and Q35 for unmarried in the Supplementary Material.)

Both WTM and Preference are a direct measure of the respondents medical occupational preferences for a loved one. We view this as a proxy for the participants preferences for own occupation. We also note that family influences are crucial for the development of young people’s occupational intentions [38-41]. Similar to those in other countries, parents in China play a crucial role in all aspects of their children’s lives, including critical decision-making points such as choosing a career [42, 43]. Moreover, there is evidence of family ties in the medical profession. For instance, Dal Bo et al. (2009) reports that almost 14% of doctors in the US have fathers who were doctors [44], while George and Ponattu (2018) shows that 10.5% of doctors in India have fathers who were doctors [45]. We believe our two measures of occupation preference are, thus, a robust way of modelling medical occupation preferences.

In the survey we also asked participants their self-evaluated influence from the pandemic along 4 aspects: health, occupation/work, financial status, relationships and mental health (see Q56-Q60 in the Supplementary Material).^{viii} The answers ranged from extremely negatively (1) to neutral (3) and extremely positively (5). These were aggregated to provide a self-reported measure of the impact of the COVID-19 pandemic. Individual risk preference is measured by 13 hypothetical questions adopted from the domain-specific risk-taking scale (DoSpeRT) [46], which is widely used in psychology and economic studies.^{ix} Social preference is measured by 4 additional questions about willingness to engage in other-regarding behavior, such as donate blood, donate money or give up a seat on the bus/metro (see Q41, Q42, Q53, Q55 in the Supplementary Material).

The UK survey was conducted on the 19-20th May with participants recruited using Prolific. Participants were paid £2.50 for completing the survey which took around 5-15 minutes to complete. The survey had a total of 61 questions (all survey questions are available in the Supplementary Material). The UK survey explored a range of issues (other than medical occupation preference) but contained questions that mirrored those in the main China survey about willingness to let children (or partner) choose a medical profession. It also contained similar measures of self-reported impact, risk-taking and social preference.

The field experiment in Wuhan was conducted in December 2020. To elicit individual pro-sociality participants were given an initial endowment of 50 Chinese Yuan and were asked if they wanted to donate part of the endowment to a charity program that supports Amyotrophic Lateral Sclerosis (ALS) patients. This was a real incentivized choice with money going either to the respondent or charity. Risk-preference was elicited using the same 13-hypothetical questions from the DoSpeRT task as with the medical occupational survey described above. Experimental instructions can be seen in the Supplementary Material.

Statistical analysis

We analyze our measures of occupation preference (WTM and Preference) against individual's experience during the pandemic. Our main approach is to assume that there were no systematic differences in medical occupation preference between Wuhan and non-Wuhan residents before the lockdown. If, therefore, we observe differences in medical occupation preference in our sample this is likely due to the COVID-19 pandemic. Given the greater negative impact of COVID-19 in Wuhan we expect Wuhan residents, particularly health care workers, to be more negatively impacted. It can be seen from Table 1 that residents in Wuhan exhibit significantly lower medical occupation preference, especially among medical workers. This is consistent with the negative impact of the pandemic lowering preference for medical occupation. We will refer to as the "Wuhan medical worker effect". We tested the robustness of this effect by running ordered probit regressions with WTM (ranging from 1-5) and Preference (ranging from 0-2) as the dependent variable, controlling for demographic variables (panel a.) and risk and social attitudes (panel b.).

We perform two pieces of analysis to check the robustness of our findings against the assumption that there were no systematic differences in medical occupation preferences before the lockdown. First, we added additional controls for provincial medical conditions, e.g. medical system capacity and medical worker compensation, in the ordered probit regression analysis. Second, we analyzed the relationship between WTM and the self-reported measure of the impact of the COVID-19 pandemic.^x In analysing this relationship there is a potential endogeneity problem caused by self-selection, because individuals who have lower medical occupation preference may be more likely to be negatively influenced by the pandemic. We, therefore, used awareness of medical-related news as an instrumental variable for influence from COVID-19.^{xi} In justifying this approach we found awareness of medical news (either positive or negative) is not a weak instrument for self-evaluated influence from COVID-19 (F-statistic equals 25.39). Second, awareness of medical-related news during COVID-19, such as “More than 3 000 medical workers were infected” may have temporary effects on perceived influence from the pandemic, but could not directly affect medical occupation preference, which shall be formed during long-term evaluation and perception of the attractiveness of medical career. In other words, the instrument affects medical occupation preference only through perceived influences from COVID-19.

A key objective of our project is to explore the channels through which the experience of the pandemic and lockdown could affect medical occupation preference. One hypothesis is that a medical occupation is seen as a risky choice, and the negative experience of the lockdown in Wuhan, and possible burnout among medical workers, made Wuhan residents less risk tolerant. A second hypothesis is that the negative experience of the lockdown could have made Wuhan residents less pro-social which, in turn, would make them less likely to have a preference for a medical occupation. We performed the Sobel-Goodman mediation test to explore the mediation pathway from the pandemic to WTM [29]. In the regression analysis we use robust standard errors and control for demographic variables.

The UK survey data is analyzed using ordered probit regressions with WTM and Preference as the dependent variable. The key independent variables are risk-taking and pro-sociality. We also control for a range of variables including self-reported influence of COVID-19 and whether the respondent is a medical worker or has direct family members who are medical workers.

The field experiment data is analyzed using the non-parametric Mann-Whitney-Wilcoxon test. We compare the amount donated to charity across the four subsamples, freshman or sophomore and medico or non-medico student. We perform a similar analysis for risk-preferences. This allows us to test whether freshman students, i.e. those who enrolled after the pandemic, differ from sophomore students, who enrolled before the pandemic.

ⁱⁱⁱ Front-line anti-pandemic activities are defined as activities directly related to pandemic prevention and the treatment of COVID-19 pneumonia and activities in which a person had direct contact with confirmed or suspected cases.

^{iv} If not separately stated, all case numbers and death numbers are as of this day, which was the time to start collecting the survey.

^v The city with the second-highest number of confirmed cases had only 3 518 patients.

^{vi} Data available at <https://coronavirus.data.gov.uk/details/deaths>

^{vii} Wuhan medical samples were from but not limited to the Zhongnan Hospital of Wuhan University, the Renmin Hospital of Wuhan University, Tongji Hospital, the Hubei Provincial Hospital of TCM, the Maternal and Child Hospital of Hubei Province, Wuhan Central Hospital, Wuhan Third Hospital, Wuhan Fourth Hospital, and the clinics at Wuhan University and the China University of Geoscience.

^{viii} We also planned to collect data on relationships with their family, but due to technical issues the data were invalid and were thus removed from the analysis.

^{ix} We selected 13 out of 30 original questions that were most applicable to and suitable for respondents in China.

^x We focus on WTM but the results also apply to Preference.

^{xi} Specifically, the instrumental variable was derived from the Q15 and Q16 in the survey: “Looking back at the development of the pandemic, which of the following events have had the most psychological impact (motivation or discouragement) on you?”. Among the 15 motivating options, two positive events had the most influence on medical workers, “Medical teams volunteered to assist in Hubei province” and “Medical workers received national cognition award”; on the other hand, among the 15 discouraging options, two negative events/news were mostly correlated with the medical industry, “The death of Dr. Li Wenliang” and “More than 3 000 medical and nursing staff members were infected”.

Results

Wuhan medical worker effect

We first examine whether residents in Wuhan and/or who are medical workers are more likely to state a preference for a medical occupation in our survey. We employed probit regression analysis on respondents’ tendency to choose medical occupation. The analysis shows that medical workers have lower medical occupation preferences and such tendency is mainly driven by medical workers in Wuhan. Medical workers in Wuhan are, *ceteris paribus*, 51.7% less likely to choose “more positive towards medical occupation” compared with the other two categories of negative and neutral (Table A1). Figure 1a depicts the treatment effect from the analysis, and illustrates the size of the “Wuhan medical worker effect”, i.e. significantly lower medical occupation preference among Wuhan residents especially medical workers. The effect remains robust after controlling for personal demographic variables (Table A1) and risk/social preferences (Table A3). Additionally, it is found that education and age are negatively correlated with medical occupation preference, especially for those who are married (Table A1).

Direct influence from COVID-19 pandemic

It is evident that Wuhan medical workers are significantly less favorable toward choosing a medical occupation. Given the timing of the survey this is almost certainly driven by the influence of COVID-19. However, causal interpretations between medical occupation preference and COVID-19 are not certain

because of potential unobserved differences between Wuhan and non-Wuhan occupation preferences before the pandemic. To account for this possibility, we first control for provincial medical conditions, e.g. medical system capacity and medical worker compensation, to capture factors that may influence medical occupation preference (see Table A2). The results remain robust.

We also conducted an analysis based on self-reported levels of influences from the pandemic with awareness of medical-related news as an instrument. Table 2 reports results from the regression analysis. The analysis shows that individuals with a more positive influence from the pandemic have significantly higher willingness to choose a medical occupation. The estimated effect is larger with IV than ordinary order Probit regressions. For one unit SD increase in self-reported influence from COVID-19, the predicted probability of choosing “Extremely likely” is 4.54 (1.41 from model (3)) times greater.

All models control for experiences during the COVID-19 pandemic, e.g. whether the individual participated/volunteered in frontline combat and whether direct family or friends were infected. It is found that participation in voluntary work during the COVID-19 has a positive effect on medical occupation preference, whereas knowledge of friends infection has a negative effect. In addition, the results showed that medical knowledge and respect for medical workers are positively correlated with medical occupation preference. In conclusion, individual medical occupation preference is not only influenced by long-term preferences such as respect for medical workers but also strongly affected by the temporary shock of the COVID-19 pandemic.

Table 2 Regressions of self-reported influences from COVID-19 on WTM

	(1)	(2)	(3)
	IV first stage	IV second stage	oprobit
Dependent variables	Influence	WTM	WTM
Medical-related news			
Negative info 1 (Dr.Li dead)	-0.0482**		
..	(0.0219)		
Negative info 2 (Medical workers infected)	-0.0625***		
..	(0.0226)		
Positive info 1 (Volunteer teams came)	0.0446*		
..	(0.0266)		
Positive info 2 (National recognition award)	-0.0196		
	(0.0303)		
Panel c			
Influence from COVID-19		1.725***	0.206***
		(0.342)	(0.0214)
Panel d			
Participated (frontline)		0.00594	-0.018
		(0.0642)	(0.0642)
Participated (volunteer)		0.124***	0.0986***
		(0.0356)	(0.0358)
Medical (family)		0.0346	0.0315
		(0.0372)	(0.0373)
Direct family infected		0.205*	0.189*
		(0.113)	(0.114)
Friends infected		-0.198***	-0.154**
		(0.0614)	(0.0608)
Medical knowledge		0.0836***	0.0708***
		(0.0181)	(0.0183)
Respect medical workers		0.329***	0.315***

		(0.0244)	(0.0242)
Observations	5 686	5 686	5 686
R ² /Pseudo R ²	0.326	0.147	0.153
Controls	√	√	√

Notes. The measure of influence from the pandemic is derived from the aggregated mean of the self-report measures of influence (see Table 1, Panel c.). All models control for demographic variables and individual risk/social preference (see in Table 1). F-statistics for specification 1: 126.33 (25.39 without control variables).

Sobel-Goodman mediation effect of risk- and social-preference

The results above show strong evidence that the pandemic had a significant negative impact on medical occupation preference. It is also important to know the potential channels through which the pandemic came to influence occupation preference. Based on the previous literature on individual behavior after natural disasters [22-25, 28], we looked into two potential mechanisms - risk-taking and pro-sociality. It can be seen from Table 1 (see also Figure 1b) that there is a striking contrast between Wuhan and non-Wuhan residents in terms of risk- and social-preferences. The contrast is exaggerated by medical occupation. Table 3 reports results from the Sobel-Goodman mediation test that explores the mediation pathway from the pandemic (variable name "Influence from COVID-19") to medical occupation preference as measured by WTM.

Our results indicate that individuals who were less affected by the pandemic (as indicated by a higher measure of "Influence from COVID-19") exhibit significantly higher pro-sociality and more risk-taking (specification 2, 4). And this effect mediates some of the effect of the pandemic on medical occupation preference (as indicated by a smaller coefficient from specification 1 to 3 or 5). The mediation pathway of pro-sociality (risk-taking) carries 45.3% (47.2%) of the total effect from the pandemic to medication occupation preference. These results provide some insight into the causality between reduced medical occupation preference and influence from the pandemic. Specifically, a medical occupation is more likely to be followed by those who are less risk-averse and more pro-social choice. Those who were most affected from the pandemic, e.g. medical workers in Wuhan, became more risk-averse and less pro-social and, as a result, are less in favor of choosing a medical occupation (see Section A.2.3 in the Supplementary Material for more details).

Table 3 Sobel-Goodman mediations tests on medical occupation preference

	Total	Pro-social		Risk-taking	
Dependent variable	WTM	Pro-social	WTM	Risk-taking	WTM
	(1)	(2)	(3)	(4)	(5)
Influence from COVID-19	0.362***	0.376***	0.198***	0.386***	0.192***
	(0.0168)	(0.0111)	(0.0194)	(0.0114)	(0.0195)
Pro-social			0.436***		
			(0.0226)		
Risk-taking					0.443***
					(0.0223)
Constant	3.524***	2.454***	2.454***	2.418***	2.454***
	(0.209)	(0.108)	(0.212)	(0.113)	(0.212)
Observations	5 686	5 686	5 686	5 686	5 686
R-squared	0.222	0.310	0.271	0.310	0.275
% of total effect mediated		45.3		47.2	
Controls	√	√	√	√	√

Notes. Linear regressions models with robust standard errors in the parentheses. Control variables including demographic variables listed in Table 1. To test for mediation effects, we use the Sobel-Goodman method. The two potential mediators that we considered in the model are “pro-social” and “risk-taking”. Our results indicate the two mediators carry some part of the negative effect from influence from pandemic onto medical occupation preference. The proportion of the total effect that is mediated by pro-social is 45.3%, and that for risk-taking is 47.2%. We showed that the partial mediation effect occurs under three conditions (i) The mediators (M) significantly predicts influences from the pandemic (X); (specification 2, 4) (ii) Influence from the pandemic (X) significantly predict medical occupation preference (Y) in the absence of mediators (M); (specification 1) (iii) Mediators (M) significantly predicts medical occupation preference (Y) controls for influence from the pandemic (X); (specification 3, 5) (iv) the effect of the pandemic (X) on medical occupation (Y) shrinks upon addition of mediators (M). In this and the following tables *** p<0.01, ** p<0.05, * p<0.1.

Table 4 Ordered probit regression of occupation preference in the UK

	(1)	(2)	(3)	(4)
Dependent variable:	WTM	WTM	Preference	Preference
Medical worker	-0.141	-0.172	0.00346	0.0486
	(0.142)	(0.154)	(0.147)	(0.164)
Direct family medical worker	0.208**	0.174*	0.130	0.0845
	(0.0820)	(0.0887)	(0.0857)	(0.0954)
Trust for NHS	0.184***	0.193***	0.126***	0.135***
	(0.0296)	(0.0305)	(0.0302)	(0.0322)
Frontline participation	0.266	0.212	0.0189	0.00691
	(0.241)	(0.250)	(0.246)	(0.257)
Risk and social-preference				
Risk-taking	-0.0272	-0.0389	-0.00350	-0.0139
	(0.0752)	(0.0776)	(0.0777)	(0.0814)
Pro-social	0.223***	0.242***	0.134***	0.171***
	(0.0499)	(0.0529)	(0.0505)	(0.0536)
Influences from COVID19				
Influence	-0.0202	-0.0717	0.204***	0.186***
	(0.0584)	(0.0618)	(0.0629)	(0.0655)
Selected demographic variables:				
Male		0.0918		0.220***
		(0.0669)		(0.0693)
Marital status		-0.00276		0.0822
		(0.0793)		(0.0815)
Household size		-0.106***		-0.0828**
		(0.0377)		(0.0384)
Key worker		0.188**		-0.0256
		(0.0931)		(0.101)
Observations	1 198	1 191	1 196	1 189
Pseudo R ²	0.0265	0.0430	0.0202	0.0480

Controls	√	√	√	√
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Notes. Ordered probit regressions with robust standard errors in the parentheses. Omitted demographic variables include: age, ethnic groups, education, income, place of residence, number of children, government’s high risk list for Coronavirus; key worker in the household. Omitted control variables include: contraction from Covid19 (own and immediate family Q28 & friends, colleagues or classmates Q29).

The UK Survey

Given the positivity created around the medical profession in the first wave of the pandemic in the UK we hypothesized there would be a less negative effect on medical occupation choice in the UK than China.^{xii} The results from the UK can be seen in Table 4. Consistent with our hypothesis we did not find evidence of a reduced medical occupation preference among medical workers in the UK. However individuals with more negative influence from the pandemic have higher tendency to change to negative views over “whether they would want a child to work in health care” (Preference, Q52 see in the Supplementary Material). Crucially, consistent with the results from China we find that pro-sociality has a strong positive influence on willingness to choose a medical career. Moreover, it is found that trust for the National Health Service (NHS) is strongly positively correlated with medical occupation preference. This is consistent with the findings in Wuhan that medical knowledge and respect for medical workers significantly increase medical occupation preference. Finally, replicating the findings in Wuhan, the top three reasons for reluctance to encourage a child to work in the healthcare are: “Risk of exposure to viruses”, “Uncertain working hours, and need to be on duty/call” and “Low income”. The results from the UK, thus, reinforce key findings from the Chinese data.

Field experiment among medical school students in Wuhan

The field experiment was designed to allow us to further examine the causal relationship between risk- and social-preference and medical occupational choice as a result of the pandemic. We recruited first- and second-year students from the standard subjects pool in the Center of Behavior and Experimental Research in one of the top universities in Wuhan. The experiment was conducted online with an average duration of around 30 mins and payment of 49.95 Yuan (including 10 Yuan participation payment). We remind that first- and second-year students were admitted just after and before the lockdown in Wuhan, respectively.

Figure 2 presents the main results from the experiment, freshman medico, who were enrolled in medical school after the outbreak of the pandemic, contributed significantly more than freshman non-medico to charity (average donation: 29.39 vs. 21.06; $p < 0.01$). They also contribute more than sophomore medico students who were registered in the year of 2019 before the lockdown (average donation: 24.15; $p < 0.05$). One might argue that there is a self-selection issue that individuals who are more pro-social are more likely to choose a medical major in college. As a control, we also compare the difference of donation between sophomore medico and non-medico, but could not find any significant difference. Thus, the

medical students who enrolled after the pandemic are significantly more pro-social. In terms of risk-preference we do not find statistically significant differences across college majors or years of study.

^{xii} The UK went on to experience a subsequent second wave that was worse than the first in terms of cases, deaths and pressures on the NHS.

Discussion

This article studies the impact of the COVID-19 pandemic on medical occupation preference, as well as the underlying role played by risk- and social-preferences. Our primary data was collected in China when the first wave of cases had just begun to subside. We used an online survey to collect data on more than 5 000 medical and non-medical workers. Our results show that negative experiences during the pandemic have a significant negative effect on the willingness for a loved one (child or partner) to choose a medical occupation. Individuals who had particular negative experiences during the pandemic, e.g. Wuhan medical workers, have significantly lower medical occupation preference. Importantly, further analysis showed that risk- and social-preferences explain around half of the total negative effect from the pandemic on medical occupation preference. Specifically, individuals who were negatively affected by the pandemic tended to become more risk-averse and less pro-social. Medical occupation preference, on the other hand, is associated with risk-seeking and pro-sociality.

To check the robustness of our results from the China survey we collected data in the UK at a time when the UK was the first wave of cases had begun to subside. Consistent with the findings in China, we find that medical occupation preference is positively related with individual risk-taking and pro-sociality. For a further robustness check of the relationship between individual pro-sociality and risk-taking and medical occupation preference we conducted a field experiment in the medical college of one of the top universities in Wuhan among first- and second-year students. The results showed that students who enrolled on a medical major after the peak of the pandemic (first-year medico) contributed significantly more to charity than non-medico students or second year medico students. We could not find any difference among second-year medico and non-medico students who were enrolled before the pandemic. The results offer additional evidence that the pandemic could have shifted social preferences which have influenced medical occupation preferences.

Our results show that the COVID-19 pandemic may have profound implications for recruitment into the medical profession. In particular, the pandemic has likely influenced risk- and social-preferences which will then influence recruitment into the profession as well as retention of existing staff. In particular, we may see an influx of new risk-loving and pro-social workers while also seeing a loss of existing staff who have become more risk-averse and less pro-social. It might be argued that these effects would be short-lived but our results suggest that they have already influenced recruitment of medical staff in Wuhan, China. The effects, therefore, are real and may persist well after the pandemic has subsided. From a policy perspective, we believe that during and after a pandemic, medical workers, especially those in areas where the pandemic is particularly severe, should be given a high level of physical and

psychological support. This is essential for staff retention. Such a view is not new, but we propose a new mechanism to justify this policy, namely that extreme pressure can alter risk- and social-preferences which then result in staff having less desire to stay in the profession.^{xiii}

^{xiii} Additional results regarding the survey questions on future expectations can be seen in the Supplementary Material A.2.4

Declarations

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Authors' Contributions

LJW and LX conceived and design the study. LJW and LX acquired the data of the online survey in China. EC acquired the data of the online survey in the UK. YTG acquired the data of the field experiment in Wuhan University, China. LX, YTG did the statistical analyses. LJW and EC were responsible for general supervision. LJW and LX drafted the initial manuscript. EC substantially edited and critically reviewed the manuscript. YTG finalized the format of the manuscript. All authors reviewed and revised the Article. All authors read the final manuscript and approved submission.

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Data availability statement

The China survey and experimental data will be published in figshare.com upon publication. The UK survey data is available at:

https://figshare.dmu.ac.uk/articles/dataset/Dataset_for_coronavirus_survey_May_2020/12936494

Ethics approval

Ethical approval for the data collected was provided by Wuhan University (China Survey and field experiment) and De Montfort university (UK Study).

Consent for publication

Not applicable

Competing interests

None declare

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Figures

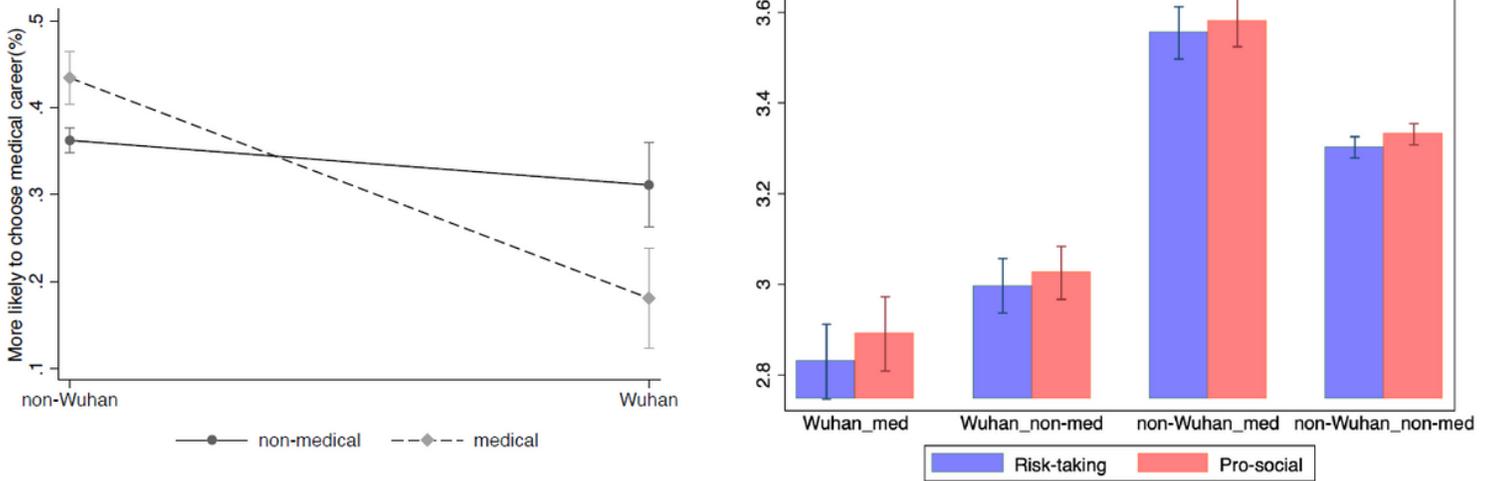


Figure 1

(a) Medical occupation preference by Wuhan and medical workers. (b) Risk- and social-preference by Wuhan and medical workers.

Panel (a) depicts the predicted probability of choosing prefer medical occupation with 95% confidence intervals (derived from post-estimation results based on Table A1 specification 2). Residents in Wuhan are significantly less likely to choose medical occupation ($p < 0.05$), especially for medical workers in Wuhan ($p < 0.01$). Panel (b) explores the underlying mechanism for the stark contrast by looking into risk- and social-preference. It can be seen from the figure that Wuhan residents exhibit significantly less pro-social and more risk-taking than non-Wuhan residents, especially for medical workers.

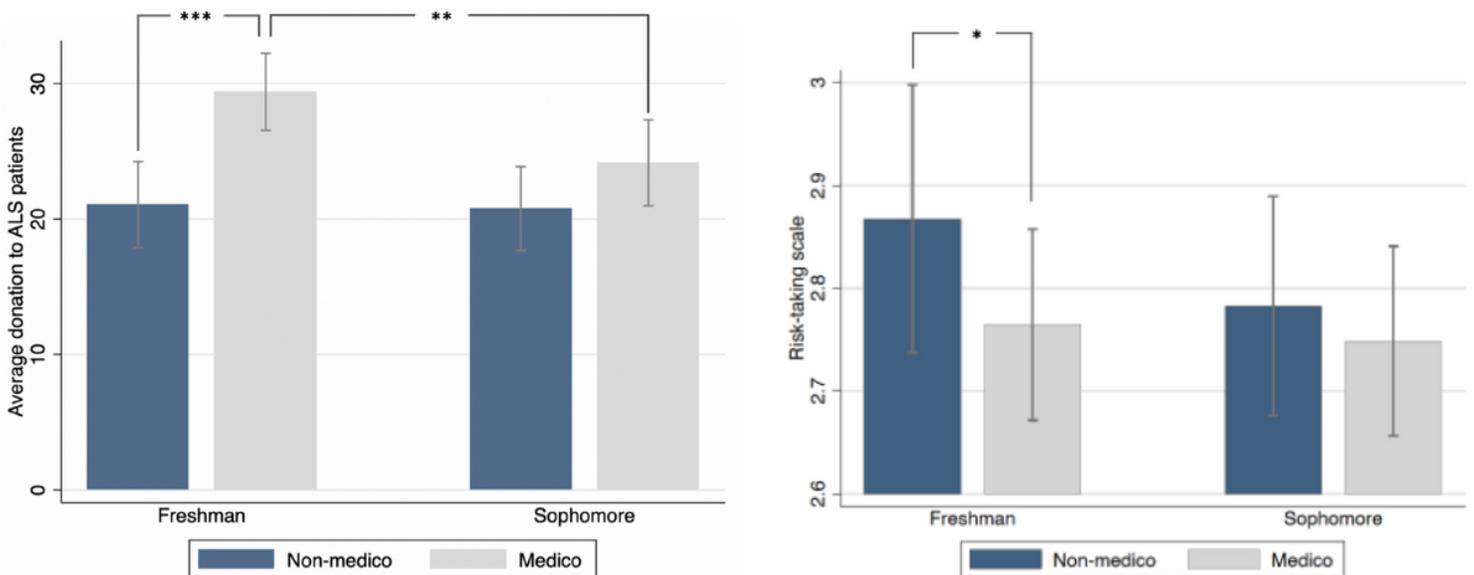


Figure 2

Results from medical school students experiment: Social-preference is measured by average donation to the ALS charity funding (out of initial endowment of 50). Risk-preference is derived from DoSpeRT task

on a scale from 1 to 5, with a higher score indicating more risk-loving.

Supplementary Files

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