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Does medical education reform change who is selected? A national cross-sectional survey from China

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ABSTRACT

Objectives Approximately 10 years ago, China introduced an education plan to improve the overall quality of medical education and to better serve the population’s health needs. Many medical schools were then recognised and financed by China’s Ministry of Education to develop and operationalise new pilot programmes (PPs) aligned with this plan. These ran in parallel with the traditional programmes (TPs). One way to achieve the plan’s first aim, improving the quality of medical education, is to select academically stronger candidates. We, thus, examined and compared who were selected into PPs and TPs.

Design Cross-sectional study.

Setting Data were collected from 123 medical schools across China via the 2021 China Medical Student Survey.

Participants Participants were undergraduate clinical medicine students across all year groups.

Primary and secondary outcome measures Medical school selection was via the National College Entrance Examination (NCEE). Medical students’ NCEE performance and their sociodemographics were used as the primary and secondary outcome measures. Mann-Whitney or χ2 tests were used to compare the means between educational programmes (PPs vs TPs) and various selection outcomes. Multilevel mixed-effects regressions were employed to account for school idiosyncratic selection results.

Results Of the 204 817 respondents, 194 163 (94.8%) were in a TP and 10654 (5.2%) a PP. PP respondents (median=75.2, IQR=69.5–78.8) had significantly higher NCEE scores than their TP counterparts (median=73.9, IQR=68.5–78.7). Holding constant their NCEE score, PP respondents were significantly more likely to come from urban areas, not be first-generation college students, and have parents with higher occupational status and income.

Conclusions Assuming quality can be indicated by prior academic achievement at the point of selection, PPs achieved this mission. However, doing so limited medical students’ diversity. This may be unhelpful in achieving the Education Plan’s goal to better serve China’s health needs.

INTRODUCTION

China has a very complex landscape of medical education linked to key historical events such as the civil war and founding of the People’s Republic of China in 1949. The evolution of medical education in China has recently been described1 but sufficient background is provided here to orient readers.

For many years, China had a multitiered medical education system. Different levels of medical education were offered by secondary specialised schools, junior colleges and universities, which were further distinguished into three quality tier groups according to selectivity or competitiveness (with universities in tier 1 offering the most selective undergraduate medical education programmes).2–5

The consequence of this system was that, at the time of writing this paper, around half of the doctors in China did not have entry-level medical training according to international standards.6 Moreover, the distribution of doctors was, and remains, uneven: higher-qualified doctors are more likely to work in wealthier regions, urban areas and in hospital medicine.6

In 2012, to improve the overall quality of medical education and to better serve population health needs, the Ministry of Education (MOE) and the Ministry of Health jointly issued a policy document encouraging university medical schools to pilot reforms under the name ‘Education Plan for Excellent Doctors’.7–8 This limited medical education to universities (bachelor level or above) plus 3 years of residency training after
graduation. The plan also set out broad expectations in respect of reforming and improving curricula content and delivery.7 9

A total of 125 out of China’s 193 medical schools were then recognised and financed by the Ministry of Education to develop and operationalise new pilot programmes (PPs) aligned with the education plan. Usually, schools continued to deliver traditional programmes (TPs) while piloting their new educational programmes on a small scale (ie, many schools run TPs and PPs in parallel).

Our aim was to examine how this policy change to improve the quality of doctors translated into practice. Given that the reform included the possibility of modifying medical school selection, we posited that an obvious first step in improving the quality of doctors was to improve the quality of medical students. How to define ‘quality’ is open to debate.10–12 However, as the global literature indicates that academic attainment is predictive of future performance in medicine,13–18 in this paper, we adopted a simple definition of quality as something indicated by prior academic attainment. Drawing on contingency theory, which posits that organisations can gain advantages through strategic adaptation,19 20 we hypothesised that medical schools would select academically stronger candidates for PPs compared with TPs, with academic ability indicated by relative performance on China’s National College Entrance Examination (NCEE).

This study adds to literature from other contexts21 22 by providing useful insights into the relative impact of different education systems operating within the same context, at the same time.

METHODS
This was a quantitative study. Data were collected by cross-sectional survey.

Data instrument
Data were collected in June 2021 via the China Medical Student Survey (CMSS) developed and administered by the National Center for Health Professions Education Development (NCHPED). The CMSS was designed in collaboration with an advisory panel of experts in medicine, education and survey methodology, and with reference to the wider literature. Its aim is to collect and collate self-reported data on medical student socio-demographics, educational experiences, achievements and future career aspirations from China’s 193 medical schools.23 The CMSS was piloted in May 2019 in 33 medical schools, first used nationally with new graduates in 2020, and expanded to medical students across all five grades in 2021.

The CMSS enquires about many different aspects of respondents’ educational experiences and achievements. Our specific interest in this study was students’ self-reported data related to demographics, prior academic attainment and selection into medical school: programme (orientation of programmes and TP or PP), year of study (1st–5th), specialty at admission (specified or not), prior academic attainment (PEA, eg, NCEE score) and socio-demographics (socioeconomic status (SES)). Socio-demographic data were relevant to the Chinese context and included ethnicity (Han Chinese/ethnicity minorities), gender (male/female), home location (small towns and villages were classified as rural; county-level cities, prefecture-level cities, provincial capital cities and municipalities classified as urban), parents’ educational attainment (eg, college education), occupation status (measured by the International Socio-Economic Index, ISEI), family members’ backgrounds in medicine and family’s annual income (with ¥10 000 and below classified as poor, ¥15 000 and above classified as high income for analysis purposes). Referring to the households income data of 2021 published by China’s National Bureau of Statistics (http://www.stats.gov.cn/), family income levels of the poor-income and high-income group in our study were at levels of approximately the bottom 10% and top 30% of the general population in the country. In addition, we consulted official school-level data to categorise each medical school in the sample by its geographical region (Eastern/Central/Western China) and quality tier (tiers 1–3, where tier 1 represents the most extensive training).

Recruitment of medical schools and student respondents
In June 2021, NCHPED invited all 193 medical schools offering undergraduate clinical medicine programmes in China to participate in the CMSS. Of these, 123 (63.7%) medical schools accepted the invitation and participated in the survey. These schools represented 67.4% (38 out of 66), 54.1% (33 out of 61) and 69.6% (32 out of 46) of all the medical schools in Eastern, Central and Western regions in China, respectively. One hundred and twenty-five medical schools in China are licensed to run PPs, of which 76 (60.8%) took part in the survey.

Each participating school appointed a study coordinator. NCHPED provided guidance about the process of data collection to these coordinators, including the suggestion to try to recruit 20%–50% of their students in each grade year. This target proportion was chosen on purely practical grounds: the number of potential participants was very high, and opportunities to gather data from medical students in clinical years were limited by the time demands of their clinical rotations.

Potential participants were sent survey details by email or WeChat/Weixin (a popular social networking platform in China) and informed by the coordinators 1 week before data collection that taking part was voluntary. The electronic survey link was distributed to students in June 2021. When students opened the survey link, they were immediately presented with the information sheet and could decide whether to proceed after reading it. Informed consent was implied by questionnaire completion. The survey was anonymous, although students were given the option to provide their school-specific student ID number and contact information if they wished to part
in follow-up surveys. Participating medical schools could use their discretion in terms of survey reminders.

**Statistical analysis**

Our outcome variables were selection results, including prior academic achievement (eg, NCEE score) and sociodemographic variables (eg, gender, ethnicity, rural origin, first-generation college student, parents’ occupation and income).

The key explanatory variable was selection into a PP or TP programme. Other explanatory variables that may affect selection results include region and tier of medical schools, grade year, the orientation of education programmes (eg, rural programmes, 5-year programmes, 8-year or 5+3 programmes) and specialty of education programmes. We controlled these variables to investigate whether pilot reform programmes select different groups of candidates, all else being equal.

PP and TP students were compared concerning entrance examination (NCEE) scores and sociodemographic variables. Differences between group means were analysed using the Mann-Whitney test for continuous variables, and differences in proportions between groups were analysed using the χ² test for categorical variables.

We first performed multilevel mixed-effects linear regressions on the numerical selection results variable (eg, NCEE score), and multilevel mixed-effects logistic regressions on categorical selection results variables (yes/no) (eg, female, ethnical minority, first-generation college student, low family ISEI, family members in medicine, no) (eg, female, ethnical minority, first-generation college student, low family ISEI, family members in medicine, no) to examine if students with the same NCEE score but different sociodemographic backgrounds had different chances of selection.

Data were cleaned by the NCHPED. Statistical analyses were performed by using STATA/MP V 17.0 (StataCorp).

**Patient and public involvement**

None.

**RESULTS**

We received completed surveys (concerning the variables of our interest) from 204817 students. This represents a response rate of 60.0% of the total student population of the participating schools, higher than our target of a 50% response rate.

Of our 204817 respondents, 194163 (94.8%) were in a TP and 10654 (5.2%) a PP. In all cases, PPs had much smaller cohort sizes than TPs. Table 1 shows the characteristics of the respondents.

Table 1 also shows the relationships between the type of programmes (TPs or PPs) and a) SES variables and b) NCEE (entrance examination) outcomes. There was a relationship between programme type and NCEE. Respondents from PPs had significantly higher NCEE outcomes (median=75.2, IQR=69.5–78.8) than their TP counterparts (median=73.9, IQR=68.5–78.7). Respondents from PPs were significantly less likely than those from TPs to come from rural areas (36.1% vs 41.5%, χ² =121.5, p<0.001) or low occupation families (54.0% vs 59.8%, χ² =141.6, p<0.001), or to be ethnical minorities (8.5% vs 11.2%, χ² =72.4, p<0.001) or first-generation college students (62.3% vs 68.3%, χ² =164.2, p<0.001). In contrast, respondents from PPs were significantly more likely to come from high-income families (19.1% vs 15.3%, χ² =109.3, p<0.001) and have family members working in medicine (36.3% vs 31.6%, χ² =100.9, p<0.001) than those from TPs.

Online supplemental table 1 shows the results from a set of multilevel mixed-effects regression models, illustrating the association between the probability of selection into PPs and medical students’ NCEE score and social demographics, with an account of the covariation between the probability of selection into PPs and medical school location and quality characteristics, students’ grade year, as well as the orientation and specialty of education programmes (as shown in table 1). There was a positive association between selection into PPs and NCEE scores, suggesting students in PPs on average have a higher NCEE score (a difference of 1.54 out of 100) than their counterparts in TPs. Selection patterns in terms of social demographics were consistent, with students from disadvantaged families having a lower likelihood (ORs: 0.73–0.77) of selection into PPs, while students from privileged families had a higher likelihood (ORs: 1.23–1.40), holding constant other covariates including their prior academic attainment.

**DISCUSSION**

The 2018 Ottawa consensus statement on selection stated that selection ‘cannot be isolated from the cultural and social structural context in which it takes place’ and concluded with a plea for selection research from under-represented regions. The current study addresses both pleas. To our knowledge, it is the first empirical paper focusing on an (early) outcome of China’s most recent medical education reforms. We found that students with higher prior academic attainment indicated by entrance examination (NCEE) scores were selected into the new PPs more often than the TPs.

Given that the main aim of the reform was to elevate the academic level of the profession, medical schools have achieved that policy mission, as far as selection can influence ultimate outcomes. However, students with higher prior academic attainment were also more likely...
to be from higher social classes and urban backgrounds. This is perhaps unsurprising; the wider global literature clearly shows that students from higher social groups do better on school examinations. However, and again seen in many countries, this meant that selecting for higher academic ability limited the socioeconomic diversity of medical students, in this case, medical students selected into PPs.

It is worth noting that even among students with the same level of prior academic attainment, those from wealthier families were still preferred by PPs that enjoy richer resources. This was a consistent pattern among medical schools across the country. This finding illustrates ‘the wicked problem of selection’ described by Cleland et al which refers to the issue that each attempt to address a particular aspect of medical school selection will have unanticipated consequences. In the current case, it may be that the incentives behind China’s national-level Education Plan encourages medical schools to strive for the short-term goal of selecting applicants with good academic attainment from traditional backgrounds, without fully considering the more distal workforce consequences of narrowing the socioeconomic diversity of students. Balancing these seemingly competing

Table 1 Differences between Chinese medical students in traditional (TP) and pilot programmes (PP)

<table>
<thead>
<tr>
<th></th>
<th>Overall No.(%)/median (IQR)</th>
<th>TP No.(%)/median (IQR)</th>
<th>PP No.(%)/median (IQR)</th>
<th>Z/χ² (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of observations</td>
<td>204817 (100.0)</td>
<td>194163 (94.8)</td>
<td>10654 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Medical school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tier 1*</td>
<td>7065 (3.4)</td>
<td>6772 (3.5)</td>
<td>293 (2.8)</td>
<td>562.7 (0.000)</td>
</tr>
<tr>
<td>Tier 2*</td>
<td>58189 (28.4)</td>
<td>56192 (28.9)</td>
<td>1997 (18.7)</td>
<td></td>
</tr>
<tr>
<td>Tier 3*</td>
<td>139563 (68.1)</td>
<td>131199 (67.6)</td>
<td>8364 (78.5)</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>79023 (38.6)</td>
<td>75073 (38.7)</td>
<td>3950 (37.1)</td>
<td>467.8 (0.000)</td>
</tr>
<tr>
<td>Central</td>
<td>57571 (28.1)</td>
<td>53664 (27.6)</td>
<td>3907 (36.7)</td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>68223 (33.3)</td>
<td>65426 (33.7)</td>
<td>2797 (26.3)</td>
<td></td>
</tr>
<tr>
<td>5-year programmes</td>
<td>176639 (86.2)</td>
<td>167556 (86.3)</td>
<td>9083 (85.3)</td>
<td>458.7 (0.000)</td>
</tr>
<tr>
<td>Rural programmes</td>
<td>13667 (6.7)</td>
<td>13300 (6.8)</td>
<td>367 (3.4)</td>
<td></td>
</tr>
<tr>
<td>8-year or 5+3 programmes</td>
<td>14511 (7.1)</td>
<td>13307 (6.9)</td>
<td>1204 (11.3)</td>
<td></td>
</tr>
<tr>
<td>Grade year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st</td>
<td>50690 (24.7)</td>
<td>48596 (25.0)</td>
<td>2094 (19.7)</td>
<td>207.9 (0.000)</td>
</tr>
<tr>
<td>2nd</td>
<td>42209 (20.6)</td>
<td>40126 (20.7)</td>
<td>2083 (19.6)</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>44859 (21.9)</td>
<td>42329 (21.8)</td>
<td>2530 (23.7)</td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>29736 (14.5)</td>
<td>28034 (14.4)</td>
<td>1702 (16.0)</td>
<td></td>
</tr>
<tr>
<td>5th</td>
<td>37323 (18.2)</td>
<td>35078 (18.1)</td>
<td>2245 (21.1)</td>
<td></td>
</tr>
<tr>
<td>Specialty</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No specialty at admission</td>
<td>148509 (72.5)</td>
<td>139282 (71.7)</td>
<td>9227 (86.6)</td>
<td>1120.5 (0.000)</td>
</tr>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCEE score†</td>
<td>74.0 (68.5–78.7)</td>
<td>73.9 (68.5–78.7)</td>
<td>75.2 (69.5–78.8)</td>
<td>10.9 (0.000)</td>
</tr>
<tr>
<td>Female</td>
<td>113419 (55.4)</td>
<td>107519 (55.4)</td>
<td>5900 (55.4)</td>
<td>0.0 (0.996)</td>
</tr>
<tr>
<td>Minority</td>
<td>22627 (11.0)</td>
<td>21718 (11.2)</td>
<td>909 (8.5)</td>
<td>72.4 (0.000)</td>
</tr>
<tr>
<td>Rural</td>
<td>84400 (41.2)</td>
<td>80555 (41.5)</td>
<td>3845 (36.1)</td>
<td>121.5 (0.000)</td>
</tr>
<tr>
<td>First-generation college students</td>
<td>139238 (68.0)</td>
<td>132596 (68.3)</td>
<td>6642 (62.3)</td>
<td>164.2 (0.000)</td>
</tr>
<tr>
<td>Low ISEI</td>
<td>121959 (59.5)</td>
<td>116202 (59.8)</td>
<td>5757 (54.0)</td>
<td>141.6 (0.000)</td>
</tr>
<tr>
<td>Family members in medicine</td>
<td>65317 (31.9)</td>
<td>61449 (31.6)</td>
<td>3868 (36.3)</td>
<td>100.9 (0.000)</td>
</tr>
<tr>
<td>Low-income families</td>
<td>20283 (9.9)</td>
<td>19265 (9.9)</td>
<td>1018 (9.6)</td>
<td>1.5 (0.217)</td>
</tr>
<tr>
<td>High-income families</td>
<td>31790 (15.5)</td>
<td>29756 (15.3)</td>
<td>2034 (19.1)</td>
<td>109.3 (0.000)</td>
</tr>
</tbody>
</table>

*Chinese undergraduate medical schools differ in quality, with those in tier one being considered as most selective and offering the most extensive training.
†For analysis purposes, original NCEE scores (ranging from 0 to 750) were converted to a scale of 0–100, by multiplying the factor of (100/750).
ISEI, International Socio-Economic Index; NCEE, National College Entrance Examination.
agendas is tricky. While the Pareto-optimal framework has been proposed to guide how selection can be optimised to maintain entrant quality while minimising the adverse impact on disadvantaged groups,\textsuperscript{29} 30 this has yet to be tested out empirically in medical school selection. Moreover, on a practical note, medical schools, particularly in China and other countries with top-down governance, are likely to change their selection goals only if required to do so.

Shifting to selection processes and medical programmes which intentionally or unintentionally privilege students from urban and more educated backgrounds may have detrimental consequences on workforce distribution across rural and urban, affluent and disadvantaged areas in future years.\textsuperscript{31–36} The pattern of distribution of doctors in China is similar to other countries,\textsuperscript{5, 37} suggesting this is a potential risk and may jeopardise the reform’s second aim of better serving population health needs. Whether this is the case or not requires long-term follow-up of the outcomes of the new programmes.

**Comparison with previous literature**

Medical schools exist within the framework and policies established by the education and social systems of their countries, and they must respond to changing demands within these systems.\textsuperscript{38–40} According to contingency theory,\textsuperscript{41} organisations (in this case, medical schools) who adapt to fit the changing features of their environment (in this case, to meet the national drive to improve the quality of medical education) will survive and thrive. It is thus unsurprising that medical schools would select academically stronger candidates for PPs compared with TPs. However, qualitative research is now needed to understand medical school selection decision-making.\textsuperscript{42}

**Implications for research, policy and practice**

The NCEE is a measure of prior attainment and an assessment of the cognitive ability considered necessary to become a successful medical student and doctor.\textsuperscript{17} 26 Some of the PP schools also included an interview as part of their selection process, thus including an assessment of personal qualities. Further research is needed to examine if there are differences between those selected into PPs via NCEE-only or NCEE-plus-interview.

Whether medical schools’ pilot education reforms add value in terms of attrition, performance in medical school and later assessments, and career choice is another obvious area for future scrutiny.\textsuperscript{21} 43

At a local level, evaluations and comparisons of PPs with TPs must consider that PP and TP students are different in terms of background and ability. The wider applicability of any ‘successful’ PP models should be considered with caution given these differences between groups.

**Strengths and weaknesses**

Our sample was representative of medical schools in China and the total number of respondents is very high for a voluntary survey. However, our sampling approach within schools was driven by practicalities, and while the total number of respondents was high, they represent less than half of the final-year student populations of the target schools. Unfortunately, the anonymous nature of the survey means we cannot compare respondents with non-respondents in terms of sociodemographics, so we do not know if the respondents were representative of all students.

Our study relied on self-report and some of the questions were retrospective, but we had no other way of gathering data on the socioeconomic background as this is not routinely collected by medical schools in China.

Medical schools can only select from the pool of applicants. PP applicants may be different from TPs: not just stronger academically, but also potentially more risk-taking (applying for new, untested programmes), which is often linked to higher social class and access to greater financial resources.\textsuperscript{34} However, we have no way of knowing without prospectives studies tracking who applies for medical school versus who is selected.\textsuperscript{43}

Conversations with schools and study coordinators suggest that differences in response rate among schools reflected differences in the timing and internal advertising, and hence attendance at, the data collection sessions. Although we did not do a formal analysis of response rate and school size, we tentatively suggest that the sheer difficulty of communicating and engaging with large numbers of students may be linked to lower response rates in larger schools.

A cross-sectional study can only provide a ‘snapshot’ in time. Longitudinal and multicohort studies are needed to examine if this pattern of PPs selecting academically stronger and more privileged students is consistent or fades over time, as TPs are phased out.

Our specific research questions and hypotheses are relevant to an international audience; change in medical education is widespread, even if the specific focus of this study was firmly grounded in the context of China’s medical education reforms. However, China has very strongly top-down directive policies and medical schools have little space to exert their preferences or choices. This milieu may be different from that of other countries; adaptations to wider systems demands are likely to differ in more heterogeneous and liberal contexts.\textsuperscript{46}

The study was designed and conducted by researchers embedded in and/or familiar with the study context. Data analysis and how the data related to international research conversations were mutually developed with an experienced researcher. Although this is a quantitative study, JC carefully considered her position as someone enmeshed in Western medical education and selection practices who has little understanding of China’s educational traditions, norms and culture.

**CONCLUSION**

In conclusion, our study provides an example of how a policy change to improve the quality of doctors translated...
into practice. Assuming quality can be indicated by prior academic achievement at the point of selection, we can conclude that the PPVs did achieve this mission. However, our data suggest that this approach has unintended consequences in terms of narrowing the diversity of medical students, which may ultimately be unhelpful in better serving China’s population health needs.

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**Contributors** YY and JC made substantial contributions to the conception and design of this paper; WP provided guidance and institutional help for the data collection; YY analysed data and interpreted the results, with support from JC. YY led the original draft of the paper which was rewritten by JC. All authors reviewed the final manuscript and agreed to be accountable for all aspects of the work. YY is responsible for the overall content as guarantor.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** Ethics (IRB) approval for educational research was not required in China when CMSS was piloted in 2019. However, the process and parameters changed and CMSS 2021 was approved by the institutional review board at Peking University (IRB00001052-20069). We followed core ethical principles: obtaining informed consent from potential research participants that their (anonymous) survey responses could be used for research purposes under the Statistics Law of the People’s Republic of China, and making clear that taking part was voluntary and participants could withdraw at any time. Only necessary variables related to this study were extracted from the anonymised CMSS 2021 dataset and made available to the study team through secure official web access to ensure high standards of security and governance when storing, handling and analysing data.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Usage of the data that support the findings of this study is under the agreement between the author (YY) and the NCHPED. The author is not allowed to send the data to a third party under this data usage agreement. However, data from CMSS are available for research purposes under a data usage agreement between a qualified researcher and NCHPED and can be reasonably requested from the CMSS corresponding author (WW).

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