

Challenges of senior 8-year-program medical students' scientific research in China

A multicenter questionnaire-based study

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Abstract

Among the diverse medical education systems in China, the 8-year program is dedicated to cultivating physician scientists. Although the research ability of senior students in 8-year medical programs is a pivotal quality, it remains unclear. This study aimed to clarify the current status and challenges of students' research experience, abilities, and outputs.

A multicenter cross-sectional study was conducted in 5 medical schools in northern China. Electronic questionnaires were sent to 235 randomly chosen fifth-grade or sixth-grade 8-year-program medical students. A total of 211 responses were collected and analyzed using SPSS 22.0.

Only 13.3% of participants chose research as their future career goal. Students generally felt that conducting research was stressful and difficult. The greatest obstacle was a lack of time due to heavy workloads. The 2 major motivations for research were graduation and/or future employment (75.8%) and research interest (24.2%). More than half of the students (142, 67.3%) had research experience by the time of the survey, among whom 84 students already had research outputs. A higher proportion of students with outputs was motivated by the requirements for graduation or employment compared to students without outputs (71.4% vs 55.2%, $P = .046$).

Senior 8-year-program medical students in China generally had high pressure to conduct research and devoted their efforts to overcome these challenges. More guidance and novel encouragement to enhance students' initiative and interest in research could be provided by medical schools and educators in the future.

Abbreviations: PKU = Peking University, PUMC = Peking Union Medical College, QU = Qingdao University, THU = Tsinghua University, XJTU = Xi'an Jiaotong University.

Keywords: 8-year program, medical education

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This study was approved by the Medical Review Ethics Committee of Peking Union Medical College Hospital (S-K1208). Because the survey was anonymously and the participants' information was not identifiable, the verbal informed consent from all the participants before the survey was obtained, which was approved by Medical Review Ethics Committee of Peking Union Medical College Hospital.

The dataset supporting the conclusions of this article is included within the article and its supplementary files.

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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Main messages

- Increasingly more 8-year medical program students have participated in research early and have made achievements.
- Medical Students generally felt stressed due to the growing requirements of research.
- Although medical students have taken active participation in research, more is needed to stimulate of their interest.

Research questions:

- How institutions foster a constructive research culture and help students with research and learning remains to be illustrated.
- The factors influencing students' choice over the different programs of the medical schools could be explored.
- Future in-person interviews to explore detailed students' attitudes and comments on research training and face-to-face interview with managing crew of the school could be designed.

1. Introduction

Evidence-based medicine has become the center of clinical practice, and translational medicine has been a research focus, which applies basic bioscientific research findings to clinical practice, thereby promoting the development of modern medicine. Physician scientists, who raise scientific questions and combine basic bioscience and clinical knowledge, play a critical role in both issues.^[1,2] To satisfy the increasing demands for physician scientists who can promote the progress of modern medical science, medical schools worldwide are designing research courses and programs to encourage students to engage in research training. Starting relatively late, China is now catching up with this trend, but many problems remain unresolved. Guided by the Healthy China 2030 target, China has launched reforms in medical education with the aim of strengthening the professional and comprehensive abilities of medical staffs.^[3,4]

Different from many Western countries, there are currently several distinct training systems for medical students in China, including 3-year, 5-year, and 8-year medical programs at least. Major programs are shown in figure, Supplementary File 1, Supplemental Digital Content, <http://links.lww.com/MD/G645>, which briefly illustrates the medical education system in China. Among them, the 8-year medical program is dedicated to cultivating master diagnosticians and physicians.^[5] In 1919, the first 8-year medical program in China was founded at Peking Union Medical College. Since 2001, more 8-year medical programs have been established as elite medical education programs in highly ranked medical schools in China. These schools select students mostly according to their National College Entrance Examination scores, and provide them more intensive training curriculums, such as more advanced courses in biomedicine, systemic training in academic skills, assigning research mentors early and so on, which is quite variable across different medical schools. Consequently, they have aggressive graduation requirements to get the Medical Doctor degree, such

as high course scores or research achievements. Research ability has become one of the pivotal qualities in the evaluation system.^[2] Currently, 8-year program requires research experience and dissertation for graduation, but publication is not mandatory. However, there's a big challenge to arouse interest in research among medical students around the world. Lack of time and difficulty finding mentors or projects were the 2 key barriers for research engagement.^[2,6,7] Our previous study indicated that senior 8-year-program students from Peking Union Medical College generally had a low level of self-evaluation of their research abilities. The study also showed that students actively participated in research despite the general lack of interest in research.^[8]

Although much attention has been paid to medical education and research training in recent years, studies exploring the progress and research abilities of Chinese medical students are still limited. Besides, a recent review on scholar experience in medical education showed that such studies were still limited, with almost all of which done in the USA and European countries through students' self-evaluation.^[9] The situation could differ greatly in other systems or regions. Eight-year medical program students usually finish the generally required courses of a medical school, premedical learning, basic medicine, and clinical medicine courses, and begin internships in the fifth or sixth year. Therefore, we conducted this multicenter cross-sectional study among 8-year-program medical students in this stage from 5 medical schools in China in an attempt to clarify the current conditions of students' research experience, abilities, and outputs and to explore the possible influential factors for research outputs.

2. Methods

2.1. Participants

This study was approved by the Medical Review Ethics Committee of Peking Union Medical College Hospital (S-K1208), followed the STROBE guidelines to report the results.^[10] Figure 1 showed the flow diagram of this study. A multicenter cross-sectional study was conducted among senior medical students from the 8-year programs of 5 medical schools in northern China, including Peking Union Medical College (PUMC), Tsinghua University (THU), Peking University, Qingdao University, and Xi'an Jiaotong University. First, the name list of all students in the fifth and sixth grades and the teaching curriculums in 5 schools were collected. Based on the overall number of students, 30 from each grade in PUMC, Peking University and Qingdao University, 20 from each grade in Xi'an Jiaotong University and 15 from the sixth grade in THU were randomly chosen among all currently enrolled students using computer-generated random numbers. Considering that the fifth-grade students in in THU were receiving scientific research training abroad during the survey,^[9] they were excluded in the analysis.

2.2. Data sources

The questionnaire was designed, distributed, and collected electronically to every participant with the wjx online survey platform (Changsha Ranxing Information Technology Co., Ltd., Changsha, P.R.C.). The survey was anonymous, and it was fully voluntary for each participant to respond or not to the questions. The composition of the enrolled participants is shown in Figure 2.

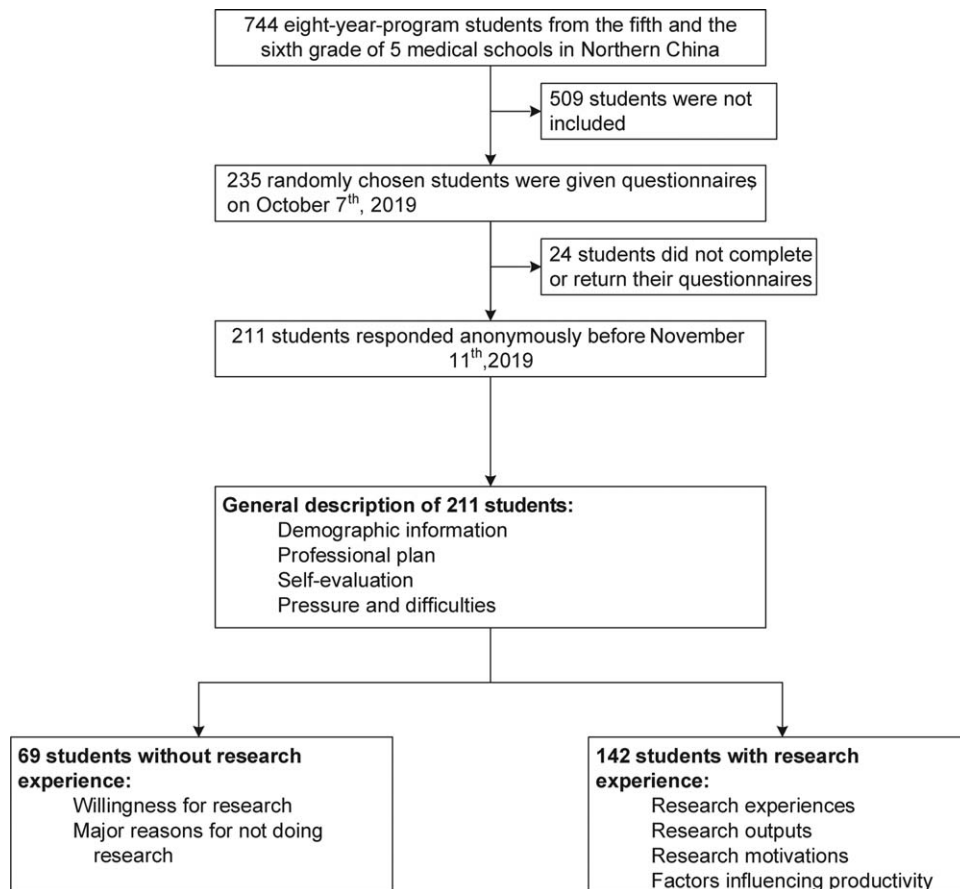


Figure 1. Study flow diagram.

The questionnaire consisted of the following aspects: demographics, future professional plans, research experience, motivations for research, and research outputs. Research experience

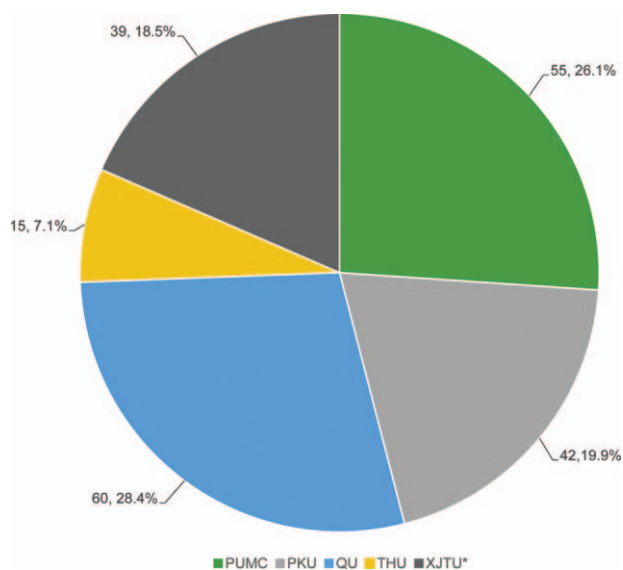


Figure 2. Composition of the students surveyed. *PKU=Peking University, PUMC=Peking Union Medical College, QU=Qingdao University, THU=Tsinghua University, XJTU=Xi'an Jiaotong University.

included the following: literature reading and presentation, academic writing, research proposal designing and/or experiment skills, and research project application. All students were asked to evaluate the difficulty of and pressure for research, with 0 points meaning no difficulty/pressure and 5 points meaning unbearable difficulty/pressure. Students were classified into 2 subgroups based on their research experience, and students with research experience were further categorized into a group with research outputs and another without research outputs. Research outputs were defined as having publication as the first author or had successful experience in applying research fund. The former indicated that the student acted as the major researcher and writer for the research results. While the later included research projects from college to nation level, which granted students financial help after evaluating the plausibility and innovation of their research topic. For details of the English version of the complete questionnaire, please see word, Supplementary File 2, Supplemental Digital Content, <http://links.lww.com/MD/G646>. All data of this study are available from corresponding author with written requests stating the aim and protocol on how to use the data.

2.3. Statistical methods

Data were exported to an Excel (2019 Microsoft, USA) table and analyzed mainly with descriptive methods. The Shapiro-Wilk test and Kolmogorov-Smirnov test were done for samples smaller than 50 and samples over 50, respectively, in which $P > .05$

Table 1
Characteristics of the medical students.

	Total	With research experience	No research experience	P value
Number, n	211	142	69	
Male, n (%)	80 (37.9%)	55 (38.7%)	25 (36.2%)	.725
Age ($\bar{x} \pm s$)	22.69 \pm 0.93	22.70 \pm 0.92	22.68 \pm 0.96	.909
Fifth grade, n (%)	104 (49.3%)	64 (45.1%)	40 (58.0%)	.079
Professional plan (multiple choices)				
Clinical doctors	209 (99.1%)	140 (98.6%)	69	.323
Researchers	28 (13.3%)	22 (15.5%)	6 (8.7%)	.172
Medical teachers	27 (12.8%)	18 (12.7%)	9 (13.0%)	.940
Others	18 (8.5%)	15 (10.6%)	3 (4.3%)	.109
Difficulties, median (range)	4 (3-4)	4 (3-4)	4 (3-5)	.274
Pressure, median (range)	3 (3-4)	3 (3-4)	3 (3-4)	.538
Motivations, n (%)				.331
For graduation or employment	160 (75.8%)	106 (74.6%)	54 (78.3%)	
Interests	51 (24.2%)	36 (25.4%)	15 (21.7%)	
Obstacles for research (multiple choices)				
Heavy load from study or internship	153	107	46	.185
Insufficient research abilities	86	64	22	.067
No suitable research groups	45	29	16	.645
No help	54	26	28	.001
No clear targets	79	53	26	.040
Ideal time to begin research, n (%)				<.001
Premedical period	53 (25.1%)	42 (29.6%)	11 (15.9%)	
Medical courses	125 (59.2%)	86 (60.6%)	39 (56.5%)	
Internship	33 (15.6%)	14 (9.9%)	19 (27.5%)	
Research ability weaknesses (multiple choices)				
Experimental design	112 (53.1%)	75 (52.8%)	37 (53.6%)	.912
Statistical analysis	103 (48.8%)	73 (51.4%)	30 (43.5%)	.280
Academic writing	77 (36.5%)	53 (37.3%)	24 (34.8%)	.719
Experimental skills	66 (31.3%)	44 (31.0%)	22 (31.9%)	.895
Literature research and reading	64 (30.3%)	39 (27.5%)	25 (36.2%)	.918

indicates normal distribution. The continuous variables with normalized distributions were presented as the mean \pm standard deviation ($\bar{x} \pm s$), and Student *t* test was used for comparisons between 2 groups. Continuous variables with a non-normal distribution were presented as the median (interquartile range), and the Wilcoxon test was used for the comparison of 2 groups. A chi-square or Fisher exact test was adopted for the comparison of categorical variables. A two-tailed $P < .05$ was considered significant. All statistical analyses were performed using SPSS 22.0 for Windows (IBM, NY).

3. Results

3.1. Characteristics of participants

The questionnaire collection lasted from October 7, 2019, to November 11, 2019, and the ideal response rate was set at 70% and above for any center. The ultimate response rate was 89.8% (211/235), with a range from 70% to 100% among these schools. Table 1 shows the characteristics of 211 students. A total of 104 (49.3%) students were from the fifth grade, and 107 (50.7%) were from the sixth grade. Female students (131) accounted for 62.1%. The average age was 22.7 ± 0.9 years. There was no significant difference in the demographics among the 5 medical schools (age: $P = .374$, sex: $P = .187$). A total of 209 (99.1%) students chose clinical doctor as one of their career goals. While, 28 (13.3%) students also considered of becoming a researcher, and 28 (13.3%) of becoming a medical educator.

3.2. Pressures and obstacles

Students felt high pressure for research, with a median score of 3 (3-4), and had difficulty doing research, with a median score of 4 (3-4). The concern about graduation and/or future employment were the pivotal motivation to conduct research among 160 (75.8%) students. Fifty-one (24.2%) students chose research interest as their pivotal motivation.

The major obstacles or challenges to conducting research were as follows: heavy load from study or internship (153, 72.5%), insufficient research abilities (86, 40.8%), and lack of access to the appropriate research team (45, 21.3%). Regarding research abilities, students hoped to improve their abilities in research design (112, 53.1%), statistical analysis (103, 48.8%), academic writing (77, 36.5%), and experiment skills (66, 31.3%). A total of 125 (59.2%) students suggested that the ideal time for starting research was the semesters when they took basic and clinical medical courses. Please see Table 1 for more relevant information.

3.3. Research experience

Table 2 shows the major results of students' research experience. In total, 142 (67.3%) students had previous research experience, including 120 (84.5%) who participated in 1 or 2 research projects and 22 (15.5%) who participated in 3 or more research programs. Among students with research experience, 69 (48.6%) had undertaken 1 or more research projects as the first applicant. Furthermore, 19 (13.4%) students had applied for nation-funded

Table 2**Characteristics of medical students with research outputs and associated factors.**

Variables	Numbers and percentage			P value
	Total (n=142)	With outputs (n=84)	Without outputs (n=58)	
Age ($\bar{x} \pm s$)	22.70 \pm 0.92	22.70 \pm 0.92	22.69 \pm 0.94	.936
Sex (male), n (%)	55 (38.7%)	33 (39.3%)	22 (37.9%)	.871
Grade (5 th grade), n (%)	64 (45.1%)	37 (44.0%)	27 (46.0%)	.768
School*	39 (27.5%)	24 (28.6%)	15 (25.9%)	.839
PUMC	35 (24.6%)	21 (25.0%)	14 (24.1%)	
PKU	21 (14.8%)	14 (24.1%)	11 (19.0%)	
QU	14 (9.9%)	9 (10.7%)	5 (8.6%)	
THU	33 (23.2%)	20 (23.8%)	13 (22.4%)	
XJTU				
Begin time for scientific research training				.337
1 st -2 nd year	33 (23.2%)	23 (27.4%)	10 (17.2%)	
3 rd -4 th year	84 (59.2%)	48 (57.1%)	36 (62.1%)	
5 th -6 th year	25 (17.6%)	13 (15.5%)	12 (20.7%)	
Average hours dedicated to research a week				.172
Over 20 h	12 (8.5%)	9 (10.7%)	3 (5.2%)	
10-20 h	31 (21.8%)	20 (23.8%)	11 (19.0%)	
5-10 h	45 (31.7%)	25 (29.8%)	20 (34.5%)	
0-5 h	42 (29.6%)	25 (29.8%)	17 (29.3%)	
Nearly no time	12 (8.5%)	5 (6.0%)	7 (12.1%)	
Having fixed research mentor	123 (86.6%)	75 (89.3%)	48 (82.8%)	.261
Feelings for obstacles during research work				.827
Avoiding or/and anxious	97 (66.2%)	55 (65.5%)	39 (67.2%)	
Peaceful or/and excited	48 (33.8%)	29 (34.5%)	19 (32.8%)	
Scoring difficulty for research, median (range)	4 (3-4)	4 (3-4)	4 (3-4)	.995
Scoring pressure for research, median (range)	3 (3-4)	3 (3-4)	3 (3-4)	.205
Motivations for research				.046
Graduation or/and employment	92 (64.8%)	60 (71.4%)	32 (55.2%)	
Interests in research or/and knowledge	50 (35.2%)	24 (28.6%)	26 (44.8%)	

* PKU=Peking University, PUMC=Peking Union Medical College, QU=Qingdao University, THU=Medical Doctor Program of Tsinghua University, XJTU=Xi'an Jiaotong University.

projects, 10 (7.0%) for province-funded projects and 25 (17.6%) for school-funded projects. Most students' research topics (118, 83.1%) were provided by their mentors. A total of 121 (85.2%), 117 (82.4%), and 96 (67.6%) students received research training in basic bioscience teams, clinical research teams, and both types of teams, respectively. Eighty-four (59.2%) students began research training in the third and fourth grades. A total of 123 (86.6%) students had a fixed research mentor. Forty-five (31.7%) spent 5 to 10 hours per week on research activities (including attending a seminar, literature reading, doing experiments, and academic writing), and 31 (21.8%) spent 10 to 20 hours per week.

However, 69 (32.7%) students had no research experience by the survey time. Among them, 16 (23.2%) already had a research plan, and 52 (75.4%) were willing to conduct research. The reason they had not started research training was mainly time restriction due to a heavy load from courses or clinical work (66.7%, 46/69).

In the comparison between students with and without research experience, there was no difference in demographics, scores in pressure and difficulty, and motivation. However, students with research experience preferred the earlier beginning time for research training ($P < .001$). The proportion of students who preferred the premedical period as an ideal beginning time for research was 29.6% among students with research experience and 15.9% among students without research experience.

3.4. Research outputs and the associated factors

Among students with research experience, 84 (59.2%) students had research outputs that included paper publications and

successful applications for research funding. Forty-one students (28.9%) had 1 or more articles published or accepted by medical or biological journals, with 35 of them as the first author or coauthor. The most common type of publication was an original article.

Compared with the group without research outputs, students with outputs were more likely to consider graduation and future employment as their original motivation for research (71.4% vs 55.2%, $P = .046$). Furthermore, students motivated by graduation or employment requirements generally scored higher for pressure than students motivated by interest (median vs median: 3.5 vs 3, $P = .030$). There was no difference in sex, grade, school, percentage with fixed mentors, beginning time for research, average weekly time spent on research, or attitude toward obstacles between the 2 groups.

4. Discussion

In recent decades, increasingly more 8-year medical programs have been established as elite medical education programs in high ranked medical schools in China. Research ability has been one of the pivotal abilities of these 8-year-program students. To the best of our knowledge, this is the first multicenter survey to focus on research ability among 8-year-program medical students in China. This study indicated that almost all students would like to be clinical doctors, and 13.3% considered of dedicating to research for their future career. The majority of them felt moderate to high pressure and found it difficult to conduct research. Concerns about graduation and/or future employment

was the leading motivation for research, and a heavy load from study or internship was the major obstacle. Fortunately, many students already had research experience and research outputs. A higher percentage of students with research outputs considered graduation and future employment as their original motivation for research compared with students without research outputs.

The modern medical education system has been engaging medical students in research for nearly half a century, and students' feedback has been generally positive in the USA.^[11–13] Research training provides valuable experience for medical students, cultivating their interest in research and allowing them to critically evaluate new research findings and advanced medical knowledge.^[14–16] Brancati et al.^[17] found that career achievement was related to research experience in medical schools.^[18] China has also made great efforts to cultivate physicians' research abilities.^[2,19] PUMC was the first medical school with 8-year program, and since 2004, totally 7 medical schools had set up this kind of educating program nationwide, aiming to cultivate core talents in medicine. The educating arrangements of the 8-year program is still developing till today.^[17] The findings of our survey indicated that most of the senior 8-year-program medical students had realized the importance of research abilities and actively participated in research. The majority of participants had either begun research or hoped to begin soon by the time of survey. Several studies proved that structured research programs could increase students' interest in research and consequently increase their research outputs.^[20,21] Our study indicated that interest in research did not correlate with research outputs. This might result from the relatively low proportion of students in this study taking the interest in research as their motivation. Physician scientists' research scope includes clinical, basic science, and translational research.^[22] Medical students at this stage might lack interest in clinical and basic research or misunderstand the meaning of physician scientists due to their relatively short time of contact with clinical practice. One study showed that female working in medicine or life science had lower self-efficacy and career intention, leading to their fewer achievements in academy.^[23] However, we found no significant difference in research experience and research outputs between male and female students. Failing to identify sex as an influencing factor might be due to different nationality, education background, culture, or limited number of participants.

Given the stated purpose of the 8-year program, it was concerning that only 13% of the respondents reported having an interest in research careers and that graduation and/or future employment were the pivotal motivations for conducting research. This raised questions about how much students' research activities could contribute to deepening their academic knowledges and promoting modern medicine. The current situation is that hospitals with strength and competitiveness usually require applicants equipped with research abilities, which could be best proved by previous research outputs. In addition, the research ability is an essential evaluation indicator in career advancement among medical centers in China. The importance attached to research has accelerated the improvement in clinical practice, yet at the same time has put great pressure to medical students and doctors.

The major obstacle found in this research was the heavy load from studies or internships, which corresponds with previous results.^[4,8] The most deficient research abilities were research design and statistical analysis, which was also consistent with other studies.^[24,25] Students performed relatively better in

academic reading and writing, probably because the 5 medical schools in this study all provided related compulsory courses. A Canadian study showed medical students' desire for a formalized research curriculum, centralized opportunities, and more help from experienced researchers.^[26] Given the major obstacles and the special abilities that these students were eager to improve, adjustments for the curriculum are essential and urgent. For example, early involvement in research, summer or winter research camps, early mentorship arrangements, special research years, and extracurricular workshops focusing on research design and statistical analysis could all be optimal choices. Tsinghua University has already assigned 2 years for full-time research in its curriculum. In this study, the sixth-grade THU medical students did not have significantly higher proportion of research outputs ($P=.618$) or research interest ($P=.581$). However, because this program was established only a few years ago,^[9] the long-term influence and results are still unknown.

More than half of the students with research experience had outputs, either publications or successful applications for research projects. Compared with our previous study in PUMC,^[8] students made progress in research productivity. However, very few students independently conceived of their research topics. Almost all students received topics from mentors, senior students, or doctors. The motivation for research was the only significant influencing factor, with slightly more students who were driven by the requirements of graduation or employment having outputs. This finding suggested that schools and hospitals had paid increasing attention to research in recent years, which put pressure on medical students and pushed them forward. However, students are expected to play a more active role in research training, which means that other stimulations might be needed.

Previous surveys have seldom focused solely on 8-year-program medical students in China. Although the sample size was not large, it surveyed 5 representative medical schools in northern China and could partly show the current status and challenges of their research accomplishment in senior 8-year-program medical students. However, this study had some limitations. First, the differences in curriculums and training arrangement among these 5 centers might introduce bias to the results. Second, there was no pretest for the questionnaire nor standard guidance for such survey, and the online questionnaire survey may decrease authenticity. Therefore, more reliable questionnaires could be expected in future studies. Besides, to improve the response rate, there was no request for exact information about the participants' publications or grants, which resulted in a lack of validation of their research outputs. The influence of students' primary goals when entering the program might affect the way they manage their time and effort, but could be hard for them to recall. Future studies could design in-person interviews to explore students' attitudes and comments on research training more deeply. While, the influence of educational environment could be better explored with face-to-face interview with managing crew of the school.

5. Conclusions

Senior 8-year-program medical students in China generally feel high pressure for research and devote their efforts to overcome these challenges. The increasing demands on research abilities and outcomes from employers have become the motivation for medical students to participate in research and the source of

pressure. More guidance and novel encouragement to enhance students' initiative and interest in research could be provided by medical schools and educators in the future. Potential measures, including adjustments to the curriculum and education reform programs, might facilitate the goal of cultivating elite physician scientists.

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Author contributions

MW and SL designed questionnaires, analyzed and interpreted data, and were major contributors in writing the manuscript. JZ, SX, LY, XL, HL, XS, WY, and GR helped design, distribute and collect questionnaires. JL made substantial contributions to the conception and also revised manuscript. All authors have read and approved the final manuscript. All authors have agreed both to be accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work.

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