Current Status of Scientific Research Accomplishments of Senior Eight-year-program Medical Students in China: A Multicenter Cross-sectional Questionnaire-based Study

Mengyao Wan
Peking Union Medical College Hospital https://orcid.org/0000-0002-2872-9851
Shuang Liu
Peking Union Medical College Hospital
Jiawei Zhu
Chinese Academy of Medical Sciences and Peking Union Medical College
Sulong Xiao
Peking University School of Pharmaceutical Science
Lei Yuan
Peking University Third Hospital
Xiaokang Lei
Beijing Cancer Hospital
Hao Lei
Xi'an Jiaotong University
Xiaomeng Shi
Qingdao Municipal Hospital
Wen You
Peking Union Medical College Hospital
Gechong Ruan
Chinese Academy of Medical Sciences and Peking Union Medical College
Ji Li (liji0235@pumch.cn)
Jiaming Qian
Peking Union Medical College Hospital

Research article

Keywords: Eight-year program, medical education, research experience, research outputs

Posted Date: September 28th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-29670/v2

Abstract

Backgrounds: Among the distinct medical education systems in China, the eight-year program is an elite program dedicated to cultivating physician scientists. Although the research ability of senior students in eight-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.

Methods: A multicenter cross-sectional study was conducted in five 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.

Results: 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 two major motivations for research were graduation and 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%, $P = 0.046$).

Conclusions: 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.

Background

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 demand for physician scientists who can promote the progress of modern medical science, medical schools worldwide are designing research courses or 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].

In contrast to 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. The majority of the programs are shown in Additional File 1. Among them, the 8-year medical program is an elite program 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]. However, there's a big challenge to arouse the research interest and engagements of medical students around the world. Lack of time and difficulty finding mentors or projects were the two 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. Eight-year medical program students usually finish premedical learning, basic medicine, clinical medicine courses, the generally required courses of a medical school, 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 five 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.

Methods

Study population

This study was approved by the Medical Review Ethics Committee of Peking Union Medical College Hospital（S-K1208）. Figure 1 showed the flow diagram of this study. A multicenter cross-sectional study was conducted among senior medical students from the eight-year programs of 5 medical schools in northern China, including Peking Union Medical College (PUMC), Tsinghua University (THU), Peking University (PKU), Qingdao University (QU), and Xi'an Jiaotong University (XJTU). 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, PKU and QU, 20 from each grade in XJTU 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.

Questionnaire design

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 respond to the

questions. The questionnaire collection lasted from October 7th, 2019, to November 11th, 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. The composition of the enrolled participants is shown in Figure 2. The questionnaire consisted of the following aspects: (A) demographics, (B) future professional plans, (C) research experience, (D) motivations for research, and (E) research outputs. Research experience 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 two subgroups based on their research experience, and students with research experience were further categorized into a group with research outputs and a group without research outputs, defined as paper publications and successful application for research funding. For details of the English version of the complete questionnaire, please see Additional File 2.

Statistical analysis

Data were exported to an Excel table and analyzed mainly with descriptive methods. The continuous variables with normalized distributions were presented as the mean standard deviation ( ), and Student's *t* test was used for comparisons between two 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 two groups. A chi-square or Fisher's exact test was adopted for the comparison of categorical variables. A two-tailed P value of < 0.05 was considered significant. All statistical analyses were performed using SPSS 22.0 for Windows (IBM, USA).

Results

Baseline characteristics of participants

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 is no significant difference in the demographics among the 5 medical schools (age: $P = 0.374$, gender: $P = 0.187$). 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.

Table 1 Characteristics of the medical students

	Total	With research experience	No research experience	*P value*
	211	142	69	
	80 (37.9%)	55 (38.7%)	25 (36.2%)	0.725
	22.690.93	22.70 0.92	22.68 0.96	0.909
(%)	104 (49.3%)	64 (45.1%)	40 (58.0%)	0.079
lan (multiple choices)				
rs	209 (99.1%)	140 (98.6%)	69	0.323
		22 (15.5%)	6 (8.7%)	0.172
ers	28 (13.3%)	18 (12.7%)	9 (13.0%)	0.940
	27 (12.8%)	15 (10.6%)	3 (4.3%)	0.109
	18 (8.5%)			
edian (range)	4 (3-4)	4 (3-4)	4 (3-5)	0.274
lian (range)	3 (3-4)	3 (3-4)	3 (3-4)	0.538
(%)				0.331
duation or	160 (75.8%)	106 (74.6%)	54 (78.3%)	
	51 (24.2%)	36 (25.4%)	15 (21.7%)	
research (multiple choices)				
from study or	153	107	46	0.185
	86	64	22	0.067
esearch abilities	45	29	16	0.645
esearch groups	54	26	28	0.001
	79	53	26	0.040
ets				
begin research, n (%)				0.001
eriod	53 (25.1%)	42 (29.6%)	11 (15.9%)	
es	125 (59.2%)	86 (60.6%)	39 (56.5%)	
	33 (15.6%)	14 (9.9%)	19 (27.5%)	
ity weaknesses (multiple choices)				
design	112 (53.1%)	75 (52.8%)	37 (53.6%)	0.912
alysis	103 (48.8%)	73 (51.4%)	30 (43.5%)	0.280
ting	77 (36.5%)	53 (37.3%)	24 (34.8%)	0.719
skills	66 (31.3%)	44 (31.0%)	22 (31.9%)	0.895
research and	64 (30.3%)	39 (27.5%)	25 (36.2%)	0.918

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 major pressure came from concern about graduation and future employment (75.8%), which was also the pivotal motivation to conduct research among 160 (75.8%) students. Only 51 (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%). With regard to 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.

Research experience

Table 2 shows the students' research experience. In total, 142 (67.3%) students had previous research experience, including 120 (84.5%) who participated in one or two research projects and 22 (15.5%) who participated in three or more research programs. Among students with research experience, 69 (48.6%) had undertaken one or more research projects as the first applicant. Furthermore, 19 (13.4%) students had applied for nation-funded 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 10-20 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 0.001*). 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.

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

Variables	Numbers and percentage			
	Total (n=142)	With outputs (n=84)	Without outputs (n=58)	*P* value
	22.70 0.92	22.70 0.92	22.69 0.94	0.936
), n (%)	55 (38.7%)	33 (39.3%)	22 (37.9%)	0.871
ıde), n (%)	64 (45.1%)	37 (44.0%)	27 (46.0%)	0.768
	39 (27.5%)	24 (28.6%)	15 (25.9%)	0.839
	35 (24.6%)	21 (25.0%)	14 (24.1%)	
	21 (14.8%)	14 (24.1%)	11 (19.0%)	
	14 (9.9%)	9 (10.7%)	5 (8.6%)	
	33 (23.2%)	20 (23.8%)	13 (22.4%)	
r scientific research training				0.337
	33 (23.2%)	23 (27.4%)	10 (17.2%)	
	84 (59.2%)	48 (57.1%)	36 (62.1%)	
	25 (17.6%)	13 (15.5%)	12 (20.7%)	
s dedicated to research a week				0.172
	12 (8.5%)	9 (10.7%)	3 (5.2%)	
	31 (21.8%)	20 (23.8%)	11 (19.0%)	
	45 (31.7%)	25 (29.8%)	20 (34.5%)	
	42 (29.6%)	25 (29.8%)	17 (29.3%)	
e	12 (8.5%)	5 (6.0%)	7 (12.1%)	
research mentor	123 (86.6%)	75 (89.3%)	48 (82.8%)	0.261
bstacles during research work				0.827
nd anxious	97 (66.2%)	55 (65.5%)	39 (67.2%)	
nd excited	48 (33.8%)	29 (34.5%)	19 (32.8%)	
ulty for	4 (3-4)	4 (3-4)	4 (3-4)	0.995
lian (range)				
ure for	3 (3-4)	3 (3-4)	3 (3-4)	0.205
lian (range)				
or research				0.046
/and employment	92 (64.8%)	60 (71.4%)	32 (55.2%)	
esearch or/and knowledge	50 (35.2%)	24 (28.6%)	26 (44.8%)	

ıg Union Medical College, PKU: Peking University, QU: Qingdao University,
l Doctor Program of Tsinghua University, XJTU: Xi'an Jiaotong University

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 one 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 = 0.046*). 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=0.030*). There was no

difference in gender, grade, school, percentage with fixed mentors, beginning time for research, average weekly time spent on research, or attitude towards obstacles between the two groups.

Discussion

In recent decades, increasingly more 8-year medical programs have been established as elite medical education programs in highly 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 engaging in research for their future career. The majority of them felt moderate to high pressure and found it difficult to conduct research. Concern about graduation and 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 [10-12]. 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*. found that career achievement was related to research experience in medical schools [17]. China has also made great efforts to cultivate physicians' research abilities [2, 13]. PUMC was the first medical school with 8-year program. However, 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 [18]. The findings of our survey indicate that most of the senior 8-year-program medical students recognized 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. However, only 13.3% of them planned to engage in research after graduation. Several studies proved that structured research programs could increase students' interest in research and consequently increase their research outputs [19-20]. 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 [21]. 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 [22]. However, we found no significant difference in research experience and research outputs between male and female students. Failing to identify gender as an influencing factor might be due to different nationality, education background, culture, or limited number of participants.

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 [26-27]. Students performed relatively better in academic reading and writing, probably because the five 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 [28]. Given the major obstacles and the special abilities these students are 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 ($P = 0.618$) or research interest ($P = 0.581$). 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 research project applications. 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 suggests that schools and hospitals have paid increasing attention to research in recent years, which puts pressure on medical students and pushes 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 this multicenter study did not involve all 8-year medical programs in China due to the limitation of time, it surveyed 5 representative medical schools in northern China and could partly show the current status and challenges of their research accomplishment. The difference in curriculums among these five centers, which might introduce bias to the results, is not our focus in this study. To improve the response rate of the survey, there was no request for exact information about the participants' publications or grants, which resulted in a lack of validation of their research outputs. Besides, 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 questions to explore this aspect, and other factors related to curriculum, educational environment, nature of the research program and research could also be further studies. In addition, the online questionnaire survey may decrease authenticity. 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.

Conclusions

Senior eight-year-program medical students in China generally feel high pressure for research and devote 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. Potential measures, including adjustments to the curriculum and education reform programs, might facilitate the goal of cultivating elite physician scientists.

Abbreviations

PUMC: Peking Union Medical College

PKU: Peking University

QU: Qingdao University

THU: Tsinghua University

XJTU: Xi'an Jiaotong University

Declarations

Ethics approval and consent to participate: This study was approved by the Medical Review Ethics Committee of Peking Union Medical College Hospital. 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. And no participant under 16 years old was involved.

Consent for publication: Not applicable.

Availability of data and materials: The dataset supporting the conclusions of this article is included within the article and its additional files.

Competing interests: The authors declare that they have no competing interests.

Funding: Education Reform Projects of Peking Union Medical College (No.2017zlgc0110). The founders have no involvement in this study.

Authors' 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 and JQ 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.

AcknowledgeThanks to all students and medical schools for their active participation and help in this survey.

References

1. Milewicz, D. M., et al. (2015). "Rescuing the physician-scientist workforce: the time for action is now." J Clin Invest **125**(10): 3742-3747.
2. Fukuhara, S., et al. (2012). "Nurturing clinician investigators is the best way to promote innovative drug development from academia." Brain Nerve **64**(3): 225-228.
3. Song, P., et al. (2017). "New medical education reform in China: Towards healthy China 2030." Biosci Trends **11**(4): 366-369.
4. The, L. (2017). "Medical education reform in China." Lancet **390**(10092): 334.
5. Wang, Z., et al. (2015) “The expansion of 8-year medical training programs in China: a status report.” Medical Education Online, **20**(1), 25890.
6. Chang, Y., & Ramnanan, C. J. (2015) “A review of literature on medical students and scholarly research: experiences, attitudes, and outcomes.” Acad Med, **90**(8), 1162-1173.
7. Funston, G., et al. (2016) “Medical student perceptions of research and research-orientated careers: An international questionnaire study.” Medical Teacher, **38**(10), 1041-1048.
8. Liu S., et al. (2018) “Research on practical experiences and attitudes of scientific training among 8-year program medical students at Peking Union Medical College.” Basic & Clinical Medicine **38**(10): 1505-1508.
9. Levine S., (2017) “Sino-U.S. partnerships in research, education, and patient care: The experience of the University of Pittsburgh and UPMC.” Science China (Life Sciences) **10**:98-104.
10. Harding, C. V., et al. (2017). "History and outcomes of 50 years of physician-scientist training in medical scientist training programs." Acad Med **92**(10): 1390-1398.
11. Dyrbye, L. N., et al. (2008). "Publications and presentations resulting from required research by students at Mayo Medical School, 1976-2003." Acad Med **83**(6): 604-610.
12. Laskowitz, D. T., et al. (2010). "Engaging students in dedicated research and scholarship during medical school: the long-term experiences at Duke and Stanford." Acad Med **85**(3): 419-428.
13. Ali, F., et al. (2017). "Doctoral level research and training abilty in the social determinants of health at universities and higher education institutions in India, China, Oman and Vietnam: a survey of needs." Health Res Policy Syst **15**(1): 76.
14. Bonilla-Escobar, F. J., et al. (2017). "Medical student researchers in Colombia and associated factors with publication: a cross-sectional study." BMC Med Educ **17**(1): 254.
15. Chang, Y. and C. J. Ramnanan (2015). "A review of literature on medical students and scholarly research: experiences, attitudes, and outcomes." Acad Med **90**(8): 1162-1173.
16. Cheng, X. and Chen, J. (2019). “An exploration of medical education in central and southern china: measuring the professional competence of clinical undergraduates.” Int. J. Environ. Res. Public

Health **16**: 4119.

17. Brancati, F. L., et al. (1992). "Early predictors of career achievement in academic medicine." Jama **267**(10): 1372-1376.
18. JIN Jing, et al. (2017). “Scientific research ability cultivation's status quo and reform suggestion of eight-year clinical medical education program” Basic & Clinical Medicine 37(12): 1782-1784
19. Dorrance, K. A., et al. (2008). "An internal medicine interest group research program can improve scholarly productivity of medical students and foster mentoring relationships with internists." Teach Learn Med **20**(2): 163-167.
20. Zier, K., et al. (2006). "Supportive programs increase medical students' research interest and productivity." J Investig Med **54**(4): 201-207.
21. Bensken, W. P., et al. (2019). "Future Directions of Training Physician-Scientists: Reimagining and Remeasuring the Workforce." Acad Med **94**(5): 659-663.
22. Epstein, N., & Fischer, M. R. (2017). “Academic career intentions in the life sciences: Can research self-efficacy beliefs explain low numbers of aspiring physician and female scientists?” PloS one, **12**(9), e0184543.
23. Mao, Y., et al. (2019). "A systematic review of depression and anxiety in medical students in China." BMC Med Educ **19**(1): 327.
24. Weber, J., et al. (2019). "Stressors and resources related to academic studies and improvements suggested by medical students: a qualitative study." BMC Med Educ **19**(1): 312.
25. Kumar, B., et al. (2019). "Depression, anxiety, and stress among final-year medical students." Cureus **11**(3): e4257.
26. Mubuuke, A. G. and F. Businge (2019). "Self-reported competence and impact of research training among medical radiography graduates from a developing country." J Med Imaging Radiat Sci **50**(1): 113-118.
27. Bonilla-Escobar, F. J., et al. (2017). "Medical student researchers in Colombia and associated factors with publication: a cross-sectional study." BMC Med Educ **17**(1): 254.
28. Riva, J. J., et al. (2019). "Medical students' challenges and suggestions regarding research training: a synthesis of comments from a cross- sectional survey." Can Med Educ J **10**(3): e91-e100.

Figures

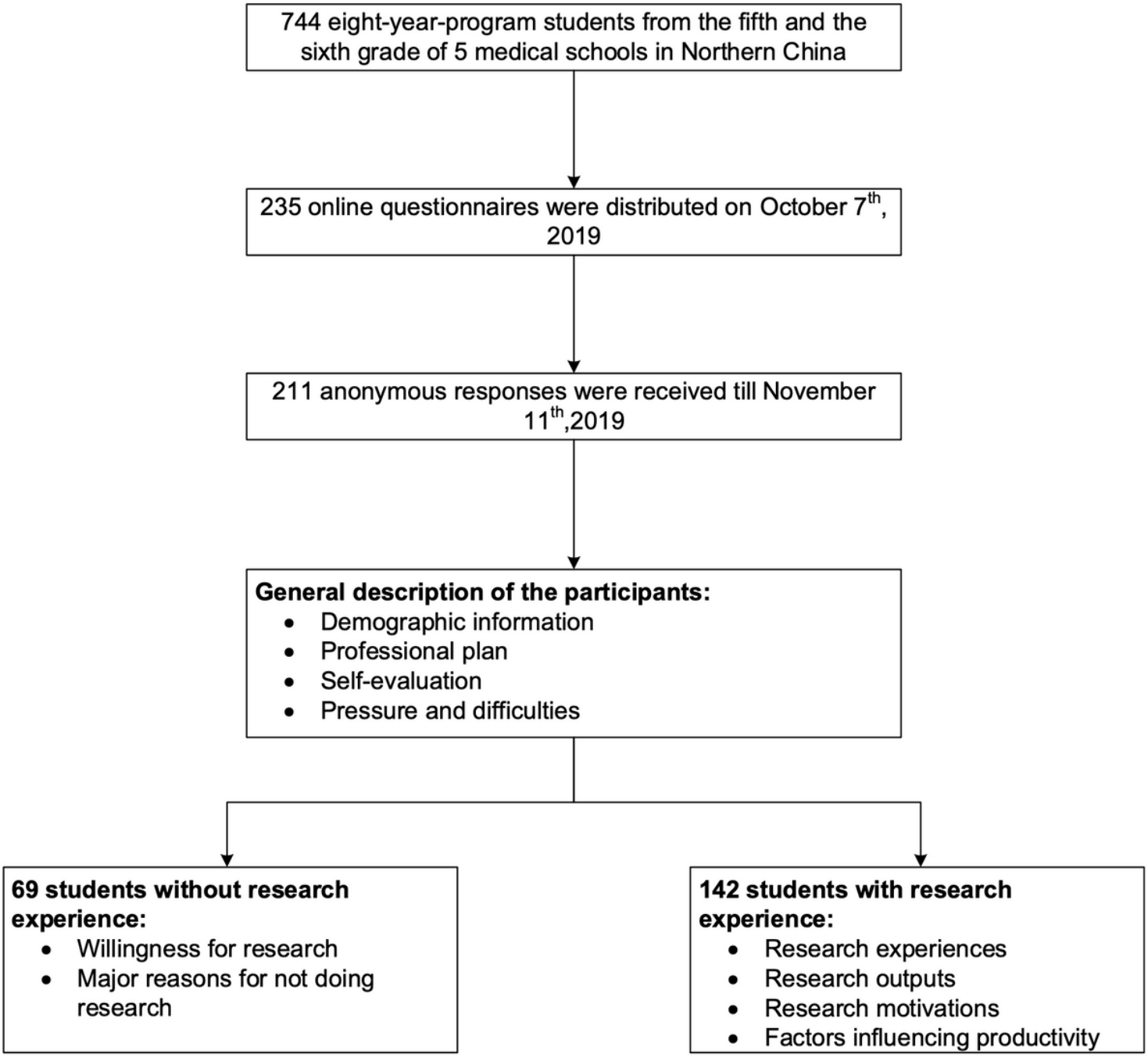

Figure 1

Flow chart of this study.

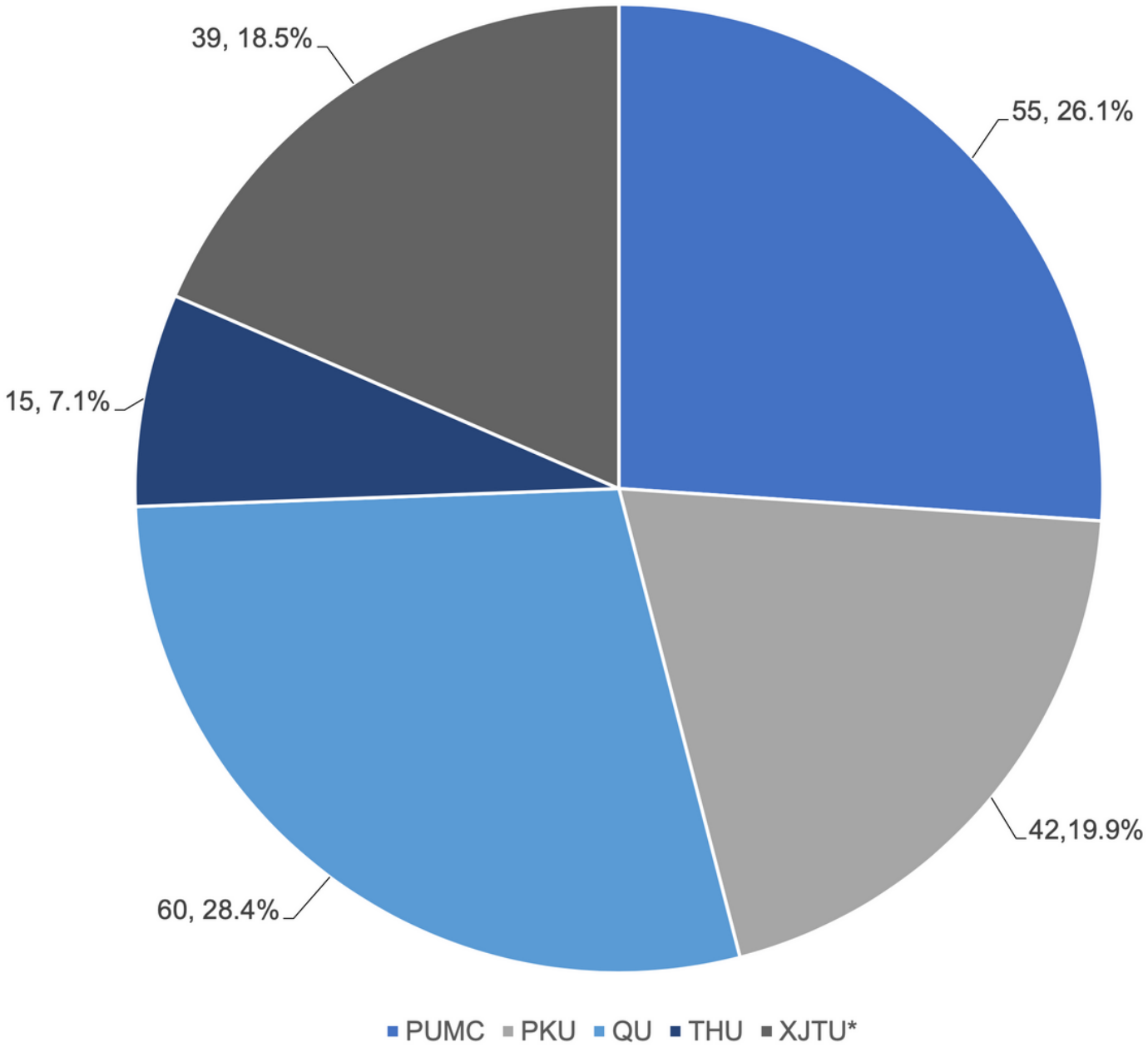

Figure 2

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

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1.pdf