The most important evaluation index for postgraduate medical students' scientific research capacity: A cross-sectional survey in Shanghai, China

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Abstract

Background

Postgraduate medical students’scientific research capability is an essential part for educational system, the current research on students’ research behavior mainly focused on the students’research attitude ,innovative ability and training methods and approaches. Therefore, we carried out this study to explore the evaluation index of postgraduate medical students’scientific research capacity,in order to establish a framework of postgraduate medical students’scientific evaluation.

Methods

We designed a 39-items questionnaire to explore the evaluation index of research capacity on the perspective of postgraduate students .The questionnaire consisted of items including demographics and other 34 items about index reflect one’s scientific research ability.The participants choose the number(1-5) according the importance of each items they think.1 means not important at all;2 means not important;3 means neutral;4 means important;5 means very important.

Results

The most important indices are ”Follow three basic ethical principles: respect, benefit and justice”(4.46±0.845);”Resist behaviour such as"data fraud, submission fraud" and other academic misconduct(4.44±0.922)”;”Adhere to the principle of patient-oriented, fully informed and voluntary participation”(4.36±0.871);”The questionnaire can be divided into four parties”Research skills and output(36.046%)”,“Theoretical and practical basis(16.034%)”,”Study Attitude(14.411)”,”Ethical of research(8.371%)”.

Conclusion

We should strengthen the training of scientific research ethics knowledge, ethical consciousness and scientific research ethics of postgraduate medical students;Improve the consciousness of patent granted;Enhance the research interest of clinical-oriented students and verify the scientific of the questionnaire further.

Background

Postgraduate medical training is an important part of the training process when becoming a medical doctor[1-3]. Postgraduate medical training is an essential requirement to ensure that doctors are competent in their profession[4]. In China, as in many other countries worldwide, postgraduate medical students’ capability for scientific research is an essential part of the educational system. Scientific research can not only make students richer in their thought processes but also update students on the latest advances in medicine[5] and enhance their ability to solve problems, make decisions, and provide high-quality health care services. Therefore, developing the capability for scientific research is a core feature of postgraduate education.[6,7]

However, current studies on students’ research behaviour have mainly focused on students’ research attitude, innovative ability and training methods and approaches[8-12]. Most universities do not have a unified and reasonable system for evaluating the scientific research capability of students. The evaluation of scientific capability for college students can provide a workable basis for objectively investigating undergraduates’ ability to be innovative. In addition, scientific capability can promote students’ initiatives to be innovative and creative and can encourage students to actively innovate[13].

In the future, medical students will play vital roles in health care services. While China has witnessed a dramatic urbanization process and an increased enrolment of college students in the past decade, an appropriate index system to evaluate postgraduate students’ comprehensive capability of scientific research does not yet exist[14]. Scientific research can not only stimulate students’ interest and curiosity to exploit their own creative spirit and practice their ability to work independently but also make students familiar with advanced concepts of modern engineering design, work flow, production processes and problem solving, which will lay a foundation for future work. At present, an increasing number of scientists worldwide pay considerable attention to strengthening scientific research and the capability for technological innovation, and these scientists are consciously developing activities for college students, such as organizing students to participate in research activities, scientific and technological competitions, or training of research methods. However, very few researchers have mentioned how to evaluate students’ scientific research capability and what contributes to the research ability of students, especially among postgraduate medical students.

Therefore, we carried out this study to explore the evaluation index of postgraduate medical students' scientific research capacity to establish a framework of postgraduate medical students' scientific evaluation and propose suggestions to improve their research capacity.

Methods

Study design

A cross-sectional study using opportunity sampling was implemented. We conducted a survey in Fudan University in Shanghai, China. Participation in the study was voluntary, and the involved students signed informed written consent forms before participating in the study. This study was approved by the Committee on Human Experimentation of each institution before their students participated in the study, and the study procedures were in accordance with ethical standards. The questionnaire was designed to explore the evaluation index of postgraduate medical students' scientific research capacity, providing an evidence base for managers to help students improve their research capacity and increase their research outcomes.

Instruments

We designed a 39-item questionnaire to explore the evaluation index of research capacity from the perspective of postgraduate students.We design the questionnaire through literature research expert consultation and group discussion .The discussion group including tutors and management secretary of postgraduates and some management experts.finally,The questionnaire consisted of items inquiring about demographics and another 34 items asking students to reflect about one's scientific research ability.The questionnaire includes: the general situation of the respondent, the constituent elements reflecting the scientific research ability (scientific research basis, scientific research attitude, scientific research quality, scientific research output 4 first-level indicators; theoretical basis, clinical basis and other 20 second-level indicators, as well as course scores and theory 33 third-level indicators including background) .

The participants chose a number (1-5) according to their belief of the importance of each item. The number 1 means the item is not very important; 2 means not important; 3 means neutral; 4 means important; and 5 means very important. Via convenience sampling, a total of 300 questionnaires were sent to 300 students, including master's and doctoral degree students majoring in medicine at Fudan University, and 263 students responded (response rate, 87.7%). Among these questionnaires, 263 were usable (100%).

Statistical analysis

The data were collected in Epidata version 3.1 and exported to SPSS version 20 for analysis. Variance and descriptive statistical analysis was conducted to determine the most important index in evaluating the research capacity from the perspective of postgraduate students and to explore the framework of evaluation of research capacity. First, we point outed the score of different indices using descriptive statistical methods. Second, we conducted variance analysis between the different demographics. Last, we explored the proportion of each index with factor analysis. In this study, variables with a p-value < 0.05 were considered to be significantly associated. The results are shown in Table 1.

Results

Descriptive results of demographics

As seen from Table 1, a total of 263 students participated in this survey. Among them, males comprised 18.6% of the participants, and females comprised 81.4% of the participants. With respect to the degree of education, 74.5% of the participants were master's students and 25.5% were doctoral students. With respect to professional types, 64.3% of the participants were study-oriented and 35.7% were clinical-oriented.

The importance of "research quality" ranks first among the first-level indicators of scientific research capabilities

As shown in Table 2, among the four first-level indicators of graduate scientific research ability, the score from high to low is scientific research quality (4.12 ± 0.79), scientific research foundation (4.08 ± 0.72), scientific research attitude (4.02 ± 0.72), scientific research Output (3.95 ± 0.92). Among them, the score of" scientific research quality" is the highest, and the score of "scientific research output "is the lowest. This indicates that the respondents believe that the importance of "research quality" ranks first among the first-level indicators of scientific research capabilities. In comparison, the score of“scientific research output ”is lower than other indicators, indicating that its importance is relatively weak, indicating that the respondents believe that scientific research output is not the most important indicator reflecting the scientific research ability of graduate students. Prompt colleges and universities should not pay too much attention to "scientific research output" in the cultivation of graduate scientific research capabilities, but should focus on training students to discover scientific research problems , master scientific research skills, data processing capabilities, and comprehensively improve the scientific research strength of postgraduate students.

Study-oriented postgraduate pay more attention to the cultivation of scientific research ability than other types of students

As shown in Table 2, the difference in the scores of the three first-level indicators of scientific research attitude, scientific research quality and scientific research output of postgraduates of different types is statistically significant (P <0.05). Among them, Study-oriented postgraduate score higher than the clinical-oriented and equivalent academic postgraduates in the three first-level indicators. It shows that study-oriented postgraduate have higher expectations and requirements for the improvement of scientific research ability. In addition, in a longitudinal comparison of the scores of different first-level indicators for students of the same degree type, it is found that the highest score for academic graduates is "scientific research quality"; the highest score for clinical-oriented and equivalent academic postgraduates are "Scientific research foundation" shows that the latter two types of graduate students pay more attention to the cultivation of "curriculum achievement", "project theoretical foundation" and "clinical practice foundation".

The score of each indicator

As is shown in Table3,among all the indicators we surveyed, the top five indicators ranked by score are as follows: “Follow three basic ethical principles: respect, benefit and justice” (4.46±0.845); “Resist behaviour such as "data fraud, submission fraud" and other academic misconduct” (4.44±0.922); “Adhere to the principle of patient-oriented, fully informed and voluntary participation” (4.36±0.871); “Have a solid theoretical base about the study” (4.35±0.766); “Be able to discover problems in clinical practice” (4.31±0.926); and “Be able to discover problems in the literature reading” (4.31±0.810). The last five indices are as follows: “Research results can be patented” (3.55±1.286); “Proficient in Epidata/SPSS/SAS and other statistical software” (3.86±1.082); “Have a good mark in specialized courses” (3.91±0.939); “Devote more time to scientific research” (3.92±1.078); and “Be able to write scientific research projects” (3.95±0.999).

The analysis of variance shows that for “education degree”, the difference between master’s students and doctoral students is statistically significant for “Consult predecessors positively” ($F=4.991$, $P<0.05$) and “Be able to publish papers in high quality journals abroad (SCI)” ($F=5.029$, $P<0.05$). For the item “Consult predecessors positively”, the average score of doctoral students (4.48±0.823) was higher than that of master’s students (4.20±0.888); for the item “Be able to publish papers in high quality journals abroad (SCI)”, the average score of doctoral students (4.24±1.031) was higher than that of master’s students (3.86±1.235).

For “professional types”, there are 27 items that differ between study-oriented students and clinical-oriented students, and the differences are statistically significant. The average score of study-oriented students was higher than that of clinical-oriented students on all 27 items. They were “Have a solid theoretical base about the study” ($F=6.374$, $P=0.012$)and so on,As shown in Table3.

Exploratory factor analysis of the questionnaire

We used exploratory factor analysis to explore the construct validity of the questionnaire. To understand the internal structure of the questionnaire after analysing the items, we analysed whether the observed variables could be well measured to achieve the purpose of the screening indicators. First, the results of the KMO and Bartlett tests show that the value of KMO is 0.965, and the Bartlett value is 10089.943, $P<0.001$. This indicates that these data are suitable for factor analysis. The exploratory results are shown in Table 4.

In this study, we can determine the number of factors from the eigenvalue. As shown in Table 3, the questionnaire can be divided into four main factors according to the principal components analysis. The characteristic values of the four components exceed 1, and the ratio of explanatory variance is 36.046%, 16.034%, 14.411%, and 8.371%. The cumulative explanatory variance is 74.862%, which represents the scientific and reliable structure of the overall questionnaire.

In this study, dimensions were extracted by principal components analysis and rotated by Varimax rotation. In terms of common degree, the variance of common factors of all items was above 0.5, indicating that common factors have explained most of the variation of the observed variables. Therefore, the structure was reasonable. Then, we analysed the project composition of each dimension, and each dimension was named as follows:

Dimension 1: Theoretical and practical basis, including “Have a good mark in specialized courses”; “Have a solid theoretical base about the study”; and “Have experience in clinical treatment”.

Dimension 2: Study attitude, including “Devote more time to scientific research”; “Have a strong interest in scientific research”; “Be confident in what he/she researches”; and “Consult predecessors positively”.

Dimension 3: Research skills and output, including “Be able to discover problems in clinical practice”; “Be able to discover problems in course study”; “Be able to discover problems in the literature reading”; “Make full use of all kinds of databases”; “Be able to understand domestic and international literature”; “Be able to understand advanced scientific questions”; “Be able to use novel research methods”; “The results can solve scientific problems that have not been solved by others”; “Be able to write scientific research projects independently”; “Be able to write proposal reports independently”; “Have excellent epidemiological thoughts”; “The designed technology is scientific and reasonable”; “Be able to select statistical methods correctly”; “Proficient in Epidata/SPSS/SAS and other statistical software”; “Be able to explain and discuss the statistical results reasonably and accurately”; “Experimental operation process is standardized and accurate”; “Scientific research records are complete and timely”; “ Have a good sense of teamwork”; “Be able to allocate human participants and financial resources reasonably”; “Be able to write research papers in both Chinese and English”; “The research results provide guidance for disease diagnosis, treatment and prognosis”; “Be able to publish papers in core domestic journals”; “Be able to publish papers in high quality journals abroad(SCI)”; and “Research results can be patented”.

Dimension 4: Ethical standards of research, including “Resist behaviour such as "data fraud and submission fraud" and other academic misconduct”; “Adhere to the principles of patient-oriented, fully informed and voluntary participation”; and “Follow the three basic ethical principles of respect, benefit and justice”.

Discussion

With the development of medical enterprises and increased competition, the innovation of medical technology plays an increasingly prominent and even decisive role in the competitiveness of a country[15,16]. Postgraduate medical students are the backbone of innovation and serve as reinforcements for health care reform to build innovative countries that carry the historical mission of national and social development[17].

Research capability training is a fundamental task of universities, and to trainand foster a number of high-level and high-quality personnel is an important indicator of high-level medical education[18]. Research capability is one of the most important abilities in the cultivation of postgraduate students, and evaluation of research capabilities is the key to measuring and improving postgraduate students’ scientific literacy and cultivating quality[19]. According to the results of our study, we found the following:

First, for the participants, in their opinion, whether they can avoid academic misconduct and strictly follow the ethics of research is the most important index to evaluate the research ability of postgraduate medical students. The results of this study show that the top three indicators all focus on ethics, and their scores are all above 4.36 and close to “very important”. These results illustrate that the participants pay more attention to research ethics, and the participants put research ethics at the top of their research capability evaluation.

Second, The survey found that graduate students scored the lowest in the "research results for patent application" item, indicating that compared with other indicators, graduate students do not pay much attention to research results for patents grants.The scores is below 4, illustrating that the participants believe this indicators is less important in the evaluation of postgraduate medical students. These results deserve urgent attention. These results may be a signal of insufficient attention to patent awards by postgraduate.Therefore, increasing the degree of attention paid by graduate students to patent applications is very important . On the one hand, the intellectual property protection and incentive policy should be strengthened, and the college should provide professional technical support to the patent application team or individual, increase the incentives for patent grants, and increase the enthusiasm for graduates to apply for patents; on the other hand, the education management department should strengthen. The promotion and popularization of patent knowledge creates an atmosphere that values the protection of intellectual property rights.

Third, there are differences between the different education degrees of the students. Doctoral candidates pay more attention to “Consult senior predecessors” and “Publish papers in high quality journals abroad (SCI)” than master’s degree candidates. The findings illustrate that doctoral candidates think that consulting senior colleagues actively and publishing high-quality academic papers play a crucial role in postgraduate research activities. These results remind us that these are important indicators in the research capability evaluation of doctoral candidates.

Fourth, there are differences between different professional types. The average score of study-oriented students is higher than that of clinical-oriented students on all 27 items. This is mainly because study-oriented students pay more attention to improving research capability in contrast to the clinical-oriented students, and universities and graduate advisors have a stricter demand about research ability regardless of type, either ordinary research activity or an activity for graduation. Correspondingly, the study-oriented students attach importance to all kinds of scientific research skills.

Last, this questionnaire has a good KMO and Bartlett test value and is suitable for factor analysis. According to the results of the factor analysis, the questionnaire can be divided into four main factors. They are “Theoretical and practical basis”, “Study attitude”, “Research skills and output”, and “Ethics of research”. The reliability and validity of the questionnaire are good and suitable for a wide range of applications.

Above all, in our study, we found that postgraduate students pay more attention to research ethics. Postgraduate students think it is the most important evaluation index of one’s research capability. At the same time, we also found that the patent granted during the scientific research activity of postgraduate medical students has a shortage of attention. Its intrinsic reason is worth pondering. In addition, we found that doctoral students and study-oriented students have a higher score on many items, reflecting that they give importance to the evaluation and improvement of research capability. Finally, the questionnaire we designed and the evaluation index we established has good reliability and validity, and we are waiting for both to be applied to large sample studies.

Limitations

This study has some limitations. First, in this study, we used opportunity sampling. This may affect the representativeness of the sample to some extent. Taking this sampling method into consideration, we increased the number of samples and strengthened the assessment towards the sample. However, random sampling methods should be used in future studies. Second, this study was conducted only at Fudan University. Therefore, caution should be exercised in making generalizations across different hospitals and countries.

Conclusions

This study gives us two enlightenments: One is that when evaluating the scientific research ability of postgraduate students, universities should focus on improving the quality of scientific research as a guide and avoid "results-oriented ". Attention should be paid to the accumulation of the theoretical foundation of students, the improvement of scientific research skills and the cultivation of the innovative thinking process of scientific research.On the other hand, in order to better quantify and evaluate the scientific research capabilities of graduate students, it is recommended that scholars at home and abroad strengthen the research on the evaluation index system of postgraduate scientific research capabilities.

Declarations

Ethics approval and consent to participate

This study did not involve any human data or private information . At the same time, participation in this study was voluntary, and the students involved in this research signed informed written consent forms before participating in the study. This project was formally determined to be quality improvement, not human subjects research, and was therefore not overseen by the Institutional Review Board,There is no committee reference number to be given.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analysed in the current study are available from the corresponding author upon reasonable request.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

YW contributed to drafting the article and critically revising the article for intellectual content. FFZ contributed to the conception and design of the project, critical input, and original ideas and gave final approval of the article. All authors critically reviewed the report and approved the final manuscript.

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Tables

Table 1 Demographic characteristics of all participants (n=263)

Respondents	n	%
Gender		
Male	49	18.6%
Female	214	81.4%
Education degree		
Master’s degree	196	74.5%
Doctoral degree	67	25.5%
Professional types		
Study-oriented	169	64.3%
Clinical-oriented	94	35.7%

$p^c < 0.001$; $p^b < 0.01$; $p^a < 0.05$

Table 2 The scores of the first-level indicators of scientific research capabilities

First-level Indicators	Average Score	Study-oriented	Clinical-oriented	Equal academic ability postgraduate	F value	P value
scientific research basis	4.08±0.72	4.12±0.74	3.98±0.71	4.45±0.53	1.746	0.178
Scientific research attitude	4.02±0.85	4.26±0.68	3.67±0.96	3.71±1.12	9.964	0.000[c]
scientific research quality	4.12±0.79	4.32±0.65	3.82±0.89	4.05±1.08	7.755	0.001[c]
scientific research output	3.95±0.92	4.15±0.71	3.64±1.13	3.94±1.12	5.715	0.004[c]

Table 3 Score of each indicator

Item	Mean±SD	Education degree		Professional types	
		F	P	F	P
1、Have a good mark in specialized courses	3.91±0.939	2.839	0.093	1.270	0.261
2、Have a solid theoretical base about the study	4.35±0.766	0.432	0.512	6.374	0.012[b]
3、Experienced in clinical treatment	4.17±0.874	0.583	0.446	0.256	0.613
4、Devote more time to scientific research	3.92±1.078	0.867	0.353	32.055	0.000[c]
5、Have a strong interest in scientific research	4.08±0.993	0.052	0.820	6.095	0.014[a]
6、Be confident in what he/she researches	3.99±1.008	1.113	0.292	9.946	0.002[b]
7、Consult predecessors positively	4.27±0.879	4.911	0.028[a]	7.718	0.006[b]
8、Be able to discover problems in clinical practice	4.31±0.926	0.353	0.553	2.485	0.116
9、Be able to discover problems in course study	4.18±0.857	0.688	0.408	3.727	0.055
10、Be able to discover problems in the literature reading	4.31±0.810	3.305	0.070	6.550	0.011[a]
11、Make full use of all kinds of databases	4.29±0.892	1.374	0.242	4.445	0.036[a]
12、Be able to understand domestic and international literature	4.26±0.930	3.186	0.075	5.842	0.016[a]
13、Be able to understand advanced scientific questions	4.12±0.993	0.300	0.584	15.361	0.000[c]
14、Be able to use novel research methods	3.98±0.979	0.011	0.917	8.783	0.003[b]
15、Solve scientific problems that have not been solved by others	4.04±1.016	1.645	0.201	14.091	0.000[a]
16、Be able to write scientific research projects independently	3.95±0.999	0.018	0.894	4.698	0.031[a]
17、Be able to write proposal reports independently	4.04±0.940	0.943	0.332	4.605	0.033[a]
18、Have excellent epidemiological thoughts	4.04±1.012	0.028	0.867	4.696	0.031[a]
19、The designed technology designed is scientific and reasonable	4.13±0.932	2.018	0.157	12.589	0.000[c]
20、Be able to select statistical methods correctly	4.16±0.994	0.132	0.717	5.313	0.022[a]
21、Proficient in Epidata/SPSS/SAS and other statistical software	3.86±1.082	0.008	0.929	2.563	0.111
22、Be able to explain the statistical results reasonably and accurately	4.17±1.031	0.146	0.703	10.684	0.001[b]
23、Experimental operation process is standardized and accurate	4.14±1.017	0.902	0.343	15.039	0.000[c]
24、Scientific research records are complete and timely	4.12±1.052	0.146	0.702	12.628	0.000[c]
25、Have a good sense of teamwork	4.15±0.924	0.790	0.375	5.228	0.023[a]
26、Be able to allocate human participants and financial resources reasonably	4.04±0.978	0.101	0.751	3.903	0.049[a]
27、Be able to write research papers in both Chinese and English	4.05±1.025	2.292	0.131	8.795	0.003[b]
28、Resist behaviour such as "data fraud and submission fraud" and other academic misconduct	4.44±0.922	2.586	0.109	5.362	0.021[a]
29、Adhere to the principle of patient-oriented, fully informed and voluntary	4.36±0.871	0.209	0.650	1.755	0.186
30、Follow three basic ethical principles: respect, benefit and justice	4.46±0.845	0.069	0.793	7.600	0.006[b]
31、The research results provide guidance for disease treatment	4.25±0.927	0.690	0.407	3.407	0.066

32 Be able to publish papers in core domestic journals	4.01±1.103	0.051	0.821	7.416	0.007^{b}
33 Be able to publish papers in high quality journals abroad(SCI)	3.96±1.196	5.029	0.026^{a}	14.114	0.000^{c}
34 Research results can be patented	3.55±1.286	0.106	0.747	4.841	0.029^{a}

$p^{c} < 0.001$; $p^{b} < 0.01$; $p^{a} < 0.05$

Table 4 Exploratory factor analysis of principal components analysis

Components	Initial Eigenvalues			Extract the sum of squares			Rotate the sum of squares		
	Total	Variance%	Accumulated %	Total	Variance %	Accumulated %	Total	Variance %	Accumulated %
1	20.881	61.414	61.414	20.881	61.414	61.414	12.255	36.046	36.046
2	2.054	6.043	67.456	2.054	6.043	67.456	5.452	16.034	52.080
3	1.352	3.977	71.433	1.352	3.977	71.433	4.900	14.411	66.491
4	1.116	3.429	74.862	1.166	3.429	74.862	2.846	8.371	74.862
5	0.867	2.549	77.411						
6	0.645	1.897	79.308						
7	0.609	1.793	81.101						
8	0.558	1.642	82.743						
9	0.526	1.548	84.290						
10	0.488	1.434	85.725						
11	0.415	1.220	86.945						
12	0.391	1.150	88.095						
13	0.355	1.044	89.139						
14	0.334	0.981	90.120						
15	0.308	0.906	91.026						
16	0.284	0.834	91.862						
17	0.265	0.780	92.642						
18	0.247	0.728	93.370						
19	0.236	0.694	94.064						
20	0.219	0.645	94.709						
21	0.210	0.619	95.328						
22	0.191	0.561	95.888						
23	0.180	0.531	96.419						
24	0.158	0.464	96.883						
25	0.151	0.443	97.326						
26	0.134	0.394	97.721						
27	0.123	0.361	98.082						
28	0.115	0.338	98.416						
29	0.109	0.322	98.741						
30	0.103	0.302	99.043						
31	0.097	0.285	99.328						
32	0.087	0.255	99.582						
33	0.077	0.227	99.809						
34	0.065	0.191	100.000						

Extraction method: principal components analysis