Original Article

Survey on status quo and development needs of research and innovation capabilities of young researchers at university-affiliated hospitals in China: a cross-sectional survey

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Background: Researches in China on the innovation ability and development needs of young scientific research talents is not enough. The survey is aimed to shed light on the status quo, problems, and development needs of research and innovation capabilities among young researchers in terms of orientation, innovation atmosphere, platform support, training mechanisms, and training measures.

Methods: From January to March 2022, a randomly-selected method was used to conduct a web-based self-made questionnaire survey on young talents in 6 university affiliated hospitals in 5 provinces in China. Intergroup comparisons were based on the chi-square test or Fisher' exact test.

Results: Overall, 586 usable responses had been collected, including 233 from full-time researchers and 353 from part-time researchers. 182 (31.06%) researchers believe that they have the ability to master innovative theories, tools and methods, 136 (23.21%) researchers choose "working alone". Compared with part-time research talents, the proportion of full-time research talents self-assessed as "very good" in scientific research innovation ability is higher (χ^2=17.048, P<0.001). Full-time researchers had less knowledge about the relevant policies at their affiliation (χ^2=3.190, P=0.074), were more likely to believe that the "talent management system" had a greater impact (χ^2=4.906, P=0.027), and had higher expectations of "multiple incentive mechanisms" (χ^2=10.312, P=0.001). In contrast, the proportion of part-time researchers who hoped that their affiliation would take measures such as "increasing financial investment" (χ^2=9.049, P=0.003) and "strengthening external supports" (χ^2=8.383, P=0.004) was significantly higher.

Conclusions: Full-time and part-time scientific researchers have different requirements for capital investment, support for scientific research platforms, leadership demonstrations by senior peers, and a good atmosphere for scientific and technological innovation. Thus, it is important to promote innovation capacity-building among young researchers at university-affiliated hospitals (UAHs) by enhancing both talent training and introduction in a hierarchical, classified, multidimensional, and stepwise manner.

Keywords: Young researchers; university-affiliated hospitals (UAHs); research and innovation capabilities; development needs

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Introduction

The training of young researchers has long been a top priority of national strategies in most countries. As China has adopted the national strategies of "Rejuvenating China with Culture, Science and Technology", a large number of young scientific and technological talents are needed. Accordingly, more efforts should be made to train young scientific and technological talents and support them to play the leading roles (1,2). University-affiliated hospitals (UAHs) offer direct platforms for talents. Young researchers, as a national strategic resource, are core to the competitiveness of UAHs in research and innovation (3). Many countries attach great importance to the growth law of young scientific and technological innovation talents, and have formulated a series of policies and plans to promote the development of young scientific and technological innovation talents, they provide support for the development of scientific and technological innovation of young talents in terms of assistance mode and improvement of evaluation methods (4). In the existing research, there are many theoretical explorations, insufficient empirical research, lack of top-level design of current policies to support young scientific and technological talents, lack of systematic arrangements for the rapid growth of young scientific and technological talents, and insufficient scientific and technological innovation vitality of young scientific and technological talents (5).

How to meet the strategic needs of the Communist Party of China (CPC) and the government for scientific and technological talents and how to cultivate outstanding young scientific and technological talents have become major issues facing UAHs. In this research, we conducted a survey among young researchers at six UAHs in five provinces and municipalities of China to better understand the status quo and development needs of young researchers in scientific research and innovation at UAHs, comparative analysis of the current situation and development needs of full-time and part-time young talents' scientific research and innovation ability, to explore optimize training mechanisms for young researchers, promote career development of young researchers, and inform the construction and development of young talent training programs in other UAHs. We present the following article in accordance with the SURGE reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-22-3692/rc).

Methods

Data sources

From January 5, 2022 to March 20, 2022, a randomly-selected method was used to conduct a web-based questionnaire survey on young talents under the age of 40 in 6 university affiliated hospitals in 5 provinces and cities in China. questionnaires were distributed via the WJX.cn website or app to the randomly-selected researchers at some universities. A self-designed questionnaire, *Survey on Research and Innovation Capabilities of Young Researchers in University-affiliated Hospitals* (Appendix 1), Reliability and validity analyses indicating the reliability and structural validity of the questionnaire were good. was developed after a literature review and pilot surveys (6-8). Based on the currently available questionnaires at home and abroad, revisions were made according to the results of pilot surveys. After discussions among the project members, an electronic questionnaire was finally formed. The questionnaire was mainly composed of objective-type questions, aiming to reveal the status quo and improvement strategies for the research and innovation capabilities of young researchers at UAHs in relation to the orientation, innovative atmosphere, platform support, training mechanisms, and training measures. The content of the questionnaire included a description of the survey purpose, personal information, evaluation of innovation ability (self-evaluation and objective evaluation), institutional support, and future prospects. The questionnaire consisted of four parts, including a total of 14 single-choice questions and 15 multiple-choice questions, with each option corresponding to a specific score. This questionnaire was distributed to a total of 650 randomly-selected part-time and full-time scientific researchers aged 40 and below at UAHs in five provinces and municipalities in the Eastern, Western, Central, Southwest, and Northern regions of China. Through direct contact with hospital management staff via the WeChat app, researchers were asked to voluntarily fill in the questionnaire, free of charge. In total, 592 valid questionnaires were collected, yielding a 91.07% response rate. In addition, questionnaires with numerous missing values were ruled out after dual verification, and 586 valid questionnaires entered final analysis, which ensured the reliability and authenticity of our study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), and approved

Table 1 Demographic data of 586 respondents

Item	Number	Part-time researchers	Full-time researchers	χ^2	P value
Gender					
Male	296 (50.51)	183 (51.84)	113 (48.50)	0.628	0.428
Female	290 (49.49)	170 (48.16)	120 (51.50)		
Age					
30 years old or younger	134 (22.87)	77 (21.81)	57 (24.46)	1.108	0.575
31–35 years old	278 (47.44)	166 (47.03)	112 (48.07)		
36–40 years old	174 (29.69)	110 (31.16)	64 (27.47)		
Professional title					
Senior	101 (17.24)	64 (18.13)	37 (15.88)	0.498	0.480
Junior and mid-level	485 (82.76)	289 (81.87)	196 (84.12)		
Education background					
Master's degree	109 (18.60)	71 (20.11)	38 (16.31)	1.342	0.247
Doctorate degree	477 (81.40)	282 (79.89)	195 (83.69)		
Period of service					
0–5 years	323 (55.12)	203 (57.51)	120 (51.50)	2.046	0.153
Over 5 years	263 (44.88)	150 (42.49)	113 (48.50)		
Total	586 (100.00)	353 (60.24)	233 (39.76)		

Data are presented as n (%).

by ethics committee of the Xiangya Hospital of Central South University (No. 2021101151). Informed consent was taken from all the participants.

Statistical analysis

Descriptive analysis was used in this study, data are mainly presented as cases and percentages. Moreover, intergroup comparisons were based on the chi-square test or Fisher' exact test. All analyses were performed using the SPSS 25.0 software package, and two-sided P<0.05 was considered to be statistically significant.

Results

Status quo of research and innovation capabilities of young researchers at UAHs

A total of 586 questionnaires were collected, involving researchers from 132 specialty areas. Among the respondents, there were 296 males (50.51%) and 290 females (49.49%). Most respondents were aged from 31 to 35 (n=278, 47.44%). The vast majority (n=477, 81.40%) held a doctorate degree. There were 233 full-time researchers, accounting for 39.76% of respondents. Most respondents (n=485, 82.76%) were still in their early career stage (with a junior or mid-level professional title). Additionally, about half of the respondents (n=263, 44.88%) had worked for 5 years or more. There was no significant difference in demographic indicators between full-time and part-time researchers (all P>0.05) (*Table 1*).

Self-assessment of innovation capabilities by young researchers at UAHs

Compared with part-time researchers, full-time researchers had a significantly higher rate of assessing themselves as "very good" in terms of the "courage to explore a new field", "willingness to overcome difficulties", "critical thinking", "sensitivity to cutting-edge knowledge and new industrial development information", "capability to master innovation theories", "capability to carry out academic exchanges", "ability of independent analysis", "problem-solving skills", "teamwork, organization/coordination

Table 2 Self-assessment of innovation capabilities by young researchers at UAHs

Item	Self-assessment very good, total	Part-time researchers	Full-time researchers	χ^2	P value
1. Sensitivity to discover problems during clinical practice and scientific research	220 (37.54)	127 (35.98)	93 (39.91)	0.928	0.335
2. Courage to explore a new field	229 (39.08)	107 (30.31)	122 (52.36)	28.661	0.000*
3. Willingness to overcome difficulties or challenges during innovations	260 (44.37)	119 (33.71)	141 (60.52)	40.854	0.000*
4. Critical thinking	221 (37.71)	108 (30.59)	113 (48.50)	19.151	0.000*
5. Sensitivity to cutting-edge knowledge and new industrial development information	214 (36.52)	114 (32.29)	100 (42.92)	6.833	0.009*
6. Capability to master innovation theories, tools, and methodologies	182 (31.06)	87 (24.65)	95 (40.77)	17.048	0.000*
7. Capability to carry out academic exchanges and learning	176 (30.03)	93 (26.35)	83 (35.62)	5.748	0.017*
8. Ability to analyze, judge, and summarize problems independently	256 (43.69)	126 (35.69)	130 (55.79)	23.050	0.000*
9. Ability to apply new theories and new technologies to solve real-world issues	209 (35.67)	102 (28.90)	107 (45.92)	17.736	0.000*
10. Teamwork, organization/coordination capabilities, and industry-university-research collaboration ability	243 (41.47)	130 (36.83)	113 (48.50)	7.876	0.005*
11. Capability to complete a research project independently	236 (40.27)	105 (29.75)	131 (56.22)	40.909	0.000*

Data are presented as n (%). *, the results are statistically significant (P<0.05). UAH, university-affiliated hospital.

capabilities, industry-university-research collaboration ability", and "capability to complete a research project independently" (all P<0.05) (*Table 2*).

Assessment of innovation teams by young researchers at UAHs

In terms of "why did you choose your current research interest", 29.69% of the respondents answered that they "obeyed the arrangement of the current scientific research team", and 39.42% responded that they "continued the research direction during the doctoral study period". With respect to the scientific research team, 23.21% of researchers chose to "work alone". In comparison to full-time researchers, part-time researchers were more likely to "work alone", with the statistically significant difference (P<0.05). In terms of "completing general administrative affairs", 63.48% of the respondents needed to "complete by myself", and this proportion was significantly higher for part-time researchers (P<0.05) (*Table 3*).

Assessment of innovation capabilities of young researchers at UAHs

According to the survey results, 61.77% of the respondents had published 1–3 scientific articles, 12.29% had published monographs or other academic books, 73.55% had not been principal investigators (PIs) of research projects at or above the provincial level, 50.34% had been granted patents, and 87.71% had not received scientific or technological awards. Compared with part-time researchers, a significantly higher proportion of full-time researchers had experiences of "being PIs of research projects at or above the provincial level" (P<0.05) (*Table 4*).

Support for innovation capacity-building for young researchers at UAHs

As shown by the results of survey, 81.23% of the respondents "understood" the capacity-building policies of their affiliation. Half of the respondents (52.39%)

Table 3 Assessment of innovation teams by young researchers at UAHs

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
Reason for choosing the current main research interest					
A. Continued the research direction during the doctoral study period	231 (39.42)	171 (48.44)	60 (25.75)	35.041	0.000*
B. Obeyed the arrangement of the current scientific research team	174 (29.69)	97 (27.48)	77 (33.05)		
C. Follow my own interest	84 (14.33)	42 (11.90)	42 (18.03)		
D. Met the major needs of society and industry	58 (9.90)	23 (6.52)	35 (15.02)		
E. Focused on the latest research hotspots	39 (6.66)	20 (5.67)	19 (8.15)		
Research team you belong to					
A. I have my own research team	113 (19.28)	59 (16.71)	54 (23.18)	9.432	0.009*
B. I have joined a research team	337 (57.51)	198 (56.09)	139 (59.66)		
C. I work alone	136 (23.21)	96 (27.20)	40 (17.17)		
Completing general administrative affairs					
A. I complete general administrative affairs by myself	372 (63.48)	241 (68.27)	131 (56.22)	20.419	0.000*
B. I complete general administrative affairs with my team	92 (15.7)	55 (15.58)	37 (15.88)		
C. They are completed by the students	54 (9.22)	32 (9.07)	22 (9.44)		
D. A committed office in my affiliation completes them	34 (5.80)	10 (2.83)	24 (10.30)		
E. They are completed by a professional research secretary/assistant	34 (5.80)	15 (4.25)	19 (8.15)		

Data are presented as n (%). *, the results are statistically significant (P<0.05). UAH, university-affiliated hospital.

believed the innovation atmosphere of their affiliation was "very good". In terms of external support, "good living conditions" (5.80%) and "boost of achievement transformation" (2.05%) accounted for the lowest proportions. A total of 83.11% of researchers "understood" the mechanism of cultivating and training young researchers at their institution, and 58.19% of the respondents believed the number of training activities at their affiliation was "relatively large". The training activities included cutting-edge seminars and symposiums (80.89%), expert lecture series (69.11%), and new skills training (31.91%). Besides, the preferred training modes included training and learning events (56.31%) and job promotion opportunities (50.00%). Full-time researchers had less knowledge about the relevant policies at their affiliation (χ^2=3.190, P=0.074). Compared with full-time researchers, part-time researchers had a significantly higher favorable attitude towards "capacity-building mechanisms" and "instructions on grant application" (both P<0.05) (*Table 5*).

Innovation capabilities of young researchers at UAHs: problems and solutions

The main internal factors restricting the improvement of innovation ability included lack of discretionary time (44.54%), poor abilities to analyze and resolve problems and apply knowledge (44.54%), and poor ability to acquire innovative knowledge (42.32%). Policies that might improve innovation capability included dedicated policies for young talent training (45.90%), a professional title-based promotion system (40.44%), and a review system for scientific research projects (34.98%). Beyond that, potential problems in increasing the innovation capability of young researchers were identified as "paying more attention to research achievements rather than capacity-building (52.39%), the narrow promotion path for young researchers

Table 4 Innovation capabilities of young researchers at UAHs

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
Scientific articles published in core journals					
1–3 articles	362 (61.77)	215 (60.91)	147 (63.09)	1.923	0.382
4–6 articles	142 (24.23)	92 (26.06)	50 (21.46)		
7 or more articles	82 (13.99)	46 (13.03)	36 (15.45)		
Formally published monographs or other academic books					
None	514 (87.71)	306 (86.69)	208 (89.27)	0.870	0.351
Yes	72 (12.29)	47 (13.31)	25 (10.73)		
Being PIs of research projects at or above the provincial level					
None	431 (73.55)	264 (74.79)	167 (71.67)	13.781	0.000*
1 project	89 (15.19)	62 (17.56)	27 (11.59)		
2 or more projects	66 (11.26)	27 (7.65)	39 (16.74)		
Patents granted					
None	291 (49.66)	171 (48.44)	120 (51.50)	0.526	0.468
Yes	295 (50.34)	182 (51.56)	113 (48.50)		
Scientific and technological awards received					
None	514 (87.71)	309 (87.54)	205 (87.98)	0.026	0.872
Yes	72 (12.29)	44 (12.46)	28 (12.02)		
Total	586 (100.00)	353 (60.24)	233 (39.76)		

Data are presented as n (%). *, P<0.05, comparison between part-time and full-time researchers. UAH, university-affiliated hospital; PI, principal investigator.

(47.95%), and lack of support from scientific research platforms (21.84%)".

Compared with full-time researchers, a significantly higher proportion of part-time researchers considered that the main internal factors restricting the improvement of innovation ability were "poor ability to complete a research project independently" and "lack of discretionary time", and the most influential policies were the "narrow promotion path for young researchers" as well as "poor effectiveness of training and learning activities" (all P<0.05). Compared with part-time researchers, full-time researchers were more likely to believe that "talent management system" was an influential policy (P<0.05) (*Table 6*).

External factors restricting the improvement of innovation capabilities of young researchers at UAHs

The main external factors restricting the improvement of innovation ability included the lack of support from research platforms (30.55%), lack of grants (27.82%), and lack of incentive policies for innovation (21.67%). Compared with full-time researchers, a significantly higher proportion of part-time researchers believed that the main external factors restricting the improvement of innovation ability were "lack of support from research platforms" and "lack of grants" (both P<0.05). In comparison to part-time researchers, a significantly higher proportion of full-time researchers believed that the main external factors restricting the improvement of innovation ability were "lack of a cultural atmosphere for scientific and technological innovations" and "unreasonable evaluation indicators of researchers" (both P<0.05) (*Table 7*).

Expectations of support for innovation capacity-building by young researchers at UAHs

The expectations of researchers for innovation capacity-building included increasing financial investment (42.32%),

Table 5 Support for innovation capacity-building for young researchers at UAHs

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
Understanding the capacity-building mechanisms in your affiliation					
Understand	476 (81.23)	295 (83.57)	181 (77.68)	3.190	0.074*
Not understand	110 (18.77)	58 (16.43)	52 (22.32)		
The innovative atmosphere in your affiliation					
Very good	307 (52.39)	187 (52.97)	120 (51.50)	0.122	0.727
Average	279 (47.61)	166 (47.03)	113 (48.50)		
External support offered by your affiliation					
A. Incentive policies and support systems	360 (61.43)	243 (68.84)	117 (50.21)	20.548	0.000*
B. Financial support	323 (55.12)	207 (58.64)	116 (49.79)	4.449	0.035
C. Research and academic teams	243 (41.47)	120 (33.99)	123 (52.79)	20.428	0.000*
D. Research platforms and facilities	322 (54.95)	170 (48.16)	152 (65.24)	16.535	0.000*
E. Instructions on grant application	196 (33.45)	125 (35.41)	71 (30.47)	1.538	0.215
F. Good living conditions	34 (5.80)	15 (4.25)	19 (8.15)	3.917	0.048*
G. Boost of achievement transformation	12 (2.05)	7 (1.98)	5 (2.15)	0.019	0.892
H. Others	22 (3.75)	16 (4.53)	6 (2.58)	1.488	0.000*
Capacity-building mechanisms for young researchers in your affiliation					
Understand	487 (83.11)	312 (88.39)	175 (75.11)	17.625	0.000*
Not understand	99 (16.89)	41 (11.61)	58 (24.89)		
Sessions of training activities held by your affiliation					
Many	341 (58.19)	212 (60.06)	129 (55.36)	1.270	0.260
Average	245 (41.81)	141 (39.94)	104 (44.64)		
Specific training activities					
A. Cutting-edge seminars and symposiums	474 (80.89)	275 (77.90)	199 (85.41)	5.112	0.024*
B. New skills training	187 (31.91)	115 (32.58)	72 (30.90)	0.182	0.670
C. Technical mentorship programs	109 (18.60)	68 (19.26)	41 (17.60)	0.258	0.612
D. Expert lecture series	405 (69.11)	231 (65.44)	174 (74.68)	5.612	0.018*
E. Academic communication with other institutions	78 (13.31)	55 (15.58)	23 (9.87)	3.965	0.046*
F. Overseas exchange opportunities	102 (17.41)	60 (17.00)	42 (18.03)	0.103	0.748
G. Continuing education programs	40 (6.83)	29 (8.22)	11 (4.72)	2.695	0.101
H. Establishment of academic exchange platforms	117 (19.97)	74 (20.96)	43 (18.45)	0.553	0.457
I. Rewards for innovative practice/behaviors	24 (4.10)	18 (5.10)	6 (2.58)	2.277	0.131
J. Others	18 (3.07)	12 (3.40)	6 (2.58)	0.320	0.571
Major training measures offered by my affiliation					
A. Payments	222 (37.88)	123 (34.84)	99 (42.49)	3.486	0.062

Table 5 *(continued)*

Table 5 *(continued)*

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
B. Training/learning activities	330 (56.31)	198 (56.09)	132 (56.65)	0.018	0.893
C. Promotion opportunities	293 (50.00)	187 (52.97)	106 (45.49)	3.142	0.076
D. Technical guidance from teams	191 (32.59)	115 (32.58)	76 (32.62)	0.000	0.992
E. Honors and rewards	103 (17.58)	60 (17.00)	43 (18.45)	0.206	0.650
F. Funding of innovation activities	157 (26.79)	82 (23.23)	75 (32.19)	5.744	0.017
G. Guidance on grant application	171 (29.18)	114 (32.29)	57 (24.46)	4.165	0.041
H. Others	17 (2.90)	12 (3.40)	5 (2.15)	0.783	0.376

Data are presented as n (%). *, P<0.05, comparison between part-time and full-time researchers. UAH, university-affiliated hospital.

creating an innovation-friendly environment (39.42%), developing capacity-building mechanisms (32.42%), strengthening external supports (30.38%), and optimizing talent assessment mechanisms (32.25%). Compared with part-time researchers, a significantly higher proportion of full-time researchers expected their affiliation to optimize talent assessment mechanisms and develop multiple incentive mechanisms (both P<0.05). In comparison to the full-time researchers, a significantly higher proportion of part-time researchers hoped their affiliation would increase financial investment and strengthen external supports (both P<0.05) (*Table 8*).

Discussion

Training and cultivation of young researchers at 'double first-class' medical colleges: problems

Weak administrative support

Young researchers are not only the backup force for basic research, but also the main force shaping the future. Only motivated young researchers can fuel the development of science and technology (9). In particular, young researchers are the backbone of scientific research at UAHs. However, young researchers also confront with many challenges, such as the lack of experience, high pressure from clinical tasks, tight schedules for completing grant-supported research projects, and low confidence, which may lead to low enthusiasm for scientific research and poor research output. According to the results of our current study, 63.48% of the respondents chose "complete by myself" for general administrative affairs, and this proportion was particularly high for part-time researchers. Fundamentally, researchers believed that a weak ability to acquire innovative knowledge and a lack of discretionary time were the internal factors restricting the improvement of innovation ability. In the real world, young researchers have few opportunities to be the PI of high-level, large-scale projects, face with strong pressure to progress their career and lack sustainable and stable support from grants (10). Therefore, being capable to offer tailored support to young, early-career researchers is crucial for increasing their awareness of and enthusiasm for independent scientific research (11).

Lack of support from research platforms

As shown by the survey results, researchers believed that insufficient support from scientific research platforms, grants, and policies were the main external factors restricting the improvement of innovation capability. Apart from that, the scientific and technological innovation platforms at medical colleges invigorate young researchers to achieve high-level scientific research results, and they are also incubators that promote the development of leading scientists and innovative teams. At present, most high-level research platforms and technological innovation platforms in medical colleges face problems such as weak teaching-research linkages, low industry participation, few high-quality research results, low technology transformation and application rates, and weak scientific research teams (12). Due to the lack of reform on collaborative innovation centers for young scientific talents in colleges and universities and lack of incentive policies, internal evaluation will eventually become a mere formality, which could hinder the enthusiasm of scientific research platforms at or above the provincial level from participating in and

Table 6 Innovation capabilities of young researchers at UAHs: problems and solutions

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
Internal factors restricting the improvement of innovation ability					
A. Poor ability to acquire innovative knowledge	248 (42.32)	146 (41.36)	102 (43.78)	0.336	0.562
B. Poor ability to apply knowledge	261 (44.54)	83 (23.51)	178 (76.39)	6.993	0.008*
C. Poor ability to work under pressure	99 (16.89)	54 (15.30)	45 (19.31)	1.612	0.204
D. Poor ability to develop new fields	187 (31.91)	99 (28.05)	88 (37.77)	6.107	0.013*
E. Poor ability to grasp innovation opportunities	145 (24.74)	86 (24.36)	59 (25.32)	0.069	0.792
F. Poor ability to complete a research project independently	141 (24.06)	102 (28.90)	39 (16.74)	11.353	0.001*
G. Unclear work goals	77 (13.14)	39 (11.05)	38 (16.31)	3.404	0.065
H. Lack of enthusiasm for career	43 (7.34)	26 (7.37)	17 (7.30)	0.001	0.975
I. Heavy family burden	91 (15.53)	54 (15.30)	37 (15.88)	0.036	0.849
J. Lack of discretionary time	261 (44.54)	182 (51.56)	79 (33.91)	17.706	0.000*
K. Others	32 (5.46)	16 (4.53)	16 (6.87)	1.482	0.224
Influential policies					
A. Talent management system	188 (32.08)	101 (28.61)	87 (37.34)	4.906	0.027*
B. Dedicated policies for young talent training	269 (45.90)	164 (46.46)	105 (45.06)	0.110	0.740
C. Reviewing system for scientific research projects	205 (34.98)	137 (38.81)	68 (29.18)	5.718	0.017*
D. Rewarding policies for scientific and technological innovations	142 (24.23)	87 (24.65)	55 (23.61)	0.083	0.774
E. Evaluation and assessment systems	161 (27.47)	94 (26.63)	67 (28.76)	0.319	0.573
F. Professional title-based promotion policy	237 (40.44)	156 (44.19)	81 (34.76)	5.180	0.023*
G. Postgraduate tutor selection policy	45 (7.68)	21 (5.95)	24 (10.30)	3.749	0.053
H. Research fund use policy	93 (15.87)	47 (13.31)	46 (19.74)	4.344	0.037*
I. Others	44 (7.51)	30 (8.50)	14 (6.01)	1.253	0.263
Problems of your affiliation in increasing the innovation capabilities of young researchers					
A. Paying more attention to research achievements rather than capacity-building	307 (52.39)	186 (52.69)	121 (51.93)	0.032	0.857
B. Lack of a cultural atmosphere for scientific and technological innovations	125 (21.33)	69 (19.55)	56 (24.03)	1.684	0.194
C. Poor effectiveness of training and learning activities	90 (15.36)	66 (18.70)	24 (10.30)	7.612	0.006*
D. Narrow promotion path for young researchers	281 (47.95)	168 (47.59)	113 (48.50)	0.046	0.830
E. Lack of academic exchange platforms	65 (11.09)	35 (9.92)	30 (12.88)	1.247	0.264
F. Lack of continuing education opportunities	89 (15.19)	53 (15.01)	36 (15.45)	0.021	0.885
G. Lack of support from research platforms	128 (21.84)	84 (23.80)	44 (18.88)	1.984	0.159
H. Difficulty in transforming innovation achievements	74 (12.63)	49 (13.88)	25 (10.73)	1.263	0.261
I. Lack of leadership from senior peers	45 (7.68)	26 (7.37)	19 (8.15)	0.123	0.726
J. Others	71 (12.12)	39 (11.05)	32 (13.73)	0.951	0.330

Data are presented as n (%). *, P<0.05, comparison between part-time and full-time researchers. UAH, university-affiliated hospital.

Table 7 External factors restricting the improvement of innovation ability of young researchers at UAHs

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
Internal factors restricting the improvement of innovation ability					
A. Lack of a cultural atmosphere for scientific and technological innovations	122 (20.82)	63 (17.85)	59 (25.32)	4.757	0.029*
B. Lack of incentive policies for innovations	127 (21.67)	73 (20.68)	54 (23.18)	0.515	0.473
C. Lack of support from research platforms	179 (30.55)	131 (37.11)	48 (20.60)	18.032	0.000*
D. Weak organization/management levels	60 (10.24)	33 (9.35)	27 (11.59)	0.766	0.381
E. Unreasonable evaluation indicators of professional titles	124 (21.16)	84 (23.80)	40 (17.17)	3.697	0.055
F. Unreasonable evaluation indicators of researchers	86 (14.68)	36 (10.20)	50 (21.46)	14.214	0.000*
G. Unreasonable postgraduate tutor selection policy	31 (5.29)	18 (5.10)	13 (5.58)	0.065	0.799
H. Lack of grants	163 (27.82)	111 (31.44)	52 (22.32)	5.823	0.016*
I. Low efficiency of innovation achievement transformation	91 (15.53)	56 (15.86)	35 (15.02)	0.076	0.083
J. Lack of training on scientific research	76 (12.97)	46 (13.03)	30 (12.88)	0.003	0.956
K. Lack of talent training program and support system	72 (12.29)	42 (11.90)	30 (12.88)	0.124	0.724
L. Lack of support on living conditions	105 (17.92)	62 (17.56)	43 (18.45)	0.076	0.783
M. Lack of leadership from senior peers	44 (7.51)	24 (6.80)	20 (8.58)	0.644	0.422
N. Others	66 (11.26)	45 (12.75)	21 (9.01)	1.959	0.162

Data are presented as n (%). *, P<0.05, comparison between part-time and full-time researchers. UAH, university-affiliated hospital.

Table 8 Expectations of support for innovation capacity-building by young researchers at UAHs

Item	Number (n=586)	Part-time researchers (n=353)	Full-time researchers (n=233)	χ^2	P value
Expectations of support for innovation capacity-building					
A. Creating an innovation-friendly environment	231 (39.42)	132 (37.39)	99 (42.49)	0.269	0.604
B. Strengthening external supports	178 (30.38)	123 (34.84)	55 (23.61)	8.383	0.004*
C. Developing capacity-building mechanisms	190 (32.42)	119 (33.71)	71 (30.47)	0.730	0.393
D. Increasing financial investment	248 (42.32)	167 (47.31)	81 (34.76)	9.049	0.003*
E. Optimizing talent assessment mechanisms	189 (32.25)	96 (27.20)	93 (39.91)	10.391	0.001*
F. Increasing organization/management levels	62 (10.58)	29 (8.22)	33 (14.16)	3.396	0.065
G. Offering more training programs	140 (23.89)	84 (23.80)	56 (24.03)	0.050	0.823
H. Providing platforms to exert innovative capabilities	118 (20.14)	72 (20.40)	46 (19.74)	0.176	0.675
I. Developing multiple incentive mechanisms	76 (12.97)	33 (9.35)	43 (18.45)	10.312	0.001*

Data are presented as n (%). *, P<0.05, comparison between part-time and full-time researchers. UAH, university-affiliated hospital.

supporting the development of collaborative innovation systems (13). It is foreseeable that future scientific and technological infrastructure will be tightly integrated with networks, data and computing, and the emerging scientific research platforms will develop into essential platforms for scientific research in various fields (14). In order to ensure effective performance of such platforms in universities and colleges, it is essential to increase investment in these platforms, improve talent-training functionality, focus more on applications, increase number/types of scientific research teams, optimize evaluation and incentive mechanisms, and improve efficiency of achievement transformation.

Lack of leadership from senior peers

A dedicated and cooperative scientific team is essential for increasing its core competitiveness and seeking research breakthroughs (15). In the current study, 23.21% of the respondents chose to "work alone without a stable scientific research team", especially among part-time researchers. Besides, some young researchers lacked the awareness of long-term partnership, leading to a short-term focus. According to the analysis of the samples, the scientific research team leaders were all outstanding experts or academic leaders in their field, with "a sharp scientific perspective" and "a far-reaching vision", and they played a positive role in supporting young researchers. Therefore, the establishment of an innovative scientific research team must include consideration of the vision of the team, the roles, duties, responsibilities, and rights of its members, along with a well-designed team management mechanism. As pointed out by Balandya *et al.*, the career development of young researchers can enter a virtuous circle by optimizing the allocation of talents to a scientific research team, cultivating reserve talents for scientific research, defining the responsibilities and rights of team members, and improving the team management mechanism (16). Policy-makers and promoters at UAHs must address the issue of how to inspire young researchers by establishing science and technology support policies and thereby promoting advances in scientific research.

Unsupportive innovation atmosphere

Deeper integration of 'industry-university-research' is the guarantee for scientific research teams to maintain their continuous innovation abilities. According to our research, young researchers hoped that their affiliation would take measures to create an innovation-friendly atmosphere, with capacity-building mechanisms and supportive external conditions. At present, medical colleges typically have problems such as insufficient utilization of scientific research resources, low awareness of the industrialization of R&D results, poorly designed assessment and incentive mechanisms, as well as a lack of professional institutions for medical intellectual property protection and achievement transformation (17). Meanwhile, few studies have explored the transformation of scientific and technological achievements in the healthcare fields, while the transformation of achievements in medical schools is inefficient. The conversion rate of scientific and technological achievements in China is below half of that in the developed countries. Only 12.6% of patents were effectively implemented in China (18). As claimed by Cheng *et al.*, deep integration and optimal allocation of innovative resources such as technology, capital, talents, and services could effectively promote the transfer and transformation of scientific and technological achievements (19).

Training and cultivation of young researchers at 'double first-class' medical colleges: solutions

It is a systematic process to build and improve the talent system. The training of young researchers relies highly on an efficient and coordinated talent cultivation system, which starts with the process of talent growth and consists of five elements, including talent classification, echelon construction, career pathways, support measures, and incentives.

Training or attracting young researchers and encouraging them to be involved in research and innovation activities

In order to support young researchers to improve their capabilities in basic research and collaborative innovation and create a good cultural atmosphere for scientific and technological innovation, a lot of UAHs have taken action to strengthen cooperation and communication and build new platforms for academic exchanges. Apart from offering academic cooperation and exchange opportunities, typical hospitals have created a platform for talent introduction, including honorary and part-time positions, in an attempt to break the rigid constraints (e.g., nationality, region, and affiliation) on the flow of young researchers. In addition, special departments have been created, special measures formulated, and scientific research buildings/rooms offered. Hospitals, with their management and clinical departments, have made joint efforts to formulate initiatives and plans

for attracting and retaining talents. When necessary, talents may be employed as special research fellows or under a dual-employment system. At the same time, distinguished research teams may be employed as a whole. Internal talent training focuses on supporting capable academic leaders, candidates for various talent programs, and reserve talents with good scientific research output. In addition to financial support, special policies are also available in terms of full-time staffing, research venues, and research time to enable the smooth implementation of key research projects. Beyond that, young researchers' associations have been established, so as to create a platform for academic exchanges among young researchers and promote the advancement of RIAs (20). It is important to build an open and collaborative scientific and technological innovation network, strengthen the accessibility and sharing of scientific and technological resources, adhere to both internal training and external introduction of talents, and enhance in-service training for young and middle-aged talents.

Offering support to talents at different levels to create the first-class talent teams that lead the development of disciplines

Special efforts should be made to prioritize the support and cultivation of state-level young researchers expected to be included in national talent programs such as "Leading Talents", "Excellent Talents", and "Outstanding Talents". One UAH has established a continuous and full-coverage training system for discipline leaders, young and middle-aged key figures, and young researchers, including academic exchange programs for academic leaders, intern programs for young and middle-aged key figures, and special postdoctoral training programs. In addition, the priority groups include high-level talents who have played a leading role in a specific discipline and have been listed in the national talent programs, as well young and middle-aged core talents who are emerging as capable and motivated figures in the industry. Meanwhile, more full-time scientific research positions are established to fulfill the urgent manpower needs of clinical departments and scientific research teams. The hospital has signed a scientific research cooperation agreement with the school of basic medical sciences, which allow both parties to selectively appoint a PI in one party as a dual-employment PI in the other party, so as to conduct effective cooperative research and establish efficient connections between basic research and clinical applications. The hospital explores sustainable translational medicine teamwork, innovates the employment and management modes of full-time scientific researchers, and provides clinical experts with reliable scientific research manpower and technical support. It also creates a positive scientific research and training environment by holding a scientific research workshop once a year, during which both domestic and international lecturers are invited to share their experiences in scientific research. The training adheres to the principle of three "first-classes": first-class lecturers, first-class curriculum design, and first-class training effectiveness, in an attempt to comprehensively enhance the critical thinking and innovation capacity of young researchers.

Training talents by their classification and optimize the environment for talent cultivation and development

According to the characteristics of talents at UAHs and the demands of clinical disciplines, Xiangya Hospital has created positions, including tenured professor and clinical scientist, for talents conducting scientific research in clinical settings, along with corresponding career paths. The key departments and top experts at the hospital are motivated and organized to apply for major grants offered by national ministries and commissions. In addition, the applications have shifted from quantity to quality. Young researchers are encouraged to read the high-quality National Natural Science Foundation of China application forms and learn how to write an effective grant proposal. In order to provide sufficient training support for young researchers in terms of funding and time, one hospital has invested 2 million yuan each year for training on projects supported by the National Natural Science Foundation of China, in an attempt to increase the research interests and capabilities of young researchers and improve their abilities in discovering and solving clinical problems. The adoption of research and study leave has not only strengthened the management process for projects supported by the National Natural Science Foundation of China Youth Fund, but also ensured the smooth completion of these studies. In order to strengthen the basic research ability of newly-employed doctors, a postdoctoral training program for new doctors has been launched, which requires all new doctors to receive 1.5–3 years of training at postdoctoral mobile stations.

Adopting multidimensional assessment to promote the transformation of "A Hospital with Massive Human Resources" to "A Hospital with Capable Human Resources"

Talents are evaluated and assessed from multiple

perspectives, including ideological and political awareness, teaching morality, academic ethics, discipline leadership, academic impact, academic contribution, clinical capacity, scientific research performance, and cooperation awareness. The work objectives during a specific employment period must be clearly defined. Mid-term and full-term assessments should be performed, along with exit mechanisms. Apart from that, hospitals must strengthen their management of shared laboratories and PI laboratories. Basic experimental research centers should gradually stay open without rest days and implement performance-based management modes according to the service volume. Scientific research platforms should develop performance evaluation indicators for full-time researchers and technicians, and focus on the research output of full-time researchers and service volume of full-time technicians, so as to steadily implement reasonably paid openness/sharing of scientific research platforms. Besides, the existing scientific research incentive policies should be adjusted to focus more on outputs including achievements, papers, and patents. Individual scientific research performance evaluation indicators should be developed for new recruits, senior researchers, and graduate tutors, and linked with rewards, promotions, and tutor qualifications, which may encourage young researchers to achieve better outputs.

Adopt a stepwise and all-round promotion system for young researchers

In recent years, both the Ministry of Education and the Ministry of Science and Technology have urged avoidance of excessive emphasis on papers, professional titles, academic qualifications, education background, and/or awards. Rather, talent assessment should focus more on research quality, academic contribution, and work performance. Moreover, scientific and technological innovation should be encouraged. Development goals may be established through assessment and incentive measures. In fact, multiple and all-round measures should be implemented to support the discovery, training, and upgrade of talents. Policies and processes for the management of achievement transformation need to be optimized. According to the *Several Opinions on Further Improving the Management of Central Financial Research Project Funds and Other Policies* and the *Several Opinions on Improving the Quality of Patents in Colleges and Universities and Promoting their Transformation and Application* (21), UAHs should develop patent management policies to cancel funding for the patent applications and approvals, and stipulate that 80% of the transformation revenue belongs to the researcher team. At the same time, high-quality third-party transformation service-providers should be selected to participate in patent management by providing tailored achievement transformation services, assisting in developing transformation plans, recommending and establishing connections with investors, funders, and intellectual property service agencies, and promoting project transformation and implementation (22). Talent training, as a top priority, should also be achieved by supporting measures. With a medical science and technology innovation evaluation system as a reference, UAHs should develop uniform assessment and incentive systems for scientific research, including a hospital science and technology reward policy, staff assessment and evaluation policies, graduate students' tutor selection policy, and discipline construction evaluation policy, so as to steer scientific and technological innovation and inspire researchers.

In this research, we conducted a large-sample survey at six UAHs across China, explored the status quo of young researcher training at Chinese UAHs, and proposed policy recommendations based on the current situation in China. However, our study had some limitations. To be specific, this study involved analysis based on the survey results only, and no case analysis or face-to-face interview was conducted. Further studies with a larger research scope and more in-depth and continuous surveys should be conducted to develop a clearer understanding of the research capacity of young researchers and to propose more tailored policy recommendations on the training and cultivation of young researchers.

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Footnote

Reporting Checklist: The authors have completed the SURGE reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-22-3692/rc

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com/article/view/10.21037/atm-22-3692/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-22-3692/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), and approved by ethics committee of the Xiangya Hospital of Central South University (No. 2021101151). Informed consent was taken from all the participants.

References

1. Marini G, Yang L. Globally Bred Chinese Talents Returning Home: An Analysis Of A Reverse Brain-Drain Flagship Policy. Sci Public Policy 2021;48:541-52.
2. Nefedova A. International Mobility And Publication Activity Of Early-Career-Researchers: What Do Statistics, Bibliometrics And Scientists Themselves Say? Journal of The New Economic Association 2021;52:98-121.
3. Huang Y, Zhang J, Zhu PZ, et al. The Practice And Exploration Of The Talent Stratification And Cultivation System In The Hospital. Chinese Journal Of Hospital Administration 2021;37:6-9.
4. Alberts B, Hyman T, Pickett CL, et al. Improving support for young biomedical scientists. Science 2018;360:716-8.
5. Lawrence PA. The Last 50 Years: Mismeasurement and Mismanagement Are Impeding Scientific Research. Curr Top Dev Biol 2016;116:617-31.
6. Zhang CY, Liu GJ, Jia ZZ, et al. Investigation And Countermeasure Analysis On The Current Situation Of Scientific Research Foundation Of New Employees In Prefecture-Level Tertiary General Hospitals. Jiangsu Health System Management 2021;32:400-2.
7. Gan SL, He XL, Wang QQ. Evaluation of the growth environment of young scientific and technological talents: based on a survey of 453 young researchers in Shanghai. Human Resource Development 20211;03:11-4.
8. Tang QQ, Lu GJ. Research on the ecological environment of innovation and entrepreneurship of scientific and technological talents in guangxi: a questionnaire-based survey. Inner Mongolia Science Technology & Economy 2017;21:19-21.
9. Zhou JZ. Reflections and Suggestions on the Development Strategy of Young Scientific and Technological Talents. Science & Technology Review 2019;37:97-101.
10. Wang Q. Provide More Policy Support For Young Researchers. Workers' Daily, 2022-03-16(007). doi: 10.28277/n.cnki.ngrrb.2022.001135.
11. Riley J. Motivations and Barriers for Young Scientists to Engage with Society: Perspectives from South Africa. International Journal of Science Education, Part B 2022:1-17.
12. Wang Y, Zhou YC, Wang YG, et al. Promoting the Construction of Scientific Research Basic Platforms Moderately Ahead of Time to Support China's High-Level Scientific and Technological Self-Reliance. Bull Chin Acad Sci 2022;37:652-60.
13. Luo ZS, Shao Y, Wu MH. Open operation mechanism of scientific research platforms in universities based on collaborative innovation. Chinese University Technology Transfer 2017:36-41.
14. Mei Y, Chen Y. Practice and exploration of promoting the management of instruments and equipment in colleges and universities by information construction. China Modern Educational Equipment 2022;01:1-3.
15. Kotsemir M. Publish More or Publish Differently? New Aspects of Relationship between Scientific Mobility and Performance of Young Researchers. 18TH International Conference on Scientometrics & Informetrics 2021:585-96. Available online: https://www.webofscience.com/wos/alldb/full-record/WOS:000709638700066
16. Balandya E, Sunguya B, Gunda DW, et al. Building sustainable research capacity at higher learning institutions in Tanzania through mentoring of the Young Research Peers. BMC Med Educ 2021;21:166.
17. Yuan J, Liu YZ, Wu QS, et al. Challenges and Countermeasures on the Translation of Scientific Research Achievements of Public Hospitals in China. Chin J Hosp Admin 2020;36:951-4.
18. Sun JL. Influencing Factors and Developmental Paths

of the Transformation of Scientific and Technological Achievements in Colleges and Universities. Industrial Innovation 2022;04:78-80.
19. Cheng H, Huang S, Yu Y, et al. The 2011 Collaborative Innovation Plan, University-Industry Collaboration and Achievement Transformation of Universities: Evidence from China. Journal of the Knowledge Economy 2022;2.
20. Li B, Wu J, Subinuer Y, et al. Practice of improving scientific research capability of primary hospitals by means of a "three-full and two-tight "management mechanism. Chin J Hosp Admin 2021;37:420-2.
21. Fu Y. Performance management for scientific research funds under the context of "assignment, management, and service". Modern Accounting 2020;11:12-7.
22. Liu X, Yang X. Complex policy causal mechanism and holistic governance of intellectual property right incentive for scientific researchers. Forum on Science and Technology in China 2021;09:143-152+162.

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Survey on Status Quo and Development Needs of Research and Innovation Capabilities of Young Talents in University-affiliated Hospitals

Hi! We are conducting a survey on the status quo and development demand of innovation capacities among young researchers in university-affiliated hospitals (UAHs), in an attempt to further optimize the training mechanisms for young talents and promote the career development of young researchers in these institutions. The survey is anonymous, and all the data will be used only for research purposes. All the information provided will be kept confidential. Thank you for your participation!

Note: You must meet the following two requirements: a) younger than 41 years old; and b) having been engaged in scientific research, technical development, scientific research service, science popularization, and other scientific research activities.

1. Demographic data

This section contains single-choice questions. Please choose one answer according to the actual situation.

1. Your gender [single choice] *

○A. Male

○B. Female

2. Your age: [single choice] *

○A. 25 years old or younger ○B. 26 - 30 years old ○C. 31 - 35 years old ○ D. 36 - 40 years (including 40 years old)

3. Your highest education level: [single choice] *

○A. Undergraduate and below ○B. Master degree ○C. Doctor degree

4. How long have you been engaged in scientific research-related work (specifically after formal employment): [single choice] *

○ A. 0 - 5 years ○ B. 6 - 10 years ○ C. 11 - 15 years ○ D. Over 16 years

5. What's your professional title? [single choice] *

○A. Senior (e.g. professor) ○B. Associate senior (e.g. associate professor) ○C. Mid-level (e.g. lecturer) ○D. Junior (e.g. assistant)

6. What's your research interest(s) (please specify): [fill in the blank] *

_____

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7. Are you a part-time or full-time researcher: [single choice] *

○A. Part-time ○B. Full-time

2. Assessment of innovation capabilities of young researchers in UAHs

2.1 This section is a self-assessment of innovation capabilities. Please mark correctly according to the actual situation.

8. Self-assessment of innovation capabilities [matrix questions]*

	Very good	Average	Poor
1. Your sensitivity to discover problems during clinical practice and scientific research	○	○	○
2. Your courage to explore a new field	○	○	○
3. Your willingness to overcome difficulties or challenges during innovations	○	○	○
4. Critical thinking	○	○	○
5. Your sensitivity to cutting-edge knowledge and new industrial development information	○	○	○
6. Your capabilities to master innovation theories, tools, and methodologies	○	○	○
7. Your capability to conduct academic exchanges and learning	○	○	○
8. Your ability to analyze, judge, and summarize problems independently	○	○	○
9. Your ability to apply new theories and new technologies to solve real-world issues	○	○	○
10. Your teamwork, organization/coordination capabilities, and industry-university-research collaboration ability	○	○	○
11. Your ability to complete a research project independently:	○	○	○

9. Why did you choose the current main research interest(s): [multiple-choice questions] *

☐A. Continued the research direction during the doctoral study period

☐B. Obeyed the arrangement of the current scientific research team

☐C. Followed my own interest

☐D. Met the major or urgent demands or the society and industry

☐E. Focused on the latest research hotspots

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10. How about your research team: [multiple-choice questions] *

☐A. I have my own research team.

☐B. I have joined a research team.

☐C. I work alone.

11. How do you deal with the general administrative affairs such as forms filling, reimbursement, and meeting affairs: [multiple-choice questions] *

☐A. I complete general administrative affairs by myself.

☐B. I complete general administrative affairs with my team.

☐C. They are completed by the students.

☐D. A committed office in my affiliation completes them.

☐E. They are completed by a professional research secretary/assistant.

2.2 This section is an objective assessment of innovation capabilities. Please mark correctly according to the actual situation.

12. What were your achievements in scientific research and innovations in the past three years? [matrix single-choice questions] *

	10 or more	7 - 9	4 - 6	1 - 3	0
① Scientific articles published in core journals:	○	○	○	○	○

②Formally published monographs or other academic books [single-choice question] *

(Options include 4 and above, 3, 2, 1, and 0)

○ 4 ○ 3 ○ 2 ○ 1 ○ 0

③Patents granted: [single-choice question] *

(Options include 4 and above, 3, 2, 1, and 0)

○ 4 ○ 3 ○ 2 ○ 1 ○ 0

④Being PIs of research projects at or above the provincial level: [single-choice question] *

(Options include 8 and above, 5 - 7, 2 - 4, 1, and 0)

○ 8 and above ○ 5 - 7 ○ 2 - 4 ○ 1 ○ 0

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⑤Other achievements (software, technology, etc): [single-choice question] *

(Options include 4 and above, 3, 2, 1, and 0)

○ 4 and above ○ 3 ○ 2 ○ 1 ○ 0

13. What's the highest level of technology awards you have ever received? [single-choice question] *

○A. National level ○B. Provincial or ministerial level ○C. Municipal level ○D. By your affiliation or other institution ○E. None

3. Your knowledge about the support (and its problems) for capacity-building of young researchers in your affiliation

3.1 Support for capacity-building of young researchers in your affiliation

1) Attitude towards capacity-building of young researchers in your affiliation

14. How well do you know about the policies of your affiliation to encourage young researchers to carry out innovative activities? [single-choice question] *

○A. Very well ○B. Average ○C. Very little

2) The innovative atmosphere in your affiliation

15. What's the innovative atmosphere in your affiliation? [single-choice question] *

○A. Very good ○B. Average ○C. Poor

3) Platforms for capacity-building of young researchers in your affiliation

16. What are the external supports provided by your affiliation to promote the innovative behaviors of young researchers? [multiple-choice questions] *

☐A. Incentive policies and support systems

☐B. Financial support

☐C. Research and academic teams

☐D. Research platforms and facilities

☐E. Guidance on grant application

☐F. Good living conditions

☐G. Boost of achievement transformation

☐H. Others

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4) Mechanisms of capacity-building of young researchers in your affiliation

17. Policies for supporting capacity-building of young researchers in your affiliation: [single-choice question] *

○A. Yes, I am quite interested ○B. Yes, but I am not interested ○C. None ○D. I don't know

5) Measures of capacity-building of young researchers in your affiliation

18. Does your affiliation often organize the training on cutting-edge knowledge or new technology every year? [single-choice question] *

○A. Often ○B. Average ○C. Seldom

19. What are the specific ways your affiliation take to cultivate the innovative ability of young researchers: [multiple-choice questions] *

☐A. Cutting-edge seminars and symposiums

☐B. New skills training

☐C. Technical mentorship programs

☐D. Expert lecture series

☐E. Academic communication with other institutions

☐F. Overseas exchange opportunities

☐G. Continuing education programs

☐H. Establishment of academic exchange platforms

☐I. Rewards for innovative practice/behaviors

☐J. Others

20. In your opinion, what are the most influential measures you affiliation has taken in cultivating your innovation capabilities? [multiple-choice questions] *

☐A. Payments

☐B. Training/learning activities

☐C. Career promotion opportunities

☐D. Technical guidance from teams

☐E. Honors and rewards

☐F. Funding of innovation activities

☐G. Guidance on grant application

☐H. Others

https://dx.doi.org/10.21037/atm-22-3692

(2) Factors restricting the improvement of innovation ability of young researchers

21. What are the main internal factors restricting the improvement of your innovation ability? [multiple-choice questions] *

☐A. Poor ability to acquire innovative knowledge

☐B. Poor ability to apply knowledge

☐C. Poor ability to work under pressure

☐D Poor ability to develop new fields

☐E. Poor ability to grasp innovation opportunities

☐F. Poor ability to complete a research project independently

☐G. Unclear work goals

☐H. Lack of enthusiasm for career

☐I. Heavy family burden

☐J. Lack of discretionary time

☐K. Others

22. What are the main external factors restricting the improvement of your innovation ability? [multiple-choice questions] *

☐A. Lack of a cultural atmosphere for scientific and technological innovations

☐B. Lack of incentive policies for innovations

☐C. Lack of support from research platforms

☐D. Weak organization/management levels

☐E. Unreasonable evaluation indicators of professional titles

☐F. Unreasonable evaluation indicators of researchers

☐G. Unreasonable postgraduate tutor selection policy

☐H. Insufficient funding in scientific research

☐I. Low efficiency of innovation achievement transformation

☐J. Lack of training on scientific research

☐K. Lack of talent training program and support system

☐L. Lack of support on living conditions

☐M. Lack of leadership from senior peers

☐N. Others

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23. Which of the following system has a greater impact on your innovation ability: [multiple-choice questions] *

☐A. Talent management system

☐B. Dedicated policies for young talent training

☐C. Reviewing system for scientific research projects

☐D Rewarding policies for scientific and technological innovations

☐E. Evaluation and assessment systems

☐F. Professional title-based promotion policy

☐G. Postgraduate tutor selection policy

☐H. Research fund use policy

☐I. Others

24. What are the problems of the government in cultivating the innovative ability of young researchers? [multiple-choice questions] *

☐A. Insufficiency in creating an innovation-friendly environment

☐B. Inadequate policy support

☐C. Insufficient support for special projects

☐D. Weak risk management and control

☐E. Highly restrictive and less inclusive in capacity-building

☐F. Low support for achievement transformation

☐G. Others

25. What are the problems of your affiliation in cultivating the innovative ability of young researchers? [multiple-choice questions] *

☐A. Paying more attention to research achievements rather than capacity-building

☐B. Lack of a cultural atmosphere for scientific and technological innovations

☐C. Poor effectiveness of training and learning activities

☐D. Narrow promotion path for young researchers

☐E. Lack of academic exchange platforms

☐F. Lack of continuing education opportunities

☐G. Lack of support from research platforms

☐H. Difficulty in transforming innovation achievements

☐I. Lack of leadership from senior peers

☐J. Others

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4. Recommendations on capacity-building of young researchers

26. Which measures do you think the government should take to improve the cultivation of innovative ability of young researchers? [multiple-choice questions] *

☐A. Creating an open innovation-friendly environment

☐B. Strengthening top-level policy-making

☐C. Improving the design of training programs

☐D. Increasing the awareness of training policies

☐E. Making full use of the resources of all stakeholders

☐F. Increasing funding for youth projects

☐G. Strengthening the services offered by scientific and technological talent departments

☐H. Others

27. Which measures do you think your affiliation should take to improve the cultivation of innovative ability of young researchers? [multiple-choice questions] *

☐A. Creating an open innovation-friendly environment

☐B. Strengthening external supports

☐C. Developing capacity-building mechanisms

☐D. Increasing financial investment

☐E. Optimizing talent assessment mechanisms

☐F. Increasing organization/management levels

☐G. Offering more training programs

☐H. Providing platforms to exert innovative capabilities

☐I. Developing multiple incentive mechanisms

☐J. Others

28. Are you satisfied with the cultivation of the innovative ability of young researchers in your affiliation? [single-choice question] *

○A. Satisfied ○B. Average ○C. Dissatisfied

29. Do you have more suggestions on the cultivation of the innovative ability of young researchers? [Please specify]

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