Physiological stress evaluation of scientific researchers during the COVID-19 outbreak in China (#46729)

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Physiological stress evaluation of scientific researchers during the COVID-19 outbreak in China

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Background: Since the end of December 2019, the new coronavirus COVID-19 has caused an outbreak of infectious pneumonia. The government introduced a series of grounding measures to prevent the spread and infection of the COVID-19. The living and working patterns of the special group of researchers (such as the group involved in this paper) have also undergone great changes during this period. **Methods:** A questionnaire containing 42 questions on scientific research progress and stress in the COVID-19 epidemic was designed, and 251 randomly selected researchers were surveyed using the questionnaire. **Results:** 76.89% of the 251 participants reported that their research is affected by the COVID-19 outbreak. They had higher stress levels than those who had not. The pressure on colleagues who conducted COVID-19 researches and the concern that they would fail to finish the research on time are positively correlated with the stress. Top 3 appeals of the respondents to relieve stress includes extending deadlines (64.14%), receiving support from superiors for research (51.79%) and increasing benefits for researchers (51.00%). **Conclusion:** The outbreak has had a major impact on the experiments of researchers in the life sciences, especially in basic and clinical medicine, and has caused high levels of psychological stress in these populations. Under the premise of ensuring safety, some measures should be taken to relieve the pressure on basic medical researchers who have a great influence on the experiment and recent graduates with a tight deadline (including Master and PhD candidates in graduating grades).

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Abstract

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experiment and recent graduates with a tight deadline (including Master and PhD candidates in graduating grades).

Introduction

Since the end of last year, the outbreak of coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 originated from Wuhan, China has shown the ability of human-to-human transmission and rapidly spread to become a pandemic emergency (Lai et al. 2020). On January 30, 2020, World Health Organization (WHO) declared that the coronavirus disease 2019 (COVID-19) epidemic was classified as a public health emergency of international concern (PHEIC). As of February 23, 2020, China has confirmed 77,150 new coronavirus infections and 2,592 deaths (Pediatric Committee et al. 2020). SARS-CoV-2 is a novel coronavirus strain that has never been found in human body. Unfortunately, no specific treatment has yet been used for its infection (Martinez 2020). Due to the severe epidemic situation and in order to avoid further transmission, most industries had been forced to shut down temporarily and science and education activities were paused in China, which had caused people much inconvenience(ScienceMag.org 2020b). Among them, scientific and social research were also influenced seriously. Animal centers and practical labs were borne the brunt not to be admitted, and many scientific and social congresses and symposiums were cancelled, and postgraduates and scientific workers were confined to be back to their workplaces (ScienceMag.org 2020a). In the severe situation of the increasing number of confirmed cases and deaths, negative emotions continue to spread, which would develop to a more serious situation (Zhou 2020). Previous studies have confirmed the significant relationship between acute infectious diseases (such as SARS) and anxiety, depression, stress and post-traumatic stress disorder (PTSD) (Hull 2005; Wu et al. 2005a; Wu et al. 2005b). It is recognized that we need to realize the extent of the psychological stress associated with the epidemic and pay more attention to specific groups of vulnerable people (Shigemura et al. 2020). Recent studies have focused on the psychological stress of the medical staff who involved in epidemic prevention in China (Xiao et al. 2020). However, there have been few studies on the impact of severe infectious disease outbreaks on the psychological state of researchers. As mentioned above, most scientific research activities were stagnant during the outbreaks. A large number of researchers' experiments progress was seriously hindered, and they might suffer the loss of samples and funds in different degrees (ScienceMag.org 2020a; Tencent 2020a; Tencent 2020b). This may negatively affect the psychological state of researchers. In addition, it is noteworthy that the stagnation of science education activities can affect the completion of graduate experiment projects. With the graduation date approaching, the stagnation of science education activities may cause a sharp increase in students' graduation pressure, and even cause the delay of graduation (Tencent 2020a).

In view of the current global concerns about the spread of COVID-19 and other infectious diseases, our study will help to identify the extent of the researchers` psychological stress during the outbreak. In particular, we explored the perceived stressors of researchers, and focus on the

differences between diverse populations. We also discussed factors that might help reduce the pressure on researchers, which provided support for finding effective solutions in current or future similar outbreaks.

Materials & Methods

Study participants

The questionnaire was randomly distributed to researchers nationwide and received 251 valid questionnaire results. All of the respondents could understand the meaning of the question and carefully answered it on their own. All participants provided written informed consent. The study protocol was reviewed and approved by the institutional review board (Ethics Committee) of the 3rd Xiangya Hospital, Central South University

Questionnaires

In order to have a more comprehensive understanding of the progress of research projects and the current psychological stress level of researchers, we designed a total of 42 related questions in the questionnaire. To begin with, the survey consists of 23 questions to score the subject's psychological stress through a stress scale. Based on the commonly used stress response questionnaire (SRQ) and the actual situation of the COVID-19 epidemic, questions of four dimensions including emotional state, somatic responses, sleep quality and behavior were modified and integrated. These constitute 23 questions in our questionnaire stress scale. The Pittsburgh sleep quality index scale (PSQI) was used as a reference for sleep quality questions (Pilz et al. 2018). In response to these questions, we presented five options to indicate the degree of self-evaluation. According to the answers of "not at all", "occasionally", "sometimes", "often" and "always", the corresponding scores were given from 1 to 5. The higher the score is, the greater the stress will be.

A certain investigation was carried out on the progress of scientific research. The goal was to better understand the research projects our participants involved in, the progress of the research projects, the reasons for the stagnation of the projects, and the corresponding psychological state of the researchers. Based on the basic situation, we conducted a more detailed investigation, including whether scientific research projects may be delayed, whether they suffer losses due to the delay of the epidemic, whether they affect academic exchange activities, whether they conduct research related to the novel coronavirus, etc., in order to understand the causes of stress in subjects more comprehensively. In addition, at the end of this questionnaire, the subjects were invited to make some demands and appeals based on the status of scientific research. It includes extending the deadline for project conclusion, providing partial financial subsidies for scientific research losses, assigning professional personnel to guide and support scientific research projects, and prioritizing the return of researchers to work. This will provide guidance on how to relieve the pressure on researchers.

Statistical analysis

The subjects filled in the questionnaire anonymously. Questionnaire results were summarized from the imported Excel and analyzed using SPSS version 18.0 software (IBM Corp., Armonk,

NY, USA). Quantitative variable is expressed as an average with a standard deviation (SD). Qualitative variables are expressed as numbers and percentages. Chi-squared (χ^2) test and analysis of variance (ANOVA) were used to compare the specific differences between different social roles and different age groups. P value less than or equal to 0.05 was considered statistically significant.

Results

Basic information of the participants

The people who filled in the questionnaire included scholars in the field of life science (medicine, biology, etc.), science (science, engineering, etc.), as well as humanities and social sciences. The gender ratio of the respondents was approximately 1:1. Most of the subjects are young people, aged from 18 to 39 years old. Most of the subjects came from colleges or universities' affiliated hospitals, which also led to more undergraduates and clinical medical staff in our sample. They are both the main force of research and the most vulnerable to stress from the outbreak. According to the respondents' titles of post, most researchers do not have advanced titles. As they struggle to plan for the future, the impact of the epidemic is likely to put more psychological and scientific pressure on their research projects. That's exactly one of our purposes of the study. The basic information of respondents is shown in Table.1.

Impact of the delay of project on researchers' stress level

Of the 251 researchers surveyed, those whose progress had been affected by the outbreak had higher stress levels than those who had not. Their emotional state, somatic response and behavior have a statistical difference with those of the unaffected. Concerning the question "The COVID-19 outbreak obstructing research projects made you feel", 11 people chose "about to collapse", and accordingly their four dimensions of stress were the highest among all. It can be roughly seen from this question that the worse the psychological state is, the higher the performance of stress in all dimensions will be. The detailed results are shown in Table 2a and Table 2b.

Regression analysis of psychological stress level

The stress scores and causes of all subjects were regressed, and two items were correlated with the stress situation. The stress scores and causes of all subjects were regressed, and two items were correlated with the stress situation. As a result of the outbreak, the researchers who needed to change or cut the experimental projects were under more pressure. In addition, researchers who had colleagues reporting on new coronavirus-related research also had higher stress levels. When analyzed separately for the population of clinical researchers, three factors contributed to the stress. In addition to the two factors mentioned above, the outbreak of the epidemic reduces the timeliness and innovation of clinical workers' research and reduces the value of their research achievements. This makes clinical researchers particularly anxious. Furthermore, for the foundation researchers, their experiments have suffered, or are about to suffer a major loss because of the COVID-19 outbreak, causing them a lot of trouble and stress these days. The detailed results are shown in Table.3.

The appeal of different people to improve the condition of scientific researches

We surveyed seven groups of people: undergraduate, Master candidate (non-graduate), Master candidate (graduation grade), PhD candidate (non-graduate year), PhD candidate (graduation year), Basic research staff (including postdoctoral) and clinical medical staff (including postdoctoral). Specifically, most undergraduates(62.03%) and Master candidate in graduation grade (66.67%) consider it unnecessary to improve the welfare of researchers temporarily, whereas non-graduating Master candidate(57.14%), PhD candidate(65.00%), foundation research staff (64.52%) and clinical medical staff(50.82%) are demanding higher funding and welfare for research. Doctoral students (60.87% in non-graduating PhD candidates and 55% in graduating PhD candidates) appealed professional guidance by tutors or instructors to better complete their research projects. Affected by the outbreak, all but doctoral students (52.17% and 50.00%) and basic medical researchers (51.61%) are not recommended to return to work as soon as possible. This may be due to considerations of safety and scientific research urgency. The detailed results are shown in Table.4.

The research progress affected by COVID-19 differs from researcher's identities

The epidemic had different effects on different research fields, and there were statistical differences. As a result of the outbreak, 46 percent of researchers in the life sciences said their programs were at a standstill, and 32 percent said their programs, while ongoing, were slower than before. Researchers in the science and engineering field had similar results, with 14 out of 25 having projects at a standstill and eight making slow progress. But the epidemic has had relatively little impact on researchers in the social sciences and other fields, mostly in a state of slower pace or completely unimpacted. According to the analysis of the differences in professional titles, 6 of the 11 professors indicated that the experiment was progressing slowly, and 2 indicated that the experiment was not affected. However, associate professors and lecturers reported that the epidemic had a greater impact on their experimental progress, with the proportion of the experiments being forced into stagnation as high as 63.64% and 59.09%, respectively. In addition, the experimental progress of other researchers without professional titles was more evenly distributed, projects being stagnated, delayed and unaffected has the ratio of 38.51%, 32.76% and 28.74% respectively. The detailed results are shown in Table.2a and Table.2b.

Discussion

It was common among respondents (76.89%) that their researches were in a state of slower pace or completely non-influenced. We found the hindered situation of scientific research projects was different in diverse research fields. The hindered situation of scientific research was more severe in life science and engineering. In contrast, the social sciences and other fields were less affected, with more than 40 percent of scientific research projects completely unaffected. The obstacle of researchers (including students) to participate and communicate were common difficulties encountered in all research activities. And the reason "laboratory is closed/experimental equipment is unavailable" varied significantly between fields. Most of the experimental facilities on which life sciences and engineering fields relied were unavailable

during the epidemic. Therefore, this is the primary obstacle in life sciences and engineering fields. However, social sciences and other fields could still use computers to conduct research activities online during the outbreak. In addition, we found that the difficulty of obtaining experimental, of which reason might be that the acquisition of materials or samples in the life sciences and engineering was more dependent on experimental equipment.

Our stress measurements showed that those whose research progress had been affected by the outbreak had higher levels of stress than those who had not been affected, which indicated that the obstruction of scientific research activities during the epidemic was a potential threat to researchers' mental health. There may be many subjective or objective factors preventing the achievement of motivating factors like job achievement, income, respect, reputation, work pride, promotion opportunities, etc. The hindered situation of scientific research might lead to reduced salaries and promotion opportunities, and extend the time required to job achievement. This might also discourage many researchers who had family or other social responsibilities. The resulting stress might be internalized and cause adverse psychological consequences (Liu et al. 2019).

In particular, we explored the perceived stressors for researchers. The results indicated that researchers who needed to change original research programs would face more pressure, of which reason might be the hindered progress affected the timeliness and innovation, thereby reducing the value of the research results. In addition, changes in programs might also mean more time and money loss. The experiment suffered significant losses due to the outbreak of COVID-19, which was obviously also an important stressor, especially for foundation researchers. This might be because they were usually the principal investigator of scientific research projects, responsible for funding and experimental results.

Interestingly, the incident that "Peers are conducting related research on COVID-19" also increased researchers' stress, which mainly occurred among researchers who themselves also had been carrying out COVID-19-related research. This showed the competition pressure among peers on a new research hotspot. Therefore, the lack of emphasis on competition and performance results might help researchers' physical and psychological health (Borowiecki & Kavetsos 2015; Randall et al. 2019). However, participants who were pessimistic about the hindered situation of research showed a higher level of stress than those who were optimistic, which suggested that we should attach importance to psychological intervention and guidance of researchers, so as to help them establish a positive mentality (Jiang et al. 2020).

To help reduce the pressure of researchers, we analyzed the demands for reducing research pressure in total and different groups. Considering the delay of the experimental progress had significantly damaged the original research plan, the desire for “extending the deadline for project conclusion/fund application/graduation” was the strongest. The high percentage of “Receiving encouragements from superiors” implied that researchers might be concerned about the blame of superiors. The blame led to an increase of staff dissatisfaction. By contrast, “respect” and “caring for others” were considered positive leadership style (Merrill 2015; Morsiani et al. 2017). In addition, sufficient funding guaranteed the smooth conduct of scientific

research activities. The compensation for scientific research losses during the epidemic was a good strategy to improve the stress situation (Fang 2015). But when faced with budget constraints, researchers also needed to learn to be shrewd about laboratory expenses (Dolgin 2018).

Researchers who were already back to work (basic research staff, clinical medical staff) tended to ask for increased welfare. This might be related to the impact of hindered situation on the personal income and professional development of researchers. And staff benefits could be an important motivator for efficiency (Brunning & Saba 2018; Lasebikan et al. 2020). Importantly, with the graduation deadline approaching, the stagnation of science education activities might cause a sharp increase in students' graduation pressure, and even cause the delay of graduation. And the uncertain careers of doctoral students and post-doctoral researchers have made them more vulnerable to the stress of paper publication (Frandsen et al. 2019). Therefore, more than 50% of PhD candidates (graduation year) and basic research staff (including postdoctoral) hope to prioritize the return to work. Furthermore, for doctoral students, the professional guidance of the mentor was helpful for the completion of scientific research projects and reducing psychological stress.

This study has several limitations. The sample size was not large enough, which might lead to a smaller-sample comparison when population was divided into several groups. It was only one month after the outbreak started, phycological stress and impacts not only occurred during or rapidly after the outbreak. Long-term phycological impacts like posttraumatic stress disorder (PTSD) should be investigated in the future study. We did not compare the situation between Hubei and non-Hubei, because of few respondents from Hubei. As the initial and severe outbreak place, it should have more serious impact of researchers' psychological issues.

Conclusions

Affected by the outbreak of new coronavirus pneumonia, the research progress of a large number of researchers has been hindered, especially those in the life sciences (mainly basic medicine and clinical medicine). The stress rating scale showed that these researchers had higher psychological stress levels, especially in terms of emotional states, somatic responses and behaviors. Our investigation shows that the pressure on researchers due to the epidemic mainly comes from the process of experiments being blocked and the competition among peers. Additionally, the clinical medicine researchers also have the concern that their value and timeliness experiment may greatly reduce due to the COVID-19 epidemic. The majority of respondents believe that effective ways to relieve stress include extending deadlines, receiving support from superiors for research and increasing benefits for researchers. The results of this investigation suggest that in addition to the focus on restoring the normal order of the laboratory after the NCP, it is also of great significance to improve the psychological state of researchers and relieve their stress and anxiety. It also has the guiding significance to implement the relevant measures to better arrange the scientific research personnel to return to work.

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Table 1(on next page)

Table 1. General information of respondents

1 **Table.1. General information of respondents**

General information		N	%
Gender	Male	104	41.43
	Female	147	58.57
Age	18-24	109	43.43
	25-39	119	47.41
	40-59	22	8.76
	≥60	1	0.4
Category of school or institution	985, 211 universities	177	70.52
	General college	13	5.18
	Independent research institutes (including research institutes)	4	1.59
	University affiliated hospital	55	21.91
	Non-university affiliated hospital	2	0.8
Education background	Undergraduates	79	31.47
	Master candidate (non-graduate)	28	11.16
	Master candidate (graduation grade)	9	3.59
	PhD candidate (non-graduate year)	23	9.16
	PhD candidate (graduation year)	20	7.97
	Basic research staff (including postdoctoral)	31	12.35
	Clinical medical staff (including postdoctoral)	61	24.3
Title of technical post	Professor (researcher, chief physician)	11	4.38
	Associate professor (associate researcher, associate chief physician)	22	8.76
	Lecturer (assistant researcher, attending physician)	44	17.53
	None	174	69.32
Total		251	100

2

Table 2(on next page)

Table 2a. Impact of the delay of project on researchers' stress level

1

2 **Table.2a. Impact of the delay of project on researchers' stress level**

Dimensions	The NCP delays the completion date of scientific research project.		F	p
	Disagree(n=83)	Agree(n=168)		
Emotional state	13.72±6.24	16.90±8.47	9.194	0.003**
Somatic responses	9.16±4.21	10.68±5.35	5.181	0.024*
Sleep quality	7.59±3.47	8.55±4.32	3.131	0.078
Behavior	11.35±4.42	13.41±5.86	8.021	0.005**

* $p<0.05$ ** $p<0.01$

3

Table 3(on next page)

Table 2b. Impact of the postponement of research project on researchers' stress level

1 **Table.2b. Impact of the postponement of research project on researchers' stress level**

Dimensions	The COVID-19 outbreak obstructing research projects made you feel					F	p
	The project is not affected(n=58)	Stressed and worried(n=122)	About to collapse(n=11)	Few influences to my emotion(n=59)	Relaxed and happy(n=1)		
Emotional state	15.47±6.95	16.30±7.43	29.00±10.81	12.71±6.64	24.00±null	12.074	0.000**
Somatic responses	9.74±4.24	10.59±4.74	19.18±6.38	8.00±4.13	15.00±null	14.688	0.000**
Sleep quality	7.98±3.68	8.52±3.93	13.73±5.95	6.80±3.41	12.00±null	8.079	0.000**
Behavior	12.28±4.53	13.09±5.39	21.09±7.29	10.73±4.65	21.00±null	10.482	0.000**

* $p<0.05$ ** $p<0.01$

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Table 4(on next page)

Table 3. Regression analysis of psychological stress level

1 **Table.3. Regression analysis of psychological stress level**

Stepwise regression analysis results		Unstandardized Coefficients		Standardized Coefficients	t	p	VIF	Adjusted R^2	F
		B	S	Beta					
Reasearchers (n=251)	Original research programmes need to be changed	9.294	2.785	0.21	3.337	0.001**	1.088	0.088	F (2,248)=13.050, p=0.000
	Pressure on colleagues to carry out research on NCP	8.176	2.962	0.174	2.76	0.006**	1.088		
Clinical Reasearchers (n=80)	Original research programmes need to be changed or cut	36.333	9.074	0.477	4.004	0.000**	1.547	0.276	F (3,76)=11.036, p=0.000
	Epidemic resistance reduces the value of research	-23.746	8.492	-0.32	-2.796	0.007**	1.429		
	Pressure on colleagues to carry out research on NCP	22.598	8.817	0.281	2.563	0.012*	1.315		
Foundation Reasearchers (n=84)	The COVID-19 has already, or is about to, caused a great loss for projects	26.997	9.345	0.304	2.889	0.005**	1	0.081	F (1,82)=8.346, p=0.005

Dependent variable: stress level

* p<0.05 ** p<0.01

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Figure 1

Figure 1. Some appeals that the researches consider effective to relieve the pressure of affected experiment (251 participants in total).

Some appeals that the researches consider effective to relieve the pressure of affected experiment (251 participants in total).

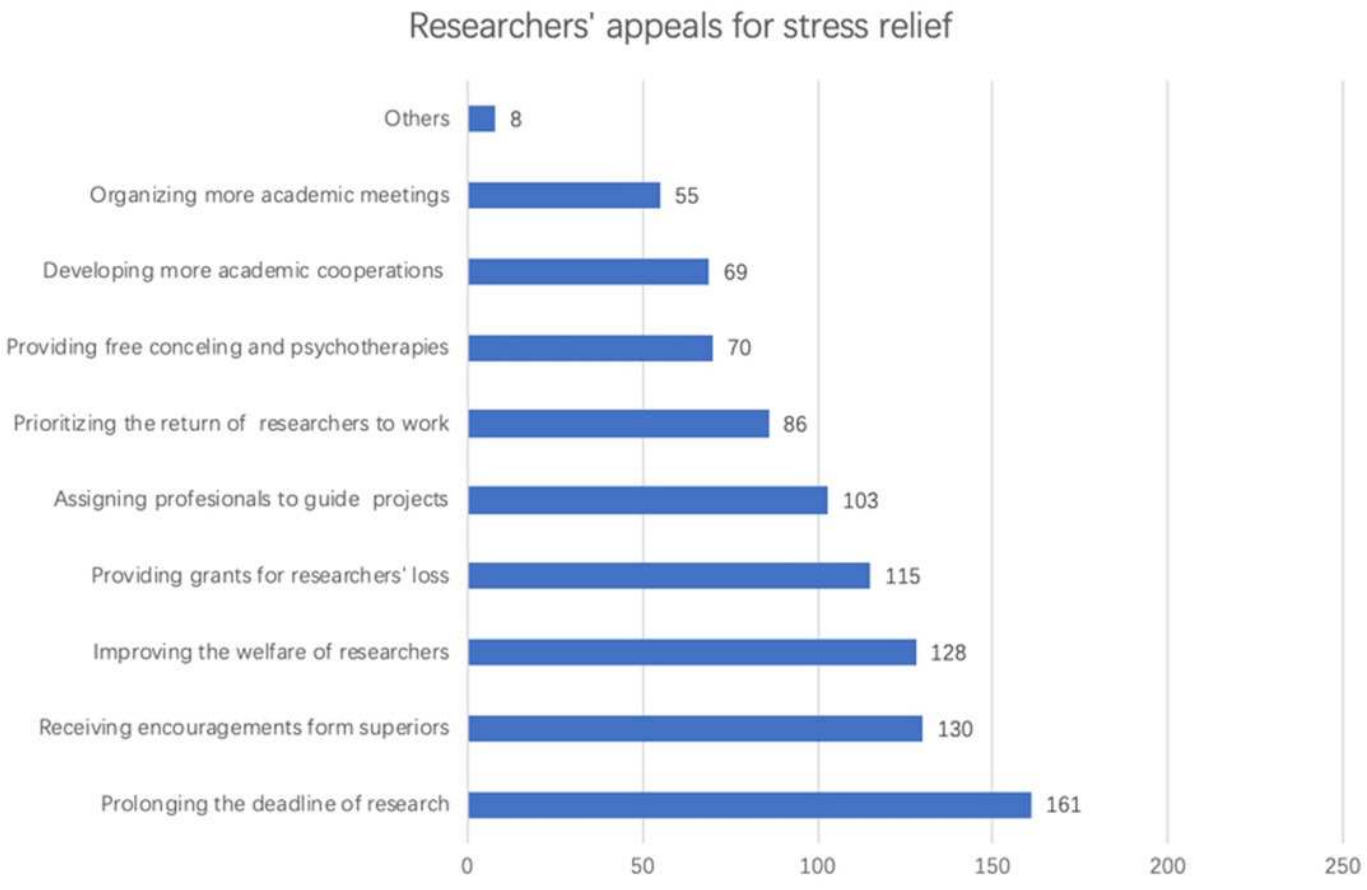

Table 5(on next page)

Table 4. The appeal of different people to improve the condition of scientific researches

1 **Table.4. The appeal of different people to improve the condition of scientific researches**

Appeals		Education background							Total	χ^2	p
		Undergra-duates	Master candidate (non-graduate)	Master candidate (graduation grade)	PhD candidate (non-graduate year)	PhD candidate (graduation year)	Basic research staff (including postdoctoral)	Clinical medical staff (including postdoctoral)			
Improving the welfare of researchers	Disagree	49(62.03)	12(42.86)	6(66.67)	8(34.78)	7(35.00)	11(35.48)	30(49.18)	123(49.00)	12.606	0.050*
	Agree	30(37.97)	16(57.14)	3(33.33)	15(65.22)	13(65.00)	20(64.52)	31(50.82)	128(51.00)		
Assigning professionals to guide research projects	Disagree	52(65.82)	16(57.14)	5(55.56)	9(39.13)	9(45.00)	25(80.65)	32(52.46)	148(58.96)	14.058	0.029*
	Agree	27(34.18)	12(42.86)	4(44.44)	14(60.87)	11(55.00)	6(19.35)	29(47.54)	103(41.04)		
Prioritizing the return of scientific researchers to work	Disagree	56(70.89)	22(78.57)	7(77.78)	11(47.83)	10(50.00)	15(48.39)	44(72.13)	165(65.74)	14.282	0.027*
	Agree	23(29.11)	6(21.43)	2(22.22)	12(52.17)	10(50.00)	16(51.61)	17(27.87)	86(34.26)		
Total		79	28	9	23	20	31	61	251		

* $p<0.05$ ** $p<0.01$

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Table 6(on next page)

Table 5a. Research progress in different fields affected by COVID-19

1 **Table.5a. Research progress in different fields affected by COVID-19**

		Research fields				Total	χ^2	p
		Life science	Science and engineering	Social sciences	Others			
Scientific research projects you participated in during the COVID-19 outbreak are	At a standstill	92(46.00)	14(56.00)	1(8.33)	3(21.43)	110(43.82)	12.854	0.045*
	Still under way but at a slower pace than before	64(32.00)	8(32.00)	6(50.00)	5(35.71)	83(33.07)		
	Completely unaffected	44(22.00)	3(12.00)	5(41.67)	6(42.86)	58(23.11)		
Laboratory facilities are closed or unavailable	irrelevant	44(22.00)	3(12.00)	5(41.67)	6(42.86)	58(23.11)	19.722	0.003**
	Disagree	46(23.00)	7(28.00)	7(58.33)	4(28.57)	64(25.50)		
	Agree	110(55.00)	15(60.00)	0(0.00)	4(28.57)	129(51.39)		
Total		200	25	12	14	251		

2 * p<0.05 ** p<0.01

Table 7 (on next page)

Table 5b. Research progress under the influence of COVID-19 by different title of the technical postTable 5a. Research progress in different fields affected by COVID-19

1 **Table.5b. Research progress under the influence of COVID-19 by different title of the technical post**

		Title of the technical post				Total	χ^2	p
		Professor	Associate professor	Lecturer	None			
Scientific research projects you participated in during the COVID-19 outbreak are	At a standstill	3(27.27)	14(63.64)	26(59.09)	67(38.51)	110(43.82)	16.243	0.013*
	Still under way but at a slower pace than before	6(54.55)	7(31.82)	13(29.55)	57(32.76)	83(33.07)		
	Completely unaffected	2(18.18)	1(4.55)	5(11.36)	50(28.74)	58(23.11)		
Total		11	22	44	174	251		

2 * $p<0.05$ ** $p<0.01$

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