ORIGINAL RESEARCH

The Difference in Learning Activities of Postgraduate Students of Different Qualification Types Under the COVID-19 Pandemic: A Multi-Group Latent Class Analysis

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Introduction: There are two types of master's qualifications in China. One is the academic qualification that pays more attention to academic research, aiming to cultivate research-oriented talents; while the other is the application-oriented qualification that focuses more on practical ability, aiming to cultivate applied-oriented talents. The purpose of this study is to explore the impact of the COVID-19 on the learning activities of postgraduate students, as well as the differences in the extent to which the learning activities of postgraduate students of different qualification types are affected and their mental health status.

Methods: A self-constructed scale for the pandemic's impact on master's students, the self-rating anxiety scale and the self-rating depression scale were applied in the study. The single- and multi-group latent class analyses were used to investigate the impact of the pandemic on postgraduate students of different qualification types.

Results: A total of 2818 responses were collected. The single-group latent class analysis identified four classes. The multi-group latent class analysis showed that no absolute homogeneity existed between different groups. In general, the number of academic master's students affected was greater than application-oriented master's students. Application-oriented master's students were more affected by course activities, while academic master's students were more affected by academic and social activities. Results show that individuals more affected had higher levels of anxiety and depression. Compared to course activities, impacts on social activities were more likely to cause anxiety and depression.

Discussion: Universities can provide a more flexible way of assistance to different qualification types of postgraduate students. Furthermore, social activities play an important role in the mental health of postgraduate students. Therefore, under the background of normalization of pandemic prevention and control, schools should pay more attention to students' interpersonal communication activities to help relieve students' anxiety, depression, and other negative emotions.

Keywords: COVID-19 pandemic, application-oriented postgraduate students, academic postgraduate students, learning activities, multi-group latent class analysis

Introduction

Since the outbreak of COVID-19 at the end of 2019, the pandemic has spread rapidly to various countries and territories around the world. Presently, the number of total confirmed cases of COVID-19 worldwide was more than 200 million. Over 200 countries and territories were affected by the pandemic.[1]

To fight against the spread of the pandemic and ensure the safety of staff and students, according to the requirements of the Ministry of Education in China, students were required to study at home and measures such as online teaching were implemented to control the spread of the coronavirus.[2] At the same time the online education has led to some

1495

disturbance in students' learning: (1) Some students, especially those who live in mountainous areas, suffer from a lack of online studying tools and stable network connections.[3] (2) Most teachers lack experience in online teaching, making it difficult to guarantee the learning effects for students.[3] (3) Students lack a good learning environment and atmosphere when studying at home, and they are easily disturbed by others.[4,5]

Existing researches have explored the impact of the pandemic on elementary, middle, college students or postgraduate students.[6–11] However, few researches have explored the impact of the pandemic on different qualification types of postgraduate students. In China, there are two types of master's qualifications, the academic qualification and the application-oriented qualification The cultivation programs for these two qualification types are quite different.[12] Wang[13] summarized the main differences between academic postgraduate students and application-oriented postgraduate students in cultivation programs, which were mainly reflected in four aspects: teaching mode, tutoring system, curriculum setting and method evaluation. First of all, in terms of teaching mode, the teaching for academic qualification usually adopts an interactive and heuristic mode, while the teaching for application-oriented qualification focuses on the combination of theory and practice, and emphasizes the cultivation of practical ability. Secondly, academic postgraduate students are generally supervised by on-campus tutors, while some universities implement a dual-tutor system on and off-campus for application-oriented post-graduate students. As for curriculum setting, the academic qualification emphasizes an exploratory and relatively complete scientific system, while the application-oriented qualification focuses on career development goals. In terms of method evaluation, academic qualification mainly focuses on academic papers and requires innovative results. But the theses of application-oriented postgraduate students are required to reflect students' problem-solving ability.

From the perspective of the differences in the cultivation goals and cultivation methods of postgraduate students of different qualification types, academic postgraduate students pay more attention to academic research, and their main tasks are to conduct academic activities. However, during the home isolation period, the academic activities of academic postgraduate students, such as the progress of experiments, literature searching, and academic writing were all restricted. And it was also difficult for tutors to directly guide their students, which had a serious impact on students' learning. Application-oriented postgraduate students are more inclined to improve their practical ability and their courses include more practical content, for this, they often do internships to improve their practical ability before graduation.[14] But it was difficult for teachers to carry out practical teaching activities during online teaching, and students could not participate in offline internships during the pandemic.[15] Therefore, the improvement of application-oriented postgraduate students' practical ability was greatly affected.

In summary, with the large differences in the cultivation methods of postgraduate students of different qualification types, the impact on students may vary in different aspects. Up to now, few researches have explored the impact of the pandemic on the learning activities of postgraduate students of different qualification types. In addition, previous studies mostly looked at students as a homogeneous group, ignoring the heterogeneity between groups. Hence, this study aimed to adopt a self-constructed scale to investigate the extent to which the postgraduate students' learning activities were affected by the COVID-19 pandemic. We classified the postgraduate students of two qualifications types into two groups. Based on the multi-group latent class model (LCA), a person-centered approach, we classified the degree to which the learning activities of postgraduate students were affected by the pandemic, and explored the differences between different groups and their mental health status.

Materials and Methods

Participants

A total of 3017 postgraduate students (93.4% valid response rate) were selected by a questionnaire investigation from 33 provinces or autonomous regions in China via the popular Chinese professional survey website Wenjuanxing (www.sojump.com; accessed from January 2021 to April 2021). All the respondents participated voluntarily and signed a consent form.

The mean age of participants was 24.95 years (SD = 3.31). There were 567 males (20.12%), 2251 females (79.88%). Participants were 1188 (42.16%) academic postgraduate students and 1630 (57.84%) application-oriented postgraduate students.

Measure

The Pandemic's Impact on Postgraduate Students Scale

The pandemic's impact on postgraduate students scale was developed to measure the extent to which postgraduate students' course activities, academic activities and social activities were affected by the pandemic. The course activities included course and assessment arrangements. The academic activities included data collection and academic writing. The social activities included interpersonal communication and academic exchanges. All items were on a 4-point Likert scale ranging from 1 (not affected) to 4 (largely affected). In the current study, the scale had proper test reliability (Cronbach's alpha = 0.899).

Self-Rating Anxiety Scale (SAS)

The self-rating anxiety scale was a 20-item self-report scale with 5 items scored in the reverse order, used to assess people's anxiety in the past week.[16] The scale was a 4-item Likert scale with scores on responses ranging from 1 (occasionally) to 4 (always). The sum of the scores was referred to as the total rough score, and the total rough score was multiplied by 1.25 to obtain the standard score. The anxiety scores were interpreted as follows: (50 ~ 59) scores indicated mild anxiety; (60 ~ 69) scores indicated moderate anxiety; and scores > 69 indicated severe anxiety.[17] In the current study, the scale had proper test reliability (Cronbach's alpha = 0.847).

Self-Rating Depression Scale (SDS)

The self-rating depression scale was a 20-item self-report scale with 10 items scored in the reverse order, used to assess people's depression in the past week.[16] The scale was a 4-item Likert scale with scores on responses ranging from 1 (occasionally) to 4 (always). The sum of the scores was referred to as the total rough score, and the total rough score was multiplied by 1.25 to obtain the standard score. According to the Chinese norm, depression scores were interpreted as follows: (53 ~ 61) scores indicated mild depression; (62–71) scores indicated moderate depression; and scores > 72 indicated severe depression.[18] In the current study, the scale had proper test reliability (Cronbach's alpha = 0.873).

Statistical Analysis

Latent class analysis, a person-centered statistical technique, was used in this study to identify latent class members with similar patterns of responses.[19] Then multi-group LCA was conducted so that the latent structures of observed variable groups across two or more groups could be analyzed.[20,21] Mplus 8.3 was used to conduct the single- and multi-group LCA to investigate the differences in the impact of the pandemic on postgraduate students of different qualification types. An analysis of variance was performed using SPSS 20.0 to explore the differences in mental health among postgraduate students of different qualification types.

In the LCA, the evaluation indicators for model fitting included: (1) Akaike information criteria (AIC), Bayesian information criteria (BIC) and sample-adjusted BIC (aBIC).[22] The smaller the above indices values, the better the fit of the model and the greater the performance of the model. (2) Entropy statistics.[23] The greater the entropy value, the higher the accuracy of the classification. At entropy = 0.8, the accuracy of the classification exceeded 90%. (3) Lo–Mendell–Rubin likelihood ratio test (LMR), sample-adjusted LMR (aLMR), and bootstrap-based likelihood ratio test (BLRT).[24] When the p-value reaches a significant level, it suggests that k classes are significantly better than the model of k-1 classes. The present study comprehensively considered the results of various indicators and the reality of postgraduate students' lives to determine the best model of postgraduate students' learning activities. All the statistical tests were two-tailed, and the test level was $\alpha = 0.05$. Harman's single factor test revealed that the first factor explained 23.7% of the total variance, which was less than 40%, indicating no common method bias in this study.

Results

Single-Group Exploratory LCA

The goodness of fit indices of the single-group exploratory LCA is presented in Table 1. The number of classes gradually increased from the 1-class model to the 6-class model. The *chi*-square test statistic gradually decreased from the benchmark model to the 6-class model. The AIC, BIC and aBIC all decreased with the number of the classes increasing,

Table I The Goodness of Fit Indices of Single-Group Exploratory LCA

Model	χ^2	G^2	AIC	BIC	aBIC	Entropy	df
M1: T=1	51071.20(<0.001)	9172.63(<0.001)	30935.11	30982.66	30957.24	–	247
M2: T=2	5986.79(<0.001)	2730.28(<0.001)	24510.76	24611.81	24557.79	0.86	238
M3: T=3	2341.73(<0.001)	1416.26(<0.001)	23214.74	23369.28	23286.67	0.88	229
M4: T=4	653.36(<0.001)	598.21(<0.001)	22414.69	22622.73	22511.52	0.86	220
M5: T=5	483.63(<0.001)	474.57(<0.001)	22309.05	22570.58	22430.78	0.82	211
M6: T=6	362.70(<0.001)	358.31(<0.001)	22210.79	22525.81	22357.42	0.83	202

but the values of these three indicators started to be stable from the 4-class model. Comparing the entropy values of 4-class, 5-class and 6-class models, the variation among them was negligible. Consequently, integrating the results of each model and the simplicity of the model, the 4-class model was selected as the best model.

Naming of Single-Group LCA

The latent class probability and the conditional probability distribution diagram of each class on the eight items are shown in Figure 1. In terms of the latent class probability, class 2 (34.20%) accounted for the largest proportion, and then class 3 (30.18%), class 4 (20.37%) whereas class 1 (15.24%) accounted for the smallest proportion. The class 2 tended to report "not affected" and "slightly affected" for all items, and they were labeled as "the overall less affected". On the contrary, the conditional probabilities of answering "moderately affected" and "largely affected" were over 0.8 for the
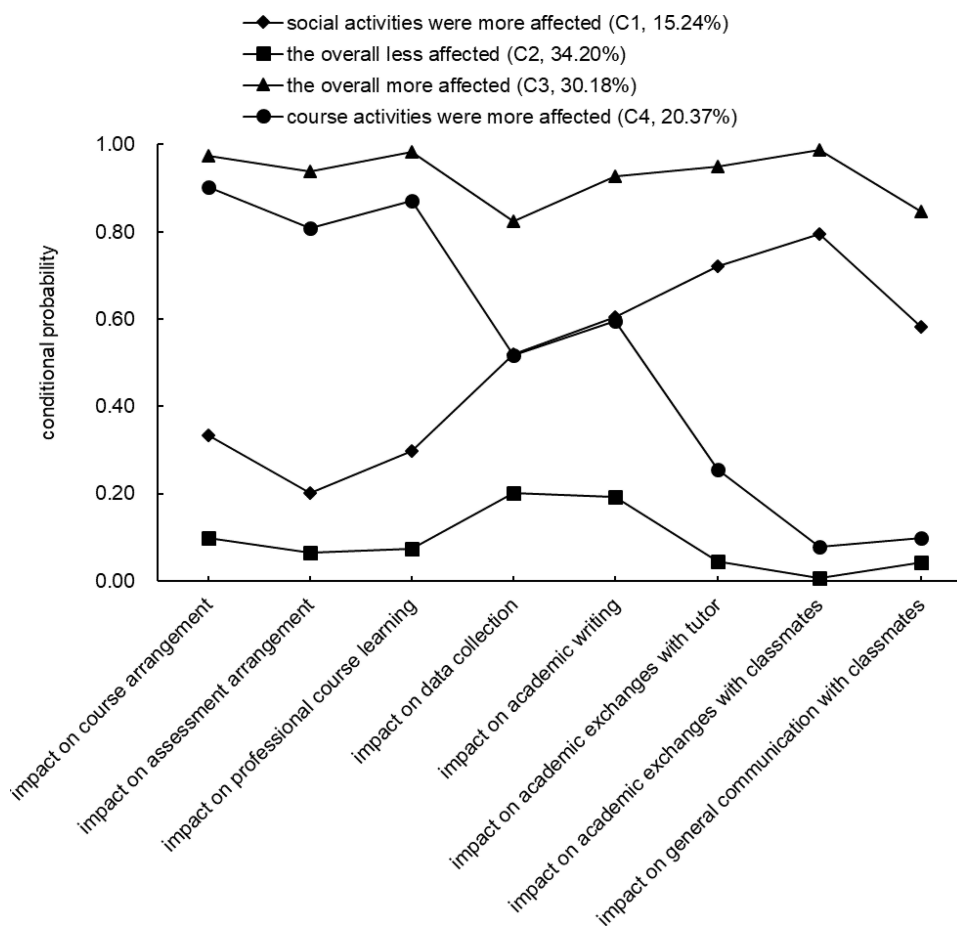
Figure I Conditional probability distribution diagram of single-group LCA.

class 3, so they were labeled as "the overall more affected". The conditional probabilities of the class 1 and class 4 responding to the fourth and fifth questions varied negligibly. The class 1 had a higher tendency to answer "largely affected" for the last three questions, while the first three questions had a lower tendency. The class 4 showed the opposite trend. The former three questions mainly reflected the impact of the pandemic on postgraduate students' course activities, whereas the latter three questions surveyed the impact of the pandemic on postgraduate students' social activities. Therefore, the class 1 and class 4 were named "social activities were more affected" and "course activities were more affected", respectively.

Homogeneity Test of Multi-Group LCA

According to the results of single-group LCA, the 4-class model was selected, the unconstrained and constrained multi-group LCA were performed for postgraduate students of different qualification types to examine whether the structure of the latent class was completely homogeneous across groups. Fit indices of the multi-group LCA for postgraduate students of different qualification types reported the *chi*-square test between the unconstrained and constrained model was significant ($\Delta G2$=55.17, Δdf=32, p<0.01), indicating that there was no complete homogeneity across groups. As a result, the present study conducted a further analysis based on the unconstrained model.

Unconstrained Multi-Group LCA

The conditional probability and the parameter estimation of unconstrained multi-group LCA were presented in Table 2. There are 42.16% academic postgraduate students and 57.84% application-oriented postgraduate students. The result showed that the conditional latent class probability of four classes were respectively 0.15, 0.31, 0.33, 0.21 for the academic postgraduate students and 0.15, 0.36, 0.29, 0.20 for the application-oriented postgraduate students. The proportion of "the overall less affected" class (t=2) for application-oriented postgraduate students (0.36) was higher than that for academic postgraduate students (0.31). Contrarily, the proportion of "the overall more affected" class (t=3) for academic postgraduate students was higher than that for application-oriented postgraduate students. The conditional probability distribution diagram of unconstrained multi-group LCA is shown in Figure 2. For the conditional probability, the differences between "the overall more affected" class (t=2) and "the overall less affected" class (t=3) were slight while the differences between the rest two classes were distinct to an extent. For the "social activities were more affected" class (t=1) and "course activities were more affected" class (t=4), application-oriented postgraduate students had a greater tendency to report "largely affected" than academic postgraduate students in the former three items, illustrating that application-oriented postgraduate students were more affected in course activities than academic

Table 2 Conditional Probability and Parameter Estimation of Unconstrained Multi-Group LCA

Variable	Academic Postgraduate Students (42.16%)				Application-Oriented Postgraduate Students (57.84%)			
	t=1	t=2	t=3	t=4	t=1	t=2	t=3	t=4
1. Impact on course arrangement	0.29	0.06	0.97	0.86	0.35	0.12	0.98	0.92
2. Impact on assessment arrangement	0.17	0.05	0.92	0.75	0.22	0.07	0.95	0.84
3. Impact on professional course learning	0.27	0.07	0.99	0.83	0.30	0.07	0.98	0.90
4. Impact on data collection	0.57	0.20	0.82	0.53	0.48	0.20	0.82	0.50
5. Impact on academic writing	0.67	0.18	0.93	0.65	0.55	0.19	0.92	0.56
6. Impact on academic exchanges with tutor	0.75	0.05	0.96	0.31	0.69	0.04	0.94	0.21
7. Impact on academic exchanges with classmates	0.81	0.02	0.98	0.09	0.77	0.00	0.99	0.06
8. Impact on general communication with classmates	0.58	0.06	0.82	0.10	0.58	0.03	0.86	0.09
Latent class probability	0.06	0.13	0.14	0.09	0.09	0.21	0.17	0.12
Conditional latent class probability	0.15	0.31	0.33	0.21	0.15	0.36	0.29	0.20
Total latent class probability	0.15	0.30	0.34	0.20				

Note: t=1: social activities were more affected; t=2: the overall more affected; t=3: the overall less affected; t=4: course activities were more affected.
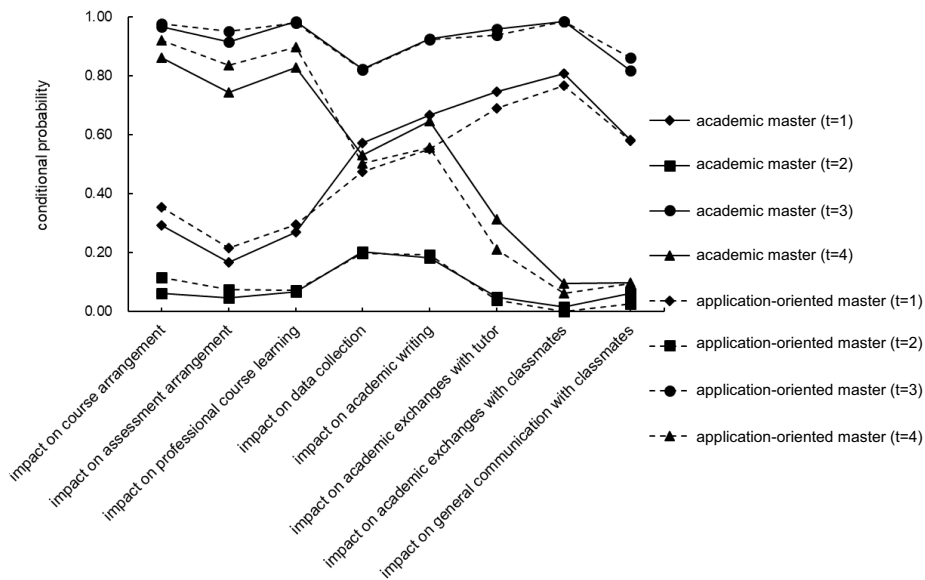
Figure 2 Conditional probability distribution diagram of unconstrained multi-group LCA.

postgraduate students. For the rest of the items, academic postgraduate students tended to report "largely affected" than application-oriented postgraduate students. The fourth and fifth items were used to assess the impact of the pandemic on postgraduate students' academic activities (including data collection and academic writing), and the items from sixth to eighth mainly evaluated the impact of the pandemic on postgraduate students' social activities. As a result, the pandemic exerted a greater influence on academic postgraduate students' academic and social activities than on application-oriented postgraduate students'.

Mental Health Status of Postgraduate Students in Various Classes

Based on the results of unconstrained multi-group LCA, our study further explored the distinction of the mental health status of postgraduate students by different qualification types. The results of variance analysis are presented in Table 3, which showed that there were significant differences in the scores for anxiety (academic postgraduate students: F=9.349, p<0.001; application-oriented postgraduate students: F=12.272, p<0.001) and depression (academic postgraduate students: F=12.963, p<0.001; application-oriented postgraduate students: F=10.270, p<0.001) among four classes. In terms of anxiety, for both academic and application-oriented postgraduate students, the scores for "the overall more affected"

Table 3 Analysis of Differences in the Mental Status of Postgraduate Students in Various Classes

Class	Anxiety		Depression	
	Academic postgraduate students	**Application-oriented postgraduate students**	**Academic postgraduate students**	**Application-oriented postgraduate students**
Social activities were more affected (c1)	43.68(10.45)	42.74(8.89)	47.97(11.72)	47.82(10.41)
The overall less affected (c2)	41.08(9.8)	40.74(9.04)	45.61(10.71)	45.77(10.32)
The overall more affected (c3)	44.72(10.35)	44.05(9.82)	50.41(11.16)	49.28(11.16)
Course activities were more affected (c4)	42.16(9.49)	41.56(8.81)	47.11(10.36)	46.64(10.56)
F	9.349	12.272	12.963	10.270
p	<0.001	<0.001	<0.001	<0.001
Post hoc comparison	c3>c4=c2, c1>c2	c3>c4=c2, c1>c2	c3>c1>c2, c3>c4	c3>c4=c2, c1>c2

class were higher than "the course activities were more affected" class and "the overall less affected" class, but not significantly different from "the social activities were more affected" class. For depression, the scores for "the overall more affected" class were significantly higher than the other three classes in the academic postgraduate students. However, the scores for "the overall more affected" class were significantly higher than the "course activities were more affected" class and "the overall less affected" class, but not significantly different from the "social activities were more affected" class in the application-oriented postgraduate students.

Discussion

Differences in the Impact on Postgraduate Students in Different Types Under the Pandemic

The single-group LCA was conducted initially to explore the impact of the pandemic on postgraduate students' learning activities. The postgraduate students were divided into four classes: "the overall less affected" class, "the overall more affected" class, "course activities were more affected" class, and "social activities were more affected" class. And we further explored the differences in the impact of the pandemic on the learning activities of different qualification types of postgraduate students. The results showed that no absolute homogeneity existed in postgraduate students of different qualification types.

More concretely, academic postgraduate students occupied a larger proportion of postgraduate students affected more by the pandemic compared with application-oriented postgraduate students. The cultivation model for academic postgraduate students is mainly a combination of course learning and tutor guidance, focusing on the mastery of the foundational knowledge and the cultivation of academic research capabilities. Furthermore, academic postgraduate students have higher graduation requirements than application-oriented postgraduate students, thus they carry out heavier academic tasks. Due to the pandemic, the students were constrained to learn online.[3] However, learning and communicating online were less efficient than face to face interaction.[25–27] Moreover, previous studies reported that learning engagement had an impact on the learning effect, the higher learning engagement, the better learning effects.[28,29] However, on account of the influence of the network environment and the learning environment, it is often difficult for students to concentrate on their learning, which leads to a negative impact on the learning effect. In addition, when communicating online, feedbacks to communication between postgraduate students and their tutors or classmates are always untimely due to poor internet.[7,30] And the academic activities such as searching literature and performing experiments are also influenced during the quarantine.[30,31] Because of the factors mentioned above, some academic postgraduate students were greatly affected, and the number was larger than that of application-oriented postgraduate students.[7]

In addition, reasoning by conditional probability, for postgraduate students in "the overall more affected" class and "the overall less affected" class, their course activities, academic activities and social activities were equally affected by the pandemic between academic postgraduate students and application-oriented postgraduate students. As for students in the "social activities were more affected" class and the "course activities were more affected" class, the conditional probability between them is different. To be more specific, application-oriented postgraduate students were more affected than academic postgraduate students in course activities, while academic postgraduate students were more affected in academic activities and social activities. This may be because the cultivation of application-oriented postgraduate students pays more attention to practical ability. Moreover, the number of courses for application-oriented postgraduate students is more than that of academic postgraduate students and the courses emphasize the combination of theory and practice.[32] However, online teaching makes practical courses hard to carry out. As a result, application-oriented postgraduate students' learning activities were more affected. The cultivation that academic postgraduate students received focuses more on their capacity in academics and the requirement of paper retrieval and academic writing skills is in higher demand. Additionally, it is hard for students to carry out academic research without the guidance of tutors and communication with the seniors and fellow students. However, on account of the pandemic, academic activities and academic exchange got restricted which led to an inconvenient situation that face-to-face communication is unachievable. Thus, for academic postgraduate students, their academic and social activities are more susceptible to the pandemic.

According to the results above, there are more people affected among academic postgraduate students than application-oriented postgraduate students, this reminds colleges and tutors to pay more concern and support to them. Postgraduate students of different qualification types were affected by the pandemic in various aspects. According to different situations, colleges can provide a more flexible way of assistance to different qualification types of postgraduate students. For application-oriented postgraduate students, it is suggested that colleges and universities pay more attention to the improvements of courses, and adjust the teaching content appropriately according to the characteristics of online teaching, so as to ensure that students adapt to online learning and harvest from the courses. Simultaneously, to better assist application-oriented postgraduate students, it is also important to timely understand their requirements and the obstacles they encountered in their learning process. For the academic postgraduate students, more attention should be paid to the hardness they met and provide sufficient assistance in their academic activities such as literature retrieval and data collection. Moreover, tutors are suggested to provide more concern and support for their students, which benefits a smoother operation of the academic and accomplishment of the academic writing under the current backdrop of a new normal.

Differences in Mental Status of Postgraduate Students in Various Classes

Based on the results of the unconstrained multi-group LCA, the present study further explored the differences in the mental health status of postgraduate students of different qualification types among various classes. It reported that the anxiety and depression of "the overall more affected" class were at a higher level. Course learning and academics, as the fundamental task for postgraduate students, were unable to be carried out as usual during the pandemic, resulting in increasing academic pressure and negative emotions like anxiety and depression for them. Previous studies reported that different learning environments and conditions during the pandemic would make students more anxious.[33] Social activities are an indispensable part of postgraduate students' lives and research showed that better social support can reduce the risk of anxiety and depression.[34] The postgraduate students in "the overall more affected" class were greatly affected in many aspects including course activities, academic activities, and social activities so they had difficulty accommodating the change caused by the pandemic. As a result, the scores of their anxiety and depression were higher.

It is worth noting that the postgraduate students in the "social activities were more affected" class also had a higher level of anxiety and depression. For both academic postgraduate students and application-oriented postgraduate students, the scores of anxiety and depression of individuals in this class were significantly higher than those in "the overall less affected" class. For application-oriented postgraduate students, the qualifications of anxiety and depression of individuals in this class had insignificant differences from the "social activities were more affected" class. The previous studies showed that factors such as care from tutors, counselors, classmates, and interpersonal communication make a difference in mental health. Among them, the care from counselors and interpersonal communication were protective factors for mental health,[35] and the tutors' concern was beneficial to the mental health of postgraduate students.[36] Based on the interpersonal relationship model when facing stress, individuals with less social support were more likely to be depressed.[37] Therefore, individuals in the "social activities were more affected" class, who gain insufficient assistance and support from the social network, were more likely to be anxious and depressed.

In conclusion, social activities play an important role in the mental health of postgraduate students. They could get support by communicating with classmates and tutors. However, during the pandemic, communication was hindered with the quality of communication decreasing and the support received from social networks decreasing, which easily led to higher levels of anxiety and depression. Therefore, under the background of normalization of pandemic prevention and control, schools should pay more attention to students' interpersonal communication activities, promoting communication between tutors and students, and between students and students to relieve students' anxiety, depression, and other negative emotions.

Limitations

This study has certain limitations that can be expanded in future research. First, a cross-sectional study has been conducted. Longitudinal research can be carried out in the future to identify developmental trends of students' mental health as the impacts of the pandemic decrease. Second, self-reporting inventories were used in this study, indicating that results may be affected by social desirability. Third, limited psychological concepts were included in this study. Future

researchers could involve more of the psychological outcomes such as loneliness and psychological well-being to fully understand the status of student mental health.

Conclusions

Firstly, according to the situation of postgraduate students learning activities affected by the pandemic, we identified four classes, namely "the overall more affected" class, "the overall less affected" class, "course activities were more affected" class, "social activities were more affected" class. Second, during the pandemic, the number of academic postgraduate students affected is more than that of application-oriented postgraduate students. Notably, the two qualification types of postgraduate students are affected by the pandemic in different aspects. Application-oriented postgraduate students are more affected by course activities, while academic postgraduate students are more affected by academic activities and social activities. In addition, individuals more affected by the pandemic have higher levels of anxiety and depression. Compared to course activities, impacts on social activities were more likely to cause anxiety and depression.

Ethical Approval

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the local Ethics Committee of the School of Psychology, South China Normal University (SCNU-PSY-2021-021).

Funding

Disclosure

The authors declare no conflicts of interest in this work.

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