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Sex-related disparities in students’ disaster responses in the post-COVID-19 era

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A R T I C L E   I N F O

Keywords:
Disaster responses
COVID-19
Sex-related disparities
Propensity score matching

A B S T R A C T

This study aimed to understand whether sex-related variations existed in responses to the pandemic as well as campus climate change of anti-epidemic measures. An online survey was distributed to full-time undergraduates in 13 postsecondary institutions located in an eastern province in China. First, we matched “similar” students in terms of a set of observational variables. Second, we compared female students with these “similar” male peers in terms of their responses to COVID-19 and responses to the campus climate change of anti-epidemic measures. Finally, the robustness of matching estimators was checked for the potential biases that might be caused by unobserved variables. The primary results showed that female students had higher awareness, preparedness, and fear, but lesser knowledge of the pandemic, and considered getting vaccinated of lesser necessity compared with male students. Also, we observed a pronounced pattern of sex-related difference in responding to campus climate changes; male students were more likely to be indifferent in keeping social distance, adopting other measures, and participating in campus activities. The findings inform postsecondary administrators and other related stakeholders to avoid making the existing sex-related disparities larger and help every student well prepare for and appropriately respond to COVID-19.

1. Introduction

The outbreak of COVID-19 has instantly become a global public health threat worldwide. Incomparable losses of lives and economies are caused largely because of the disease's novelty, human beings' lack of preparedness, and authorities' slow responses [1,2]. As the pandemic continues, people have been more familiar with the disease; however, it is still crucial to respond in appropriate ways. Recent research has found sex-related and gender disparities in various aspects on COVID-19 [3–6]. For example, Alahdal et al. found that women had better practices toward COVID-19, such as wearing masks, washing hands, and keeping social distance, than men [5]. Gausman & Langer illustrated that women, especially pregnant women, suffered more risks from the pandemic than men [3]. In addition, de la Vega et al. found that women’s attitudes toward the pandemic were more responsible than men’s in Spain [7], which may affect their adaptations of preventive measures [8]. It should also be noted that men may perceive they are physically strong and inaccurately believe coronavirus is just a flu, thereby being more resistant to take preventive measures [9].

As a vulnerable population, adolescents and young adults are severely influenced by the pandemic besides drastic anti-epidemic measures, which may also affect their overall mental health and well-being [10]. Ranta et al. found that compared with older people, young adults were more worried about the impacts of a pandemic on their mental well-being, studies, and such [11]. Notably, they also found that young females were more concerned about their mental health than males. In the lens of gender, Pinchoff et al. also

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https://doi.org/10.1016/j.ijdrr.2022.103446
Received 23 December 2021; Received in revised form 5 November 2022; Accepted 11 November 2022
Available online 17 November 2022
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found that COVID-19 had disproportionately impacted young girls and women in terms of knowledge and preventive behaviors [12]. Zhao et al. highlighted the significant relationships between sex and students’ COVID-19 knowledge and preparedness [13]. All together, these studies indicated that it was important to understand among young adults how sex played roles in responding to the pandemic.

In the educational setting, school sectors take actions such as school campus closures to prevent the transmission of COVID-19 at its severity [10,14]. Nowadays, although educational sectors are back to normal operation, necessary disease prevention measures, such as wearing masks and keeping social distance in public, are still required. In China, the level of austerity of prevention measures is properly changed in accordance with the real-time situation of the pandemic, which has been established as a new anti-epidemic policy by Chinese governments [15]. College campuses follow tightly with the governments’ anti-epidemic policies. For example, when the pandemic is severe, campus anti-epidemic policies/measures remain extremely strict, like closing campuses, in contrast, the anti-epidemic policies/measures will be moderate, like resuming face-to-face classes. In this study, we regarded this as campus climate change of anti-epidemic measures. Therefore, it is equally important to understand how students respond to the campus climate change of anti-epidemic measures and whether the response varies by sex.

This study sought to explore whether sex-related disparities existed in responses of young adults to COVID-19. This might add a sex-related lens in adolescents and young adults to the existing literature as suggested by Gaußman & Langer [3]. In addition, to our knowledge, insufficient empirical results have been found to inform postsecondary institution stakeholders whether young females are more prepared for and better respond to COVID-19, or their counterparts, despite a few [12,13], especially in the Chinese context. So far, an increasing number of scholars have examined how individuals psychologically respond to COVID-19, such as awareness, knowledge, prevention behaviors, and preparedness, but limited research focuses on how they respond to institutional climate/policy changes. This study aimed to examine this from both perspectives. Counterfactually setting sex as the treatment and using the propensity score technique for the survey data of College Students’ Epidemic Preparedness in Post-COVID-19 Era (CSEPPCE), we examined the effects of sex on students’ responses to COVID-19.

2. Material and methods

2.1. Data and sample

The data for this study were obtained from the CSEPPCE survey conducted in May 2021. The questionnaire was carefully designed referring to the studies by Ahmed et al. [16] and Ikhlq et al. [17], and comprehensively surveyed students’ responses to COVID-19, such as their awareness of, knowledge of, and preparedness for COVID-19, as well as their reactions to campus climate change of anti-epidemic measures, which fit our main research objectives. In addition, the survey contained students’ demographic information such as ethnicities, grades, and urbanicity and parental information such as occupations and family income, which could be used in the matching process.

The survey participants were full-time traditional undergraduate students currently living on campuses. The data collection was performed in two steps. First, we recruited one or two university representatives from major postsecondary institutions located in an eastern province in China to ask their willingness to help distribute the survey link; we obtained 13 four-year postsecondary institutions. Second, we delivered the survey through an online survey platform and acquired 1470 responses. Considering no missingness of the intended variables in this study, the final analytic sample was 1470, including 777 (52.86%) male students and 693 (47.14%) female students. The data use and design of this study were approved by the authors’ institutional review board.

2.2. Measures

2.2.1. Responses to COVID-19

Students’ responses to COVID-19 in the present study included their awareness of COVID-19, knowledge of COVID-19, preparedness for COVID-19, fear of COVID-19, and necessity of getting vaccinated. Among them, awareness, knowledge, and preparedness as latent factors consisted of multiple survey items. In detail, we asked “the frequency that students talk COVID-19 with classmates/ roommates, friends, and family, respectively” for awareness, “students’ knowledge of COVID-19’s symptoms, spread ways, prevention, and differences with other similar diseases, respectively” for knowledge, and “the frequency that students wear a mask when taking class, etc., use hand sanitizer, and keep social distance, respectively” for preparedness, all of which were measured using a 5-point Likert scale with 5 = strongly agree and 1 = strongly disagree. To assess whether these survey items shared a common factor, we conducted factor analysis for awareness, knowledge, and preparedness. The factor loadings ranged from 0.65 to 0.90 (see details in Table 1), indicating an acceptable validity of the construct [18]. Moving to the reliability test, Cronbach’s alpha yielded the values of 0.90, 0.91, and 0.76 for awareness, knowledge, and preparedness, respectively, indicating a strong internal consistency among survey items [19]. For the variable of fear of COVID-19 and necessity of getting vaccinated, we asked “how were students afraid of COVID19 infection” and “how necessary they feel to get vaccinated,” respectively, also in a 5-point Likert scale.

2.2.2. Responses to campus climate change

Four items were measured as students’ responses to campus climate change in the post-COVID-19 era. Participants were asked when the campus anti-epidemic measures were loosened, whether it would influence their frequency of wearing a mask (1 = Yes, 0 = No), whether it would affect them to keep social distance in public areas (1/0), whether it would influence their frequency of adopting other anti-epidemic measures (1/0), and whether it would influence their participation in campus activities (1/0).
Table 1
Reliabilities for awareness, knowledge, and preparedness.

| Variables     | Cronbach’s α | Items                                                                 | Mean  | SD  | FL  |
|---------------|--------------|-----------------------------------------------------------------------|-------|-----|-----|
| Awareness     | 0.90         | Discuss COVID-19 with classmates/roommates                           | 2.37  | 0.80| 0.86|
|               |              | Discuss COVID-19 with friends                                         | 2.26  | 0.75| 0.82|
|               |              | Discuss COVID-19 with the family                                      | 2.29  | 0.77| 0.88|
| Knowledge     | 0.91         | Know about the symptoms of COVID19                                    | 2.93  | 0.92| 0.83|
|               |              | Know how COVID-19 spreads                                             | 3.07  | 0.93| 0.90|
|               |              | Know about COVID19 prevention                                          | 3.16  | 0.91| 0.86|
| Preparedness  | 0.76         | Wear a mask when taking class, participating in school activities, etc.| 2.22  | 0.93| 0.65|
|               |              | Use a hand sanitizer                                                  | 2.25  | 0.95| 0.69|
|               |              | Keep social distance                                                  | 2.24  | 0.87| 0.68|

Note. The analytic sample N = 1470. FL = Factor loading. All the survey items were on a 5-Likert scale with 5 = strongly agree and 1 = strongly disagree.

2.2.3. Matching variables
We collected a set of observational variables as matching variables to operate the matching process. As known, 56 ethnical groups are present in China, among which Han is the dominant ethnical group, while all other 55 are minorities such as Zang, Miao, and so on. Thus, a student’s ethnicity was sorted into Han and Others in terms of their representatives. Their grade was categorized into freshman, sophomore, junior, and senior. We also surveyed where a student originally came from (i.e., urbanicity): urban, suburban, or rural areas. In addition, students’ family characteristics were included. A student’s family income was set to low-income, middle-income, and high-income. Parental occupations, including father’s and mother’s jobs, were measured by eight categories in terms of the Occupational Classification of the People’s Republic of China. All these categories were coded to 1 = Yes and 0 = No as dichotomous variables (see detailed descriptive statistics in Table 2).

2.3. Analytic strategy
First, since our variables of interest contained latent factors, we generated these variables by conducting factor analysis and Cronbach’s alpha test, as shown in Table 1. Second, descriptive statistics were presented in three groups (i.e., female, male, and pooled) to provide the basic information about each group, as shown in Table 2.

Table 2
Descriptive statistics of variables of interest.

| Variables             | Pooled (N = 1470) | Female (N = 693) | Male (N = 777) |
|-----------------------|-------------------|-----------------|--------------|
|                       | Mean | SD  | Mean | SD  | Mean | SD  |
| Ethnicity             |      |     |      |     |      |     |
| Han                   | 0.94 | 0.24| 0.92 | 0.27| 0.95 | 0.21|
| Others                | 0.06 | 0.24| 0.08 | 0.27| 0.05 | 0.21|
| Grade                 |      |     |      |     |      |     |
| Freshman              | 0.43 | 0.50| 0.44 | 0.50| 0.42 | 0.49|
| Sophomore             | 0.30 | 0.46| 0.31 | 0.46| 0.28 | 0.45|
| Junior                | 0.15 | 0.35| 0.13 | 0.34| 0.16 | 0.36|
| Senior                | 0.12 | 0.33| 0.11 | 0.31| 0.14 | 0.34|
| Urbanicity            |      |     |      |     |      |     |
| Urban                 | 0.36 | 0.48| 0.31 | 0.46| 0.40 | 0.49|
| Suburban              | 0.11 | 0.31| 0.13 | 0.33| 0.09 | 0.29|
| Rural                 | 0.53 | 0.50| 0.57 | 0.50| 0.50 | 0.50|
| Family income         |      |     |      |     |      |     |
| Low                   | 0.27 | 0.45| 0.30 | 0.46| 0.25 | 0.43|
| Middle                | 0.69 | 0.46| 0.66 | 0.47| 0.71 | 0.46|
| High                  | 0.04 | 0.20| 0.03 | 0.18| 0.05 | 0.21|
| Responses to COVID-19 |      |     |      |     |      |     |
| Awareness             | 2.31 | 0.71| 2.34 | 0.68| 2.27 | 0.73|
| Knowledge             | 2.95 | 0.84| 2.89 | 0.79| 3.01 | 0.87|
| Preparedness          | 2.23 | 0.75| 2.28 | 0.79| 2.19 | 0.79|
| Fear                  | 1.95 | 0.86| 2.08 | 0.85| 1.83 | 0.85|
| Vaccine               | 4.07 | 1.10| 3.99 | 1.11| 4.14 | 1.09|
| Responses to climate change |      |     |      |     |      |     |
| Mask                  | 0.56 | 0.50| 0.55 | 0.50| 0.56 | 0.50|
| Social distance       | 0.47 | 0.50| 0.43 | 0.50| 0.50 | 0.50|
| Other measures        | 0.42 | 0.49| 0.38 | 0.49| 0.46 | 0.50|
| Campus activity       | 0.42 | 0.49| 0.37 | 0.48| 0.45 | 0.50|

Note. Father’s and mother’s jobs are categorical variables, and are not shown in this table, but we included them as observational variables in the matching process.
Third, we applied the propensity score matching technique to examine sex-related disparities in responses to COVID-19 (i.e., responses to COVID-19 and campus climate influence) by estimating the average treatment effect on the treated (ATT) using Stata 16 [20]. In the real world, sex could not be the treatment, however in this study, we artificially set the female as the treatment, denoted as \( t \), and then used a set of observational variables to calculate students’ propensity score conditioning on the female sex by applying the probit regression model [21]:

\[
p = \Pr(t = 1|X) = E(t|X)
\]

where \( t \in \{0, 1\} \) is the indicator of whether a student was female and \( X \) is the set of observational variables. Next, we counterfactually matched “similar” female and male students in terms of the calculated propensity scores and then examined the effect of sex on students’ responses to COVID-19 [20,22]:

\[
ATT = E(\gamma_{11}|X, t_1 = 1) - E(\gamma_{00}|X, t_1 = 0|t_1 = 1)
\]

where \( \gamma_{11} \) and \( \gamma_{00} \) were the outcomes of the treatment group (female) and the control group (male), respectively.

In the matching processing, the 1:1 nearest neighbor matching algorithm was implemented [22,23], which matched treated and control units in terms of how close their propensity scores were [24], as known as caliper, defined as \( \min_{j} ||p_i - p_j|| \) [20], where \( p_i \) and \( p_j \) were the propensity scores for the treatment and control groups, respectively. Taking into account the suggestions by Austin [25] and Wang et al. [26], we used 0.2 standard caliper width to pair treated (female student) and control units (male student).

Finally, a sensitivity analysis was conducted for the robustness check to examine whether the hidden bias caused by unobservable variables would also possibly affect the treatment effects. Following Olitsky [27], we adopted the Rosenbaum Bounds (RB) to see to what degree the hidden bias would make the treatment effect insignificant.

3. Results

3.1. Descriptive statistics

Table 2 provides descriptive statistics of variables of interest by three groups. Further, 92% of female students and 95% of male students were Han. With respect to the grade, female and male groups presented a similar pattern that newcomers accounted for the largest share of the groups while seniors accounted for the smallest share. For the urbanicity, 31% of female students and 40% of male students were from urban areas, while 57% of female students and 50% of male students were from rural areas. Notably, on average, female students had higher values than their male peers for awareness of, preparedness of, and fear of COVID-19, and lower values for COVID-19 knowledge and necessity for getting a vaccine. Looking at the mean of each variable measuring students’ responses to campus climate change, male students had a higher value.

3.2. Matching results

Using probit regression to calculate the propensity scores and then matching students in terms of these scores, we obtained 635 pairs, meaning that 635 “similar” male students were found to compare with female students. A balance check was suggested before moving to estimate the treatment effect [28]. The \( t \) statistics for differences in means of the matching covariates for matched and unmatched groups showed that all the matching covariates yielded no statistically significant difference in the matched group. However, in the unmatched group, most covariates were statistically significantly different. This indicated that the matching played an effective role in balancing the two groups. We also checked the standardized bias of each matching covariate after the matching, which was less than 5%, meaning a good match. In addition, the kernel density plots of propensity scores were drawn to clearly show the pattern of female and male students [29]. As shown in Fig. 1, the substantial overlaps indicated that sufficient “similar” students were found and enabled us to move to the next step—examining the treatment effect.

3.3. ATT results

Table 3 presents the results from our propensity score analysis for students’ responses to COVID-19 in the post-COVID-19 era. These ATT results measured the difference in mean in responses to COVID-19 between female students and these female students if they were male, indicating whether sex-related disparities existed in students’ responses to COVID19. With respect to the awareness of COVID-19 and preparedness for COVID-19, we found that the matching estimates indicated that female students had higher awareness and better preparedness than their male peers; both were significant at the 0.05 level. The results also showed that female students were more afraid to get COVID-19 (\( P < 0.001 \)). Notably, female students had less knowledge and considered getting vaccinated of lesser necessity compared with male students.

With regard to the influence of campus climate change, we saw that the statistically significant variations in different responses of men and women to the change in campus climate of anti-epidemic measures. The results indicated that when a campus loosened its anti-epidemic measures, male students were more likely to be indifferent in continuing to keep social distance, adopting other anti-epidemic measures such as washing hands frequently, and participating in campus activities (\( P < 0.01 \)). In addition, no significant sex-related disparities were found in wearing a mask when the climate was not strict.
Figure 1. Kernel density plots of propensity scores for the female and male groups.

Table 3
ATTs of students’ responses to COVID-19 and campus climate change.

| Responses to COVID-19 | Responses to climate change |
|-----------------------|-----------------------------|
|                       | Awareness | Knowledge | Preparedness | Fear | Vaccine | Mask | Social distance | Other measures | Campus activity |
| ATT                   | 0.080*    | -0.096*   | 0.108*       | 0.217*** | -0.175* | -0.030 | -0.080**       | -0.088**       | -0.082**       |
| SE                    | 0.039     | 0.047     | 0.043        | 0.046 | 0.061   | 0.028 | 0.028          | 0.028          | 0.028          |

Note. Matched sample N = 635; *P < 0.05, **P < 0.01, ***P < 0.001. ATT, Average treatment effects on the treated; SE, standard error.

3.4. Sensitivity analysis results

Conducting RB, Table 4 reports the critical P values, which were used to judge the point at which no treatment effect was observed [30]. The value of \( \Gamma \) indicated to what degree the unobservable variables would affect the odds of being treated. A higher value of \( \Gamma \) represented a more important role of unobservable variables. In other words, if the effect of a model was significant or became insignificant at a high value of \( \Gamma \), it was less likely to suffer from hidden bias [27]. To more clearly present at which point the effect became insignificant at the 0.05 level, we bolded them in Table 4.

For awareness and knowledge, \( \Gamma \) values ranged from 1.0 to 1.1 (see Table 4). For preparedness, vaccine, social distance, other measures, and campus activity, \( \Gamma \) values varied from 1.1 to 1.2. For fear, the \( \Gamma \) value was 1.4, suggesting that in this model, the treatment effect was most robust to unobservable variables compared with the rest of the models. In other words, the result of sex-related disparities in fear of getting COVID-19 was the most robust in this study.

Table 4
Sensitivity analysis: Using Rosenbaum Bounds to test hidden bias.

| \( \Gamma \) | Awareness | Knowledge | Preparedness | Fear | Vaccine | Mask | Social distance | Other measures | Campus activity |
|-------------|-----------|-----------|--------------|------|---------|------|----------------|----------------|----------------|
| 1.00        | 0.008     | 0.021     | 0.002        | <0.001 | 0.003   | 0.370 | 0.004         | 0.001          | 0.001          |
| 1.05        | 0.028     | 0.066     | 0.009        | <0.001 | 0.012   | 0.544 | 0.012         | 0.004          | 0.003          |
| 1.10        | 0.074     | 0.157     | 0.031        | <0.001 | 0.037   | 0.703 | 0.033         | 0.013          | 0.010          |
| 1.15        | 0.158     | 0.299     | 0.082        | <0.001 | 0.088   | 0.825 | 0.073         | 0.033          | 0.026          |
| 1.20        | 0.282     | 0.472     | 0.174        | <0.001 | 0.175   | 0.907 | 0.140         | 0.073          | 0.087          |
| 1.25        | 0.434     | 0.644     | 0.307        | 0.004 | 0.296   | 0.955 | 0.234         | 0.139          | 0.109          |
| 1.30        | 0.589     | 0.785     | 0.465        | 0.011 | 0.442   | 0.980 | 0.350         | 0.231          | 0.185          |
| 1.35        | 0.727     | 0.884     | 0.623        | 0.026 | 0.589   | 0.992 | 0.478         | 0.345          | 0.283          |
| 1.40        | 0.833     | 0.944     | 0.758        | 0.054 | 0.720   | 0.997 | 0.602         | 0.470          | 0.397          |
| 1.45        | 0.906     | 0.975     | 0.858        | 0.100 | 0.823   | 0.999 | 0.714         | 0.594          | 0.515          |
| 1.50        | 0.951     | 0.990     | 0.924        | 0.168 | 0.896   | 1.000 | 0.805         | 0.706          | 0.629          |

Note. Awareness, preparedness, and infection report upper bound significance level, while the rest report lower bound significance level because their ATTs are negative. See details in DiPrete & Gangl (2004). The effect becomes insignificant at the 0.05 level starting at the bolded value.
4. Discussion

4.1. Sex-related differences in students’ responses to COVID-19

This study used the survey data among Chinese undergraduates to examine whether sex-related disparities existed in students’ responses to COVID-19 as well as their responses to campus climate change of anti-epidemic measures. Sex-related and gender disparities have been found in different outcomes in COVID-19 with different cultural backgrounds [12,13,31–33]. Women had fewer reported cases and lower fatality rates [4]; however, as a vulnerable group, they were likely to suffer a larger psychological impact from the pandemic compared with men [3,32]. Our study indeed found sex-related disparities among students’ responses to COVID-19. The results indicated that female students had significantly higher awareness and preparedness than their male peers and were more afraid of being infected. These findings were consistent with those of Rana et al. [34], showing that women were more likely to perceive risk and take precautionary measures than men. Broche-Pérez et al. found that women experienced greater fear than men during the pandemic [35]. These phenomena were observed probably because men believed that in nature they were biologically strong, tended to engage in high-risk activities, and thus neglected potentially severe harms to them, in forms of not avoiding large public gatherings, wearing a mask, and washing hands, while responding to the pandemic [36].

With respect to COVID-19 knowledge, Pinchoff et al. surveyed Indian adolescents and young adults and found that adolescent girls and young women had lower knowledge that COVID-19 main symptoms than their male peers [12]. In Italy, Gallé et al. found that knowledge of female students regarding the COVID-19 vaccine was lower than that of their male peers [37]. Similar results were found in our study, showing that female students had lower knowledge scores compared with male students. However, Al-Hanawi et al. found an inconsistent pattern that men had lower knowledge scores than women in Saudi Arabia [31]. U.S. women were reported to be more likely to know how the COVID-19 spreads [38]. Women in Greece scored higher in the COVID-19 knowledge assessment than men [39]. The results of sex-related disparities in individuals’ knowledge varied in different regions [40] and studies probably due to different backgrounds such as age, educational level, and income. Bates et al. found that individuals with a lower education level and/or unemployment had lower COVID-19 knowledge scores [41]. Limaaco et al. surveyed 1091 respondents from 41 countries, and found that perceived stress and anxiety of females were significantly higher than those of their male peers [42]. Carli also pointed out that more women than men have experienced higher psychological stress during the pandemic [43]. This might prevent them from reading news, which was an effective way to gain knowledge about COVID-19. These informed postsecondary education administrators and/or policymakers to broaden the channels of knowledge and information acquisition so as to moderate the sex-related disparities in knowledge.

With regard to vaccination, previous studies found sex-related differences in receiving the COVID-19 vaccine. For instance, Karlsson et al. conducted three sub-studies including Finnish samples of parents of small children, individuals from insufficient vaccine coverage, and nationwide Internet users, and found that women expressed lesser willingness to get vaccinated than men [44]. Surveying 27,036 participants in Japan, Ishimaru et al. found that women (33.0%) reported pronouncedly lower COVID-19 vaccine intentions than men (41.8%) [45]. These results were consistent with our findings, indicating female students’ inactive attitudes toward the vaccine. It was possible that women were less knowledgeable on the COVID-19 vaccine [37] and perceived more risks in vaccination than men, such as adverse events, which was also in line with the findings of Rana et al. [34] and this study, showing that women were more likely to have higher risk perceptions and awareness. Also, in the pandemic, young females experienced higher perceived stress and anxiety than males [46], which might reduce their willingness to receive vaccines since there still exists potential risks. In addition, the COVID-19 vaccine was not suggested to be taken along with other vaccines such as HPV during the same period, which might also harm women’s attitude toward the COVID-19 vaccine.

4.2. Sex-related differences in students’ responses to campus climate change

In an educational setting, it is important to understand how students respond when schools take action in preventing the transmission of COVID-19. While entering the post-COVID-19 era, governments across the world adjust their anti-epidemic policies according to the epidemic situation, as postsecondary institutions in China. Our finding regarding the campus climate change of anti-epidemic measures suggested that when the anti-epidemic climate was loosened, male students were more likely to ignore social distance and other anti-epidemic measures, such as handwashing with a sanitizer, than their female peers. Still, a possible explanation is that women, in general, are more cautious and have higher risk awareness than men [34,45]. Women are reported to adopt more anti-epidemic measures than men [47]. Although the pandemic is well controlled in China, female students may still be willing to take preventive measures than male students.

College students have been found to be more likely to respond negatively to COVID-19, such as negative sentiments toward social distancing and campus closure [48], largely because their college lives, such as study groups, sports, parties, and club activities, are limited due to various restrictions. Parker et al. surveyed American undergraduate and graduate students and also found that students were more satisfied with in-person instruction than remote instruction [49]. Energetic college students, especially these young men, might be more eager to participate in campus activities when they were permitted. Our finding also revealed that young male students expressed more interest in participating in campus activities when the campus restrictions were loosened. Not surprisingly, no pronounced sex-related differences were found in wearing a mask because this had gradually become a daily habit of an individual’s life.

4.3. Limitations and future directions

Despite carefully conducting this study, it still had the following limitations. First, although we had a rich set of matching variables, some potential variables such as parental education level and students’ academic performance, which were not collected in our
survey, could also be included to create more similar pairs of treated and control students conditioning on sex. Future research should include more comprehensive survey questionnaire to enrich students' demographic and family information as well as school-level information to more precisely perform the matching technique. Second, we restricted our survey participants to an eastern province in China. This might lack external validity and hence could not generalize the results to the whole nation. Future research should recruit participants at the national level to see whether the sex-related patterns of responses to COVID-19 changed. Third, in this study, we only explored whether sex-related disparities existed in students' responses to COVID-19 as well as their responses to campus climate change. Future research should explore the cause for these sex-related disparities and the factors influencing students’ responses to COVID-19. Fourth, due to our sample limited to traditional undergraduate students, factors such as age and education level may not vary significantly among the current sample, future research could target on residents, thereby exploring age, education level, and/or other factor-related disparities in responses to COVID-19.

5. Conclusions

Appropriate individual responses to COVID-19 are important, especially for students. This study aimed to understand whether sex-related variations existed in responses to the pandemic as well as campus climate change of anti-epidemic measures. The results showed that female students had higher awareness, preparedness, and fear, but lesser knowledge of the pandemic, and considered getting vaccinated of lesser necessity. In addition, we also observed a pronounced pattern of sex-related difference in responding to campus climate changes; male students were more likely to be indifferent in keeping social distance, adopting other measures, and participating in campus activities. The model robustness was checked using the sensitivity analysis. These findings might remind postsecondary administrators and other related stakeholders to avoid making the existing sex-related disparities larger and help every student well prepare for and appropriately respond to COVID-19.

Notes

1. There is a dearth of literature on gender beyond the binary among young adults in China. Perez-Felkner et al. [50] operationalized gender as behavioral characteristics attributes to each sex and sex as biological distinction between females and males at birth. In addition, the ways of asking an individual's biological sex and gender identity are quite different in Chinese. Unlike Yu and Xie [51], we did not design specific survey items for students’ gender identity. Instead, we surveyed students' biological sex (i.e., female and male). Therefore, we used “sex” throughout the paper.

2. Since China's undergraduate students generally follow a normal educational trajectory (starting college at 18 or 19, and leaving at 22 or 23), the patterns of grade and age are expected to be similar. We chose grade due to the large missing values in age variable.

Funding

This work was supported by the National Social Science Foundation of China (20BGL273, BIA190198).

Consent for participation

Informed consent was obtained from all participants, and cannot be identified in any way via the manuscript.

Declarations of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Acknowledgments

The authors would like to thank all the participants of the survey of CSEPPCE. We also appreciate Drs. Lara Perez-Felkner’s and Yanyun Yang’s helps in reviewing the 2nd revision of the manuscript.

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