

# BMJ Open Impact of COVID-19 on college students at one of the most diverse campuses in the USA: a factor analysis of survey data

Bowen Liu <sup>1,2</sup> Edward Huynh <sup>2</sup> Chengcheng Li,<sup>3</sup> Qing Wu <sup>4</sup>

**To cite:** Liu B, Huynh E, Li C, *et al.* Impact of COVID-19 on college students at one of the most diverse campuses in the USA: a factor analysis of survey data. *BMJ Open* 2022;**12**:e061719. doi:10.1136/bmjopen-2022-061719

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-061719>).

Received 05 February 2022  
Accepted 17 August 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Nevada Institute of Personalized Medicine, University of Nevada Las Vegas, Las Vegas, Nevada, USA

<sup>2</sup>Department of Mathematical Sciences, University of Nevada Las Vegas, Las Vegas, Nevada, USA

<sup>3</sup>Faculty of Foreign Languages, Open University of China, Beijing, China

<sup>4</sup>Department of Biomedical Informatics, The Ohio State University College of Medicine, Columbus, Ohio, USA

## Correspondence to

Dr Qing Wu; [qing.wu@unlv.edu](mailto:qing.wu@unlv.edu)

## ABSTRACT

**Objective** This survey study is designed to understand the impact of the COVID-19 pandemic on stress among specific subpopulations of college students.

**Design, settings and participants** An online questionnaire was sent to the students from University of Nevada, Las Vegas, between October 2020 and December to assess the psychological impact of COVID-19. A total of 2091 respondents signed the consent form online and their responses were collected.

**Main outcome measures** Measures of psychological stress, as prescribed by the Perceived Stress Scale (PSS-10). An explanatory factor analysis was carried out on the PSS-10 results. We subsequently analysed each factor using stepwise linear regression that focused on various sociodemographic groups.

**Results** A two-factor model was obtained using the explanatory factor analysis. After comparing with the past studies that investigated the factor structure of the PSS-10 scale, we identified these two factors as 'anxiety' and 'irritability'. The subsequent stepwise linear regression analysis suggested that gender and age ( $p < 0.01$ ) are significantly associated with both factors. However, the ethnicities of students are not significantly associated with both factors.

**Conclusions** To our knowledge, this is the first study that assessed the perceived stress of university students in the USA during the COVID-19 pandemic. Through exploratory factor analysis, we showed that the PSS-10 scale could be summarised as a two-factor structure. A stepwise regression approach was used, and we found both of the factors are significantly associated with the gender of the participants. However, we found no significant association between both factors and ethnicity. Our findings will help identify students with a higher risk for stress and mental health issues in pandemics and future crises.

## INTRODUCTION

The USA has reported more than 500 000 deaths due to the COVID-19 pandemic, with over 49 million total reported cases of COVID-19 as of December 2021.<sup>1</sup> Studies have shown a significant effect on students' mental health, including anxiety and depression, resulting from the onset of the COVID-19 pandemic.<sup>2-4</sup> Due to the transition to online models of instruction, many university campuses have closed, and resident students

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first study that assessed the perceived stress of university students with Perceived Stress Scale (PSS-10) scale in the USA during the COVID-19 pandemic.
- ⇒ This study was conducted at one of the most diverse campuses in the USA.
- ⇒ This study investigated the possible sociodemographic variables that may affect university students' perceived stress, through both univariate analysis and linear regression.
- ⇒ The fact that only the participants who completed the PSS-10 scale were included in the quantitative analysis in this study leads to potential selection bias.
- ⇒ The proportions of African American students and Pacific Islander students are low within the survey sample compared with the demographics of University of Nevada, Las Vegas, which may lead to potential volunteer bias.

are forced to live away from campus.<sup>5</sup> Furthermore, the unexpected shift from in-person classes to online instruction has proven difficult for students who do not have free or easy access to digital resources.<sup>5</sup> In addition, increased levels of anxiety and depression have been more prevalently observed within specific ethnic communities and have been especially difficult for women and for those of Chinese descent.<sup>6-8</sup>

Many survey results have been collected and analysed regarding the impact of COVID-19 on mental health; however, those have been mainly limited to studies in low-income and middle-income countries.<sup>9</sup> In most of the studies focusing on college students within the USA, anxiety and depression were measured using Patient Health Questionnaire Depression scale and the Generalised Anxiety Disorder scale.<sup>3 10 11</sup> Some have also included deeper analyses regarding the impact of race and ethnicity with respect to increased levels of stress, anxiety and depression.<sup>12</sup> On the other hand, very few studies investigated the mental health of female college students

**Table 1** Demographic information

Variable name	Sample size (n=1699%)	Percentages
Age		
18–24	1151	67.7
25–34	371	21.8
35 and over	157	9.2
Gender		
Male	515	30.3
Female	1152	67.8
Other	32	1.9
Marital Status		
Married	205	12.1
Widowed	3	0.2
Divorced	27	1.6
Separated	12	0.7
Partnered	209	12.3
Single	1226	72.2
Other	17	1.0
Ethnicity		
American Indian/Native Alaskan	16	0.9
Asian/Asian American	341	20.1
Black/African American	96	5.7
Hispanic/Latino/a/x	403	23.7
MENA/Arabic Origin	25	1.5
Pacific Islanders/Native Hawaiian	32	1.9
White/Caucasian	650	38.3
Biracial/Multiracial	115	6.8
Other	21	1.2
Class standing		
1st year undergraduate	285	16.8
2nd year undergraduate	270	15.9
3rd year undergraduate	317	18.7
4th year undergraduate	273	16.1
5th year or more undergraduate	158	9.3
Master's	174	10.2
Doctorate	190	11.2
Not seeking a degree	8	0.5
Other	24	1.4
Employment status		
Full time	316	18.6
Part time	595	35.0
Unemployed	520	30.6
Laid off due to COVID-19	178	10.5
Retired	10	0.6
Not working due to disability	13	0.8
Other	67	3.9
Financial situation Compared with pre-COVID-19		
A lot more stressful	626	36.8

Continued

**Table 1** Continued

Variable name	Sample size (n=1699%)	Percentages
Somewhat more stressful	601	35.4
No change	392	23.1
Somewhat less stressful	49	2.9
A lot less stressful	31	1.8
MENA, Middle Eastern or Northern African.		

during the pandemic.<sup>13 14</sup> Moreover, we discovered that there had been only one study that was conducted for the University of Nevada, Las Vegas (UNLV) student population, which is considered the most diverse student body in the USA.<sup>15</sup> However, that study only considered changes in depression and physical activity, whereas our work focuses directly on stress.

The objective of this study was to conduct a survey-based assessment of stress among college students at UNLV<sup>16</sup> during the COVID-19 pandemic. We measured college students' stress levels using the Perceived Stress Scale (PSS-10). We sought to identify severity levels of stress related to COVID-19, validate the factors under the PSS-10, and examine the relationships between those factors and the demographic variables (gender, age, financial situation, marital status, class standing, employment status and ethnicity).

## METHODS

### Recruitment of the participants

The participants of this study were students at UNLV during 2020 fall semester. A major aim of the study is to give the students an opportunity to express their own feelings against a global pandemic like COVID-19. Student email addresses were requested by the principal investigator of this study, using the inclusion criteria of currently enrolled UNLV students, age 18 and older, including undergraduate, graduate, professional and/or non-degree seeking students provided from the Registrar's Office at UNLV. A recruitment email was sent to each qualifying participant, with a link generated by the Qualtrics online survey platform, to invite them to participate voluntarily in the study. Informed consent was indicated once the willing participants clicked the survey link in the recruitment email. Only consenting participants were directed to respond to the survey. The online survey was completely open during all the steps of this study, and we made the student aware of the possible time taken to finish the survey via the Qualtrics online survey platform.

### Measures

PSS-10 was used to measure perceived stress. PSS-10 includes 10 questions and the participants of this study choose their degree of agreement (4=very often; 3=fairly often; 2=sometimes; 1=almost never; 0=never).<sup>17</sup> The scale items measure stress and the ability to cope with

the stress. The range of the PSS-10 scale is 0–40. A higher PSS-10 score indicates a higher level of stress. We provided the PSS-10 scale as one of online supplemental file 1. Since the PSS-10 scale is not a diagnostic tool, there is no prespecified threshold to classify the stress level. However, several previous studies used PSS-10 scores of 0–13, 14–26 and 27–40 to categorise low, moderate and high-stress levels correspondingly.<sup>18–21</sup> A previous study showed that PSS-10 has good reliability measures among college students.<sup>22</sup> Demographic information was also collected, including gender, age, ethnicity, class standing (ie, undergraduate (first year, second year, third year, fourth year, fifth year or more), graduate (mMaster's, doctorate) or non-degree seeking), marital status (ie, married, widowed, divorced, separated, partnered, single or other) and financial situation.

### Statistical analyses

The data were downloaded from the Qualtrics online survey platform. Statistical analysis was conducted using R statistical software. Univariate analysis of students' stress from the COVID-19 pandemic was done on the responses from the participants who completed all 10 questions from PSS-10. The Kruskal-Wallis test and the one-way ANOVA F-test were used to assess the relationship between the student's stress and the demographic variables. Furthermore, a factor analysis using the principal axis and the varimax rotation methods was conducted on the responses. The Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were used to check for factorisation and validate variance homogeneity. Based on the previous factor analysis on PSS-10,<sup>22 23</sup> we extracted the factors correspondingly in our exploratory factor analysis. Stepwise linear regression using Akaike information criterion was applied to assess the association between demographic variables and the factors extracted in the factor analysis stage.

### Patient and public involvement

Patients or the public were not involved in this research study's design, conduct or dissemination.

## RESULTS

### Sample demographics

A total of 2091 responses were collected via Qualtrics. After removing the responses which did not complete all 10 questions from PSS-10, 1699 responses remained

**Table 2** Univariate analysis of UNLV students' stress about the COVID-19 pandemic

Variable	Total	Low stress (%)	Moderate stress (%)	High stress (%)	Mean PSS-10 score	One-way ANOVA*	Kruskal-Wallis† test*
Age							
18–24	1151	153 (13.3)	661 (19.1)	337 (29.3)	22.2	<0.01	<0.01
25–34	371	71 (19.1)	204 (55.0)	96 (25.9)	20.8		
35 and over	157	49 (23.3)	93 (21.7)	35 (55.0)	18.8		
Gender							
Male	515	117 (22.7)	292 (56.7)	106 (20.6)	19.7	<0.01	<0.01
Female	1152	154 (13.4)	654 (56.8)	344 (29.9)	22.2		
Other	32	2 (6.2)	12 (37.5)	18 (56.3)	27.4		
Marital status							
Married	205	54 (26.3)	113 (55.1)	38 (18.5)	19.0	<0.01	<0.01
Widowed	3	0 (0)	3 (100)	0 (0)	22.3		
Divorced	27	6 (22.2)	13 (48.1)	8 (29.6)	20.6		
Separated	12	1 (8.3)	5 (41.7)	6 (50.0)	26.4		
Partnered	209	22 (10.7)	116 (56.3)	71 (34.5)	22.7		
Single	1226	186 (15.2)	699 (57.0)	341 (27.8)	21.7		
Other	17	4 (23.5)	9 (53.0)	4 (23.5)	20.5		
Ethnicity							
American Indian/Native Alaskan	16	3 (18.7)	8 (50.0)	5 (31.3)	21.8	0.36	0.45
Asian/Asian American	341	52 (15.2)	212 (62.2)	77 (22.6)	21.1		
Black/African American	96	21 (21.9)	48 (50.0)	27 (28.1)	20.3		
Hispanic/Latino/a/x	403	50 (12.4)	240 (59.6)	113 (28.0)	22.2		
MENA/Arabic Origin	25	4 (16.0)	13 (52.0)	8 (32.0)	22.3		
Pacific Islanders/Native Hawaiian	32	6 (18.7)	19 (59.4)	7 (21.9)	21.3		
White/Caucasian	650	117 (18.0)	342 (52.6)	191 (29.4)	21.5		
Biracial/Multiracial	115	14 (12.2)	67 (58.3)	34 (29.6)	21.9		
Other	21	6 (28.6)	9 (42.8)	6 (28.6)	19.6		
Class standing							

Continued

**Table 2** Continued

Variable	Total	Low stress (%)	Moderate stress (%)	High stress (%)	Mean PSS-10 score	One-way ANOVA*	Kruskal-Wallis† test*
1st year undergraduate	285	45 (15.8)	182 (63.9)	58 (20.3)	20.6	<0.01	<0.01
2nd year undergraduate	270	28 (10.4)	161 (59.6)	81 (30.0)	22.5		
3rd year undergraduate	317	40 (12.6)	165 (52.1)	112 (35.3)	22.9		
4th year undergraduate	273	45 (16.5)	141 (51.6)	87 (31.9)	22.3		
5th year or more undergraduate	158	23 (14.5)	84 (53.2)	51 (32.3)	22.5		
Master's	174	40 (23.0)	100 (57.5)	34 (19.5)	19.6		
Doctorate	190	46 (24.2)	106 (55.8)	38 (20.0)	19.5		
Not seeking a degree	8	0 (0)	7 (87.5)	1 (12.5)	19.4		
Other	24	6 (25.0)	12 (50.0)	6 (25.0)	20.8		
Employment status							
Full time	316	60 (19.0)	183 (57.9)	73 (23.1)	20.8	<0.01	<0.01
Part time	595	89 (15.0)	336 (56.5)	170 (28.6)	21.7		
Unemployed	520	87 (16.7)	306 (58.8)	127 (24.4)	21.1		
Laid off due to COVID-19	178	18 (10.1)	85 (47.8)	75 (42.1)	23.9		
Retired	10	4 (40.0)	4 (40.0)	2 (20.0)	16.6		
Not working due to disability	13	0 (0)	6 (46.2)	7 (53.8)	26.5		
Other	67	15 (22.4)	38 (56.7)	14 (20.9)	20.3		
Financial situation compared with pre-COVID-19							
A lot of more stressful	626	41 (6.5)	320 (51.1)	265 (42.3)	24.7	<0.01	<0.01
Somewhat more stressful	601	95 (15.8)	375 (62.4)	131 (21.8)	21.0		
No change	392	117 (29.8)	220 (56.1)	55 (14.0)	17.9		
Somewhat less stressful	49	9 (18.4)	28 (57.1)	12 (24.4)	20.2		
A lot less stressful	31	11 (35.5)	15 (48.4)	5 (16.1)	17.1		

\*The p values are obtained via F tests in one-way Analysis of Variance (ANOVA). The F tests were performed to test the equality of the means for the groups within each variable.

†The p values are obtained via Kruskal-Wallis tests. The Kruskal-Wallis tests were performed to test the equality of the medians for the groups within each variable. MENA, Middle Eastern or Northern African; PSS-10, Perceived Stress Scale.

**Table 3** Factor analysis summary with rotated component matrix\*

	Factor 1 (irritability)	Factor 2 (anxiety)	Communalities	Diagonal of anti-image matrix
PSS_4	0.727	0.199	0.569	0.633
PSS_5	0.568	0.419	0.498	0.567
PSS_7	0.491	0.414	0.412	0.634
PSS_8	0.555	0.524	0.583	0.507
PSS_9	0.155	0.468	0.243	0.567

\*Varimax rotation with principal axis factoring was used. The objects with corresponding diagonal elements >0.5 in the anti-image matrix were kept.

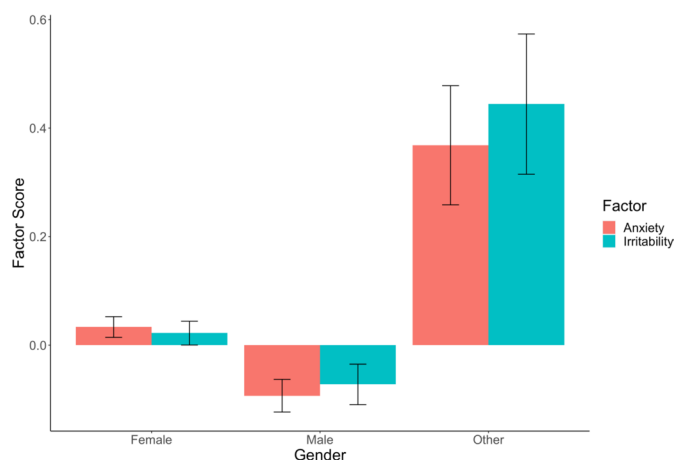
PSS, Perceived Stress Scale.

for analysis. Among these 1699 students, 1152 (67.8%) were females. The sample includes both undergraduate (n=1303, 76.7%) and graduate students (n=364, 22.4%). 38.3% of the students (n=650) identified themselves as 'white/Caucasian', 23.7% (n=403) were 'Hispanic/Latino', 20.1% were (n=341) are 'Asian/Asian American', 6.8% (n=115) classified themselves as 'biracial/multiracial', 5.7% (n=96) were 'black/African American'. In addition, 1.9% (n=32) identified themselves as Pacific Islanders/Native Hawaiian, 1.5% identified themselves as 'Middle Eastern or Northern African (MENA)/Arabic Origin' and 0.9% (n=16) identified themselves as 'merican Indian/Native Alaska'n. Age, gender, marital status, ethnicity, class standing, employment status and financial situation are summarised in [table 1](#).

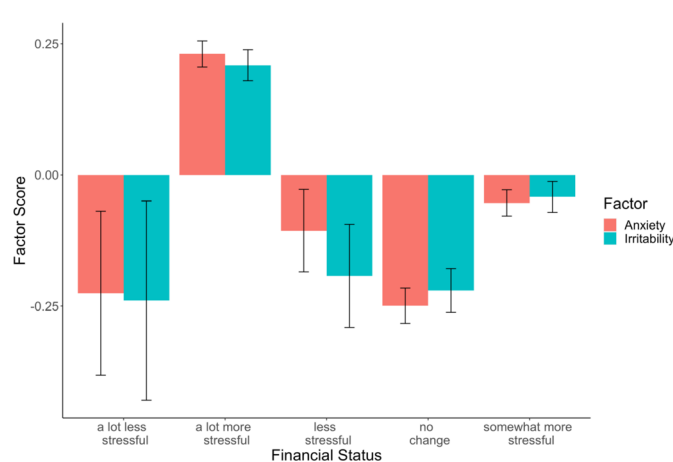
### Descriptive statistics

For all the participants who completed PSS-10, the average PSS score was 21.55. 83.9% of these participants perceived moderate to severe stress. The mean PSS scores for different groups are listed in [table 2](#). The female participants had a mean PSS score of 22.20, while the male participants had a mean PSS score of 19.7. The mean PSS score of the participants who reported their gender as 'other' was 27.4. Among

all the age groups, the participants between 18 and 24 had the highest PSS score at 22.2, while the participants 35 years or over had the lowest PSS score at 18.8. Among all the ethnic groups, the African American/black participants had the lowest mean PSS score, at 20.3, and the MENA/Arabic origin participants had the highest mean PSS score, at 22.3. Among all the class standings, the undergraduate participants generally had higher mean PSS scores (freshmen: 20.7; sophomore: 22.5; junior: 22.9; senior: 22.3; 5th year or more: 22.5) compared with all other students (master's: 19.6; Ph.D.: 19.5; non-degree seeking: 19.4). The participants who identified themselves as 'a lot more stressful' in financial situations during COVID-19 had the highest mean PSS score, at 24.7. In contrast, the participants who identified themselves as 'a lot less stressful' in financial situations had the lowest mean PSS score, at 17.1. For the employment status, the retired participants had the lowest mean PSS score, at 16.6, and the participants who were not working due to disability had the highest mean PSS score, at 26.5. The participants who lost their jobs due to COVID-19 also had a high mean PSS score, at 23.9. The married students had the lowest mean PSS score, 19.0, while the separated students had the highest mean PSS score, 26.4.

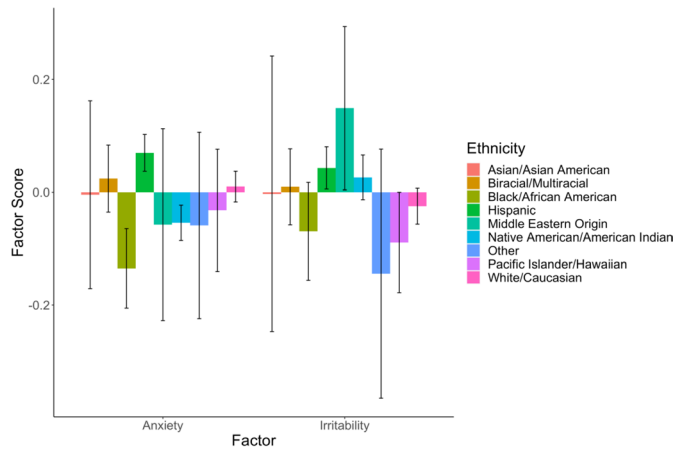


**Figure 1** Mean factor scores for UNLV students (n=1699) by gender. Means and SEs are presented. UNLV, University of Nevada, Las Vegas.



**Figure 2** Mean factor scores for UNLV students (n=1699) by financial status. Means and SEs are presented. UNLV, University of Nevada, Las Vegas.





**Figure 3** Mean factor scores for UNLV students (n=1699) by ethnicities. Means and SEs are presented. UNLV, University of Nevada, Las Vegas.

### Univariate analysis

The relationship between students' stress and the demographic variables is also presented in [table 2](#). The PSS scores for the students were calculated following the instructions from the PSS-10 scale.<sup>17</sup> For both of the statistical tests, variables including age ( $p<0.01$ ), gender ( $p<0.01$ ), marital status ( $p<0.01$ ), employment status ( $p<0.01$ ), class standing ( $p<0.01$ ) and financial situation ( $p<0.01$ ) demonstrated significant effects on stress ([table 2](#)). However, ethnicity did not significantly influence students' stress ([table 2](#)).

### Factor analysis

An initial factor analysis was performed on all ten measures from the PSS-10. The KMO value of 0.90 justified that the sample was factorable. Bartlett's test was performed to confirm the homogeneity of variance ( $\chi^2(45) = 8276.4$ ,  $p<0.01$ ). We obtained the anti-image correlation matrix to determine if any 10 items should be dropped. There were five items within the anti-image correlation matrix with the corresponding diagonal elements  $<0.5$  (Q1, Q2, Q3, Q6, Q10). These items were not included in the final step of factor analysis.

The final step of the factor analysis was conducted using five items (Q4, Q5, Q7, Q8, Q9). KMO value of

0.81 indicates the sample was factorable, and Bartlett's test provided significant evidence for homogeneity of variance ( $\chi^2(10) = 2215.8$ ,  $p<0.001$ ). Communalities were above 0.40 except for Q9. However, we did not drop the item since it still has a communality over 0.2. We found it necessary to keep it in the next step of the factor analysis in order to more accurately interpret the model.

We extracted two factors after we inspected the scree plot (online supplemental figure 1). The two factors correspondingly explained 52.7% and 17.5% of the total variance. The cumulative percentage of variance explained by these two factors was 70.2%. The rotated component matrix and the communalities for five measures are provided in [table 3](#). After comparing the factor analysis result with the past literature on PSS-10,<sup>23 24</sup> we named the first-factor 'Irritability' and the second factor 'anxiety'. The factor 'anxiety' contained only one item. However, we kept it because this factor provided a different aspect on perceived stress when compared with the factor of 'irritability'.

We constructed the bar plots of mean factor scores with respect to different categories within demographic variables. [Figure 1](#) shows that the students who identified their gender as 'other' have higher irritability and anxiety scores compared with the male and female students. The students in a much more stressful financial situation during COVID-19 also have higher irritability and anxiety scores compared with other students ([figure 2](#)). The students of Middle East Origin experienced higher irritability scores compared with other students, and the African American students had lower anxiety scores compared with other students ([figure 3](#)). The plots of mean factor scores with respect to class standing are provided in (online supplemental figures 2 & 3).

### Stepwise linear regression

The factor scores for all participants who completed PSS-10 were computed using a regression method. Stepwise linear regression with demographic variables (gender, age, financial situation, marital status, class standing, employment status and ethnicity) as predictors was performed for two factors. Since most of the demographic variables are categorical, we created the dummy variables correspondingly.

**Table 4** Results of stepwise linear regression on 'irritability' with categorical predictors

Response	Predictor(s)	$\beta$	T	P value
Irritability	Gender: Male	-0.46	-3.39	<0.01
Base level: gender=other;	Gender: Female	-0.41	-3.10	<0.01
Age=35 or over;	Age: 18–24	0.32	4.74	<0.01
Financial status=no change;	Age: 25–34	0.27	3.89	<0.01
	Financial Status: a lot more stressful	0.39	7.92	<0.01
	Financial Status: somehow more stressful	0.14	2.81	<0.01
	Financial Status: somehow less stressful	-0.01	-0.08	0.94
	Financial Status: a lot less stressful	0.004	0.03	0.97

**Table 5** Results of stepwise linear regression on 'anxiety' with categorical predictors

Response	Predictor(s)	$\beta$	T	P value
Anxiety	Gender: Male	-0.42	-3.67	<0.01
Base level: gender=other; Age=35 or over; Financial status=no change;	Gender: Female	-0.32	-2.93	<0.01
	Age: 18–24	0.15	2.98	<0.01
	Age: 25–34	0.09	1.56	0.12
	Financial Status: a lot more stressful	0.47	11.43	<0.01
	Financial Status: somehow more stressful	0.18	4.29	<0.01
	Financial Status: somehow less stressful	0.13	1.32	0.19
	Financial Status: a lot less stressful	0.06	0.49	0.63

Both male ( $\beta=-0.46$ ,  $p<0.01$ ) and female ( $\beta=-0.41$ ,  $p<0.01$ ) were highly associated with higher irritability (table 4). The students aged between 18 and 24 years old ( $\beta=0.32$ ,  $p<0.01$ ) and students aged between 25 and 34 years old ( $\beta=0.27$ ,  $p<0.01$ ) were also associated with higher irritability (table 4). In addition, the students with a lot more stressful ( $\beta=0.39$ ,  $p<0.01$ ) and somehow more stressful financial status ( $\beta=0.14$ ,  $p<0.01$ ) are significantly associated with higher irritability. Ethnicities, employment status and marital status of students were not found to be significantly associated with the factor 'irritability' (table 4).

Both male ( $\beta=-0.42$ ,  $p<0.01$ ) and female ( $\beta=-0.32$ ,  $p<0.01$ ) findings predicted anxiety (table 5). While all other predictors were held as constants, females were associated with higher anxiety than males. Similar to the analysis on factor 1 ('irritability'), the base level 'other' was associated with higher anxiety in comparison to the other two groups (ie, male and female). Stressful financial situations were associated with higher anxiety ('a lot more stressful':  $\beta=0.47$ ,  $p<0.01$ ; 'somewhat more stressful':  $\beta=0.18$ ,  $p<0.01$ ) (table 5). In addition, the students aged between 18 and 24 years old ( $\beta=0.15$ ,  $p<0.01$ ) were also associated with higher anxiety (table 5) compared with the students aged 35 or over. Ethnicities, employment status and students' marital status were not found to be significantly associated with the factor 'anxiety' (table 5).

## DISCUSSION

This study investigated how the COVID-19 pandemic has impacted the psychological status of college students and what demographic variables possibly contribute to such impacts. The factor analysis resulted in two factors: Anxiety and Irritability. The two-factor model is consistent with what was found by Wu and Amtmann.<sup>24</sup> Furthermore, our stepwise regression on both factors revealed key risk factors for the prevalence of irritability and anxiety. Variables such as gender and financial situation demonstrated significant association with both factors in the analyses, while other variables were surprisingly insignificant such as ethnicity.

For the first factor, 'irritability', students who identified themselves as 'other' gender scored significantly higher in

this factor than those who identified themselves as either male or female. This finding is reasonable since LGBTQ young persons might experience unique mental health problems compared with other gender groups during the COVID-19 pandemic.<sup>25</sup> However, female students are more likely to be irritable than male students in our study, which is consistent with the finding of Hou.<sup>7</sup> Students who experience more stress financially are also associated with higher irritability. Among all the ethnic groups, the students with Middle East origin demonstrated higher irritability during the COVID-19 pandemic than other ethnicities. However, as the stepwise linear regression suggests, the ethnicity of college students does not show up as a significant predictor of irritability. Our results also suggested that Ph.D. students and master's students have lower irritability levels than others. This result might be surprising since master's students and Ph.D. students generally experience much pressure due to their coursework or research. However, due to their long-term experience coping with stress during their academic career, they might have developed an excellent ability to deal with stress under unexpected circumstances such as COVID-19. The students who were laid off during COVID-19 and those who could not work due to disability generally have higher irritability than other groups, which is expected since unemployment due to COVID-19 led to mental health issues, as a previous study suggested.<sup>26</sup>

The second factor, 'anxiety', is associated with stressful financial status and gender, based on our stepwise regression analysis. Again, the students who identified themselves as 'other' gender had significantly higher anxiety levels than males or females. Among all the ethnicities, the Hispanic-origin students had the highest level of anxiety. However, our stepwise linear regression suggests that students' ethnicities are not significant predictors of anxiety. The widowed and separated students had higher anxiety levels than other students, which is expected since the loss of support from a loved one might reduce their ability to cope with stress. This result is also partially consistent with the finding of Nkire *et al*.<sup>27</sup>

The factor analysis and stepwise linear regression confirm some observations found in the existing literature, such as the correlation of gender with anxiety and



stress due to COVID-19. Interestingly, in contrast to what has been suggested by some researchers,<sup>6 12</sup> our results show that ethnicity seems not to be a significant risk factor in either irritability or anxiety. We speculate that the ethnically diverse UNLV student body and the overall social atmosphere that characterises the university environment lead to less discrimination. Hence, ethnicity is considered insignificant in predicting stress. We recommend that the university administration focuses on mental health policies that protect women and students who identify as other genders. We hope that this study raises awareness of all students' growing mental health needs, with a priority to females, especially for students who identify as other genders. Furthermore, efforts should be made to provide low-cost mental health services for all students, particularly those who have lost their jobs and are in stressful financial situations due to the ongoing pandemic.

We realise that our survey study has several limitations. Although this study has a relatively large sample size with participants from diverse backgrounds, the study's response rate is relatively low. In addition, compared with the student demographics data provided by UNLV during the 2020 fall semester, African Americans and Pacific Islanders have a lower proportion within our sample. This result indicates that African American and Pacific Islander students were under-represented in our sample, leading to potential volunteer bias. In addition, we only included the responses that fully completed the PSS-10 scales, which might lead to potential selection bias. Since most of the responses that did not complete the PSS-10 scales also did not complete the demographic questions, we could not check the differences between sample compositions of the responses that completed the PSS-10 scale and those that did not complete the PSS-10 scale.

## CONCLUSION

To our knowledge, this is the first study that assessed the perceived stress of university students in the USA during the COVID-19 pandemic. We first investigated the relationship between each demographic variable and perceived stress. Variables such as age, gender, marital status, employment status, financial status and class standings are significantly associated with the perceived stress scores in our univariate analysis. Through exploratory factor analysis, we demonstrated that the PSS-10 scale could be summarised as a two-factor structure. After referring to previous studies, we identified two factors: 'irritability' and 'anxiety', respectively. A stepwise regression analysis found that both factors are significantly associated with the gender of the participants and their financial status. However, no significant association was observed between both factors and ethnicity. This finding is consistent with the plot of mean factor scores for the ethnic groups. In summary, our findings will help identify students with increased risk for stress and mental health issues in pandemics of the Omicron variant and future crises.

**Acknowledgements** We would like to thank all the student participants, the Office of Registrar, the Institutional Review Board, the Office of Information Technology, and the Department of Epidemiology and Biostatistics at the University of Nevada, Las Vegas (UNLV). Part of Dr. Qing Wu's work was completed at UNLV during the period when he was employed by UNLV.

**Contributors** Conceptualisation, BL, EH, CL and QW; methodology, BL, EH and CL; software, BL; validation, BL, EH, CL and QW; formal analysis, BL; investigation, BL, EH, CL and QW; resources, BL, EH, CL and QW; data curation, BL, EH, CL and QW; writing—original draft preparation, BL, EH and CL; writing—review and editing, BL, EH, CL and QW; visualisation, BL, EH and CL; supervision, administration, and guarantor, QW.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

**Ethics approval** The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of the University of Nevada, Las Vegas (approval number 1632208, effective on 3 November 2020). Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available on reasonable request. All data relevant to the study are available on request.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## ORCID iDs

Bowen Liu <http://orcid.org/0000-0002-6918-9871>

Edward Huynh <http://orcid.org/0000-0003-1915-0693>

Qing Wu <http://orcid.org/0000-0003-4679-8903>

## REFERENCES

- 1 CDC. COVID data Tracker, 2020. Cent. Dis. control Prev. Available: <https://covid.cdc.gov/covid-data-tracker>
- 2 John A. Increased anxiety and depression top college students' concerns in coronavirus survey Los angel. times, 2020. Available: <https://www.latimes.com/california/story/2020-03-25/college-students-anxiety-depression-coronavirus-survey> [Accessed 09 Apr 2021].
- 3 Wang X, Hegde S, Son C, *et al.* Investigating mental health of US college students during the COVID-19 pandemic: cross-sectional survey study. *J Med Internet Res* 2020;22:e22817.
- 4 Browning MHEM, Larson LR, Shariyevska I, *et al.* Psychological impacts from COVID-19 among university students: risk factors across seven states in the United States. *PLoS One* 2021;16:e0245327.
- 5 Dennon A. Coronavirus impacts on students and online learning | BestColleges.com, 2021. Available: <https://www.bestcolleges.com/blog/coronavirus-impacts-on-students/> [Accessed 09 Apr 2021].
- 6 Cheah CSL, Wang C, Ren H, *et al.* COVID-19 racism and mental health in Chinese American families. *Pediatrics* 2020;146:e2020021816.

- 7 Hou F, Bi F, Jiao R, *et al.* Gender differences of depression and anxiety among social media users during the COVID-19 outbreak in China: a cross-sectional study. *BMC Public Health* 2020;20:1648.
- 8 Molock SD, Parchem B. The impact of COVID-19 on college students from communities of color. *Journal of American College Health* 2021;1–7.
- 9 Lakhan R, Agrawal A, Sharma M. Anxiety, and stress during COVID-19 pandemic. *J Neurosci Rural Pract* 2020;11:519–25.
- 10 Fruehwirth JC, Biswas S, Perreira KM. The Covid-19 pandemic and mental health of first-year college students: examining the effect of Covid-19 stressors using longitudinal data. *PLoS One* 2021;16:e0247999.
- 11 Son C, Hegde S, Smith A, *et al.* Effects of COVID-19 on college students' mental health in the United States: interview survey study. *J Med Internet Res* 2020;22:e21279.
- 12 Woo B, Jun J. COVID-19 racial discrimination and depressive symptoms among Asians Americans: does communication about the incident matter? *J Immigr Minor Health* 2022;24:78–85.
- 13 Debowska A, Horeczy B, Boduszek D, *et al.* A repeated cross-sectional survey assessing university students' stress, depression, anxiety, and suicidality in the early stages of the COVID-19 pandemic in Poland. *Psychol Med* 2020;1–4.
- 14 Thibaut F, van Wijngaarden-Cremers PJM. Women's mental health in the time of Covid-19 pandemic. *Front Glob Womens Health* 2020;1:588372.
- 15 Coughenour C, Gakh M, Pharr JR. Changes in depression and physical activity among college students on a diverse campus after a COVID-19 Stay-at-Home order. *J Community Health* 2020;1–9.
- 16 News US. World Report: UNLV Again Named Nation's Most Diverse Campus, 2021. Univ. Nev. Las Vegas. Available: <http://www.unlv.edu/news/release/us-news-world-report-unlv-again-named-nation-s-most-diverse-campus> [Accessed 08 Dec 2021].
- 17 Cohen S, Kamarck T, Mermelstein R. a global measure of perceived stress. *J Health Soc Behav* 1983;24:385–96.
- 18 Drachev SN, Stangvaltaite-Mouhat L, Bolstad NL, *et al.* Perceived stress and associated factors in Russian medical and dental students: a cross-sectional study in north-west Russia. *Int J Environ Res Public Health* 2020;17:5390.
- 19 Alharbi H, Alshehry A. Perceived stress and coping strategies among ICU nurses in government tertiary hospitals in Saudi Arabia: a cross-sectional study. *Ann Saudi Med* 2019;39:48–55.
- 20 Gambetta-Tessini K, Mariño R, Morgan M, *et al.* Stress and health-promoting attributes in Australian, New Zealand, and Chilean dental students. *J Dent Educ* 2013;77:801–9.
- 21 Wiriyakijja P, Porter S, Fedele S, *et al.* Validation of the HADS and PSS-10 and a cross-sectional study of psychological status in patients with recurrent aphthous stomatitis. *J Oral Pathol Med* 2020;49:260–70.
- 22 Roberti JW, Harrington LN, Storch EA. Further psychometric support for the 10-Item version of the perceived stress scale. *J Coll Couns* 2006;9:135–47.
- 23 Chatterjee SS, Chakrabarty M, Banerjee D, *et al.* Stress, sleep and psychological impact in healthcare workers during the early phase of COVID-19 in India: a factor analysis. *Front Psychol* 2021;12:611314.
- 24 SM W, Amtmann D. Psychometric evaluation of the perceived stress scale in multiple sclerosis. *ISRN Rehabil* 2013;2013:e608356.
- 25 Salerno JP, Devadas J, Pease M, *et al.* Sexual and gender minority stress amid the COVID-19 pandemic: implications for LGBTQ young persons' mental health and well-being. *Public Health Rep* 2020;135:721–7.
- 26 Posel D, Oyenubi A, Kollamparambil U. Job loss and mental health during the COVID-19 lockdown: evidence from South Africa. *PLoS One* 2021;16:e0249352.
- 27 Nkire N, Nwachukwu I, Shalaby R, *et al.* COVID-19 pandemic: influence of relationship status on stress, anxiety, and depression in Canada. *Ir J Psychol Med* 2021;1–12.