The relations between COVID-19 stress, social connectedness, and mental health: a longitudinal investigation comparing Chinese and American college students

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Abstract

College students in the U.S. and China have faced significant challenges during COVID-19. Data were collected from 120 Amerian students ($M_{age} = 19.48$, $SD_{age} = 1.30$) and 119 Chinese students ($M_{age} = 18.61$, $SD_{age} = 0.91$) in November, 2019 and March, 2020 to examine risk and protective factors for mental health (depression, anxiety, life satisfaction) during the pandemic, and potential cultural and gender differences. Results indicated that the frequency and impact of COVID-19-related stressful life events predicted deterioration of mental health over time, while social connectedness before the pandemic buffered the negative impact of COVID-19 stressful life events on life satisfaction. Chinese students reported higher levels of social connectedness and larger impact of COVID-19-related stressful life events, but lower frequency of stressful life events than American students. Stressful life events and social connectedness predicted mental health outcomes similarly for Chinese and American students. Gender differences were identified. Females reported more stressful life events, higher levels of depression, anxiety and less life satisfaction during COVID-19 than males. In addition, the frequency of stressful life events had a stronger impact on depression and anxiety for females compared with males. It is important to implement prevention and intervention programs to promote social connections and wellbeing among college students, especially among female students.

Keywords Stressful life events · Social connectedness · Mental health · Gender differences · Cultural differences

COVID-19 has significantly impacted college students' lives worldwide since the beginning of 2020. Cross-sectional survey studies have suggested that students experienced high levels of depression and anxiety in both China and U.S. upon the onset of the pandemic (Wang et al., 2020a, b). However, there have been few longitudinal studies examing the impact of COVID-19 on mental health over time. Recent longitudinal research showed that American college students reported significantly more feelings of sadness, depression, difficulty concentrating, or anger, during the pandemic (April 2020) than pre-pandemic (Fall 2019) (Charles et al., 2020; Reuter et al., 2021; Roche et al., 2022).

College students have experienced high levels of stressful life events/stressors during COVID-19 including contracting COVID-19, knowing people or having contact with people who were diagnosed with COVID-19 (Chi et al., 2020), financial strain (Cao et al., 2020), media exposure to negative events (e.g., hearing about increased number of COVID-19 cases and death counts, Hong et al., 2020; Zhang et al., 2020) and social isolation (Reuter et al., 2021). In light of these stressors, it is critical to examine protective factors that may buffer the effects of stressful life events on mental health in order to inform future prevention and intervention efforts. Social connectedness, or "the subjective awareness of being in a close relationship with the social world" (Lee & Robbins, 1998, p. 338), can be one such protective factor. The large cultural differences between the two countries and how they handled COVID-19 differently during the early stage of the pandemic (Wang et al., 2022a, b) provide us with the perfect opportunity to examine the impact of culture in relation to risk and protective factors. In addition,

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culture has been found to impact social connectedness (Li, 2002; Markus & Kitayama, 1991) as well as mental health (Wang et al., 2022a, b). Thus, the current study aims to understand the role of COVID-related stressors, and social connectedness on mental health among college students in the US and China over time, and the potential cultural and gender differences.

Theoretical framework

According to the Process- Person- Context-Time model (PPCT, Bronfenbrenner & Morris, 2006), human behavior is influenced by the complex interplay of multiple systems (e.g., micro-, meso-, macro-, chrono-systems) and context (e.g., culture) and time. This study is guided by PPCT to examine the impact of a person's characteristics (gender), process (interaction between individual and the environment [COVID-19-related stressors as the risk factor, social connectedness as the protective factor]), and context (e.g., cultural differences) on adjustment among students in US and China. In addition, our longitudinal design enables us to capture the time component of the PPCT model and examine what risk and protective factors can predict the changes in mental health over time during COVID-19.

Process

Proximal processes in the PPCT model refer to the complex reciprocal processes between the individuals and the multiple systems (e.g., micro-, meso-, macro-, chrono-systems) over extended periods of time to impact human development (Bronfenbrenner & Morris, 2006). One such interplay is the interaction between risk factors and protective factors as described in the risk and resilience model. This risk and resilience model seeks to explain why some individuals fare well despite facing serious threats to development (Masten, 2001; Masten & Narayan, 2012). A risk factor is considered to be any negative event, situation, or experience (e.g., stressful life events, maltreatment, trauma) that increases the likelihood of adjustment difficulties (Masten, 2001). Resilience refers to the ability to cope (Raskauskas & Huynh, 2015), garner social resources, and positively adapt even in the face of adversity (Masten, 2001). Resilience is a dynamic process and may vary depending on a given culture and historical context (Masten, 2001). We seek to understand how social connectedness (see more description later), defined as feeling emotionally connected with close relationships before the pandemic, can serve as a resilience factor during the pandemic when individuals experience significant stress (risk factor).

Person

Individuals bring personal characters (e.g., gender) into any social interactions. Gender may influence one's interaction with others because of the expectations formed. Repeated research shows that females are more likely to have connection-oriented goals (e.g., value relationships) than males, are more sensitive to others' distress, and are more likely to be exposed to stressful life events in peer and social networks, which may increase their risk for emotional difficulties (for a review, see Rose & Rudolph, 2006). Research also shows that females tend to report higher levels of depression and anxiety than males (Hankin & Abramson, 2001). These gender differences are influenced by the context as societies socialize boys and girls differently. Influenced by Confucius (Tu, 1985), gender role socialization in China emphasizes females as caregivers, and males as the breadwinners and the head of the family. Similarly, in the U.S., males are socialized to be more independent and competitive, while females are socialized to be relationship-focused and caring (e.g., Li, 2002; Rose & Rudolph, 2006; Underwood, 2003).

Context

Culture is an important contextual factor to consider when examing adjustment. Cultural values and norms can impact an individual's behavior as well as their interactions with others. Research suggests that countries in North America tend to value individualism, independence, autonomy, and self-reliance (e.g., Hofstede, 1980), while countries in Asia often value interdependence, social harmony, and collectivism (Bond & Hwang, 1986; Markus and Kitayama (1991). Individuals from collectivistic cultures may experience a greater motivation to fit in, and may place a higher importance on social connections than those from individualistic cultures. For example, Singelis (1994) found that Euro-Americans scored significantly higher on the independent scale and significantly lower on the interdependent scale as compared to four Asian-American groups. In addition, Li (2002) also found that Chinese students reported higher social connectedness (ie., how emotionally connected one feels with others, Lee & Robbins, 1998) with family than Canadian students, but the two groups reported similar levels of social connectedness with their closest friends.

China and U.S. governments handled the COVID-19 crisis very differently in Spring 2020. The Chinese government placed very clear and strict national quarantine rules between January 23, 2020 and early March, 2022 (e.g., home quarantine, mandate of facial masks, travel

restrictions, and widespread contact tracing) and consequently, the COVID-19 situation was under control in China during our 2nd wave of data collection (March 2020). However, the U.S. federal government did not have the power to authorize national mask mandates or travel restrictions. COVID-19 regulations were inconsistent and unclear in the U.S., and the COVID-19 cases were increasing quickly in March 2020 (New England Journal of Medicine, 2020). A prior study showed that Chinese college students reported more compliance with the government's COVID-19 regulations (e.g., quarantine, wearing masks) than American students (Wang et al., 2022b). These contextual differences may likely impact students' mental health during the pandemic.

Time

Time includes micro-time ("continuity versus discontinuity in ongoing episodes of proximal process"), meso-time (days, weeks, months), and macro-time (e.g., environmental events) (Bronfenbrenner & Morris, 2006, p. 796). The COVID-19 pandemic is a specific time period that significantly altered people's lives and impacted how college students interact with the world around them. The pandemic also provides a unique opportunity to study resilience because some people may find meaning out of struggles, and gain personal growth during this period (Choi et al., 2021; Tang et al., 2021). While social connection has been considered as a protective/resilience factor, COVID-19 quarantine also presents unique challenges for individuals to feel connected with their social networks and the society broadly. Using a longitudinal design, we were able to examine the changes in mental health and how risk (COVID-19 stressful life events) and protective factors (social connectedness) predict such changes during this unique time period.

Social connectedness

Social connectedness is defined as "the subjective awareness of being in a close relationship with the social world" (Lee & Robbins, 1998, p. 338). It has been described as a relational schema and as an attribute of the self, that comprises enduring cognitions of interpersonal closeness (Lee et al., 2001). Individuals high in social connectedness tend to experience interpersonal closeness in their relationships with friends, family, peers, community, and the society (Lee & Robbins, 1998); they tend to easily identify with others, participate in social events, and perceive others as approachable (Lee et al., 2001). On the other hand, individuals low in social connectedness tend to avoid social opportunities to connect with others. Individuals with a lower sense of social connectedness may have difficulties in managing their needs,

may struggle to develop relationships, and feel isolated (Duru & Poyrazli, 2011; Lee & Robbins, 1995). Loneliness, a construct related to the lack of social connection, has been found to significantly predict more mental health difficulties among U.S. adults during the COVID-19 lockdown (Megalakaki & Kokou-Kpolou, 2021).

The benefits of social connectedness have been well documented. Several researchers have found strong associations between social connectedness and higher subjective well-being, self-esteem, and self-efficacy (Brown et al., 2012; Diener et al., 2017; Lee & Robbins, 1998), and less mental health difficulties, such as depression (Armstrong & Oomen-Early, 2009; Soares et al., 2022), anxiety (Soares et al., 2022), and adjustment problems (Duru & Poyrazli, 2011). Among U.S. adolescents (13 to 20 yr), receiving more social help related to COVID-19 predicted lower depressiveness and higher belongingness (Alvis et al., 2022). Data from U.S. national Adolescent Behaviors and Experiences Survey (January–June 2021) also showed that high school students who felt close to persons at school had fewer mental health difficulties and fewer feelings of sadness or hopelessness than high school students who did not feel close to others at school (Jones, et al., 2022). However, most existing studies used a cross-sectional design. Researchers suggested that conclusions in cross-sectional studies can be misleading due to "variations in the causes, tempo, context, and timing of development within and across systems" (Masten, 2004). To fill this gap in the literature, in this study, we followed freshman and sophomore college students in U.S. and China, and examined how stressful life events and social connectedness impacted their mental health over time. We focus on freshmen and sophomores because social connection is especially important as students transition to college and build new social connections on campus over time.

Social connectedness may buffer the effects of stressful events on mental health for several reasons. First, individuals with a high sense of social connectedness may be able to relate better with other individuals and be able to feel that they are a part of the larger community, which in turn may impact their mental health in a positive way. Second, experiencing a sense of social connectedness may confer several benefits such as increased self-self-esteem (Lee & Robbins, 1998), and greater intimacy and group attraction (IJsselsteijn et al., 2003). Third, individuals with a higher sense of social connectedness may be able to seek support from their networks when needed. Research suggests that young adults are more likely to turn to their friends or family for help when they struggle with mental health issues rather than seeking formal services (Sawyer et al., 2012). Thus, individuals low in social connectedness may be unable to seek help, which may negatively impact their mental health and adjustment.

Several studies have demonstrated the moderating effects of social connectedness with relation to stressful life events

and mental health. A recent study found that social connectedness moderated the relation between discrimination and mental health among Chinese international students, such that discrimination predicted depression and anxiety symptoms only for those students who reported lower levels of social connectedness with American students (Sun et al., 2021). In a longitudinal study of American adolescents during COVID-19, Magson et al. (2021) found that perceived social connectedness served as a protective factor. Social connectedness predicted changes in depression, anxiety, and life satisfaction from T1 (pre-pandemic) to T2 (post-pandemic). Specifically, adolescents with higher levels of social connection reported significantly less increase in depressive and anxiety symptoms from T1 to T2 than those with lower levels of social connection. Similarly, McLoughlin et al. (2019) found that social connectedness buffered the negative effects of cyberbullying on mental health outcomes (depression, anxiety and stress) among adolescents.

However, some researchers found that social connectedness did not serve as a buffer for mental health concerns. For example, Macrynikola and colleagues (2018) examined the relations between social connectedness, stressful life events, and suicidal thoughts and behaviors. While lower levels of social connectedness were associated with higher levels of suicidal thoughts and behaviors, it did not moderate the relations between stressful life events and suicidal thoughts and behaviors. Similarly, another study found that social connectedness did not moderate the effects of bullying involvement on suicide risk (Arango et al., 2016). These conflicting findings suggest the need for further research, especially longitudinal research to control for prior levels of adjustment. In addition, given that the COVID-19 pandemic and quarantine pose its own unique stressors, it is important to study how social connectedness may function differently during this unprecedented time.

Current study

Several research studies have demonstrated the negative impacts of COVID-19 on college students' mental health in the U.S. and in China (e.g., Cao et al., 2020; Roche et al., 2022; Wang et al., 2022a). Social connectedness has been linked to better mental health outcomes, and some research has also found that it buffered the effects of stressful/negative life events on mental health (e.g., Sun et al., 2021). Yet, no published research has examined the moderating effects of social connectedness in the relation of COVID-19-related stressful life events and mental health outcomes over time. The current cross-cultural longitudinal study aims to examine (a) the effects of COVID-19 stressful life events (both frequency and impact) on mental health outcomes (depression symptoms, anxiety symptoms and life satisfaction),

(b) whether social connectedness moderates the effects of COVID-19-related stressful life events on mental health outcomes, and (c) potential gender and cultural differences among a sample of U.S. and Chinese college students. We hypothesize that (a) the frequency and impact of COVID-19 related stressors and social connectedness will predict depression and anxiety symptoms, and life satisfaction, (b) social connectedness will buffer the effects of COVID-19 related stressors (frequency and impact) on mental health outcomes. We also hypothesize that female students will experience more stressful life events than male students. Social connectedness may be more important for female students' mental health, especially during stressful times such as COVID-19. Regarding potential cultural differences, this is an exploratory research question and we did not have any specific hypothesis.

Methods

Procedures

This study was approved by the Institutional Review Board. Data were collected from undergraduate students in one large university located in the Mid-Atlantic region in the U.S. as well as from a large university in Shanghai, China. Time 1 data were collected in November 2019 (before COVID-19) to study students' adjustment (freshmen and sophomores). Time 2 data collection was completed between March 27 and April 4, 2020 during the COVID-19 campus closure. The campus of the participating university in the U.S. was closed on March 13, 2020. For all the universities in China, the campuses were closed during the winter break in January 2020. Many cities in China (including Shanghai) were in a lockdown between January 23 and March, 2020, including closing of all schools and nonessential businesses, with strict home quarantine. During the time of data collection at T2, COVID-19 cases were increasing in the U.S. while new COVID-19 cases had decreased in Shanghai, China.

Student participation in the online survey was voluntary. At Time 1, 306 American students and 296 Chinese students participated in the survey. In March, students who completed Wave 1 data collection were invited to complete an online anonymous survey to share their experiences during COVID-19. During both time points, participants were encouraged to answer all questions but were given the option to skip questions or withdraw from the study at any point. The survey took approximately 30 min to complete. No compensation was provided at Time1. At Time 2, the participants in the U.S. received $5, and the participants in China received ¥10 as a compensation for their time. The attrition rate was high (only 36.32% American students and 40.20% Chinese students completed Wave 2 of

data collection), partially because we were not able to reach some of the participants (e.g., email not working, students not checking university emails during the break). Results showed that there were no significant differences in students' social connectedness (t = 0.580, p = 0.562, d = 0.042), depression (t = 0.983, p = 0.326, d = 0.066), and life satisfaction (t = -0.682, p = 0.495, d = -0.053) at T1 between those who completed both T1 and T2 surveys and those who only completed T1 survey. Only students who completed surveys at both time points were included in the analysis.

Participants

For the American sample (n = 120), participants were primarily female (75.2%), and they ranged in age from 18 to 23; M_{age} = 19.48, SD_{age} = 1.30. The sample was diverse in terms of the ethnic and racial background, including a majority of the sample being White American (54.5%), followed by Asian (28.1%), African American (8.3%), Latinx (5.0%), and other (4.1%). Due to campus closure on March 13th, students were away from campus when they completed the survey at T2. While a majority of the participants were in the Southeast U.S. (84.8%), others were in Northeast (12%), West (0.3%), Midwest (0.3%), and Southwest (0.8%).

A total of 119 Chinese students completed the measures included in the current study. Participants were primarily female (57.1%), and they ranged in age from 17 to 23; M_{age} = 18.61, SD_{age} = 0.91. Due to campus closure, students were home with their families (away from campus) when they completed the survey at T2. While a majority of the participants were in eastern China (73.1%), others were in central China (11.8%) and western China (15.1%).

Measures

Most of the measures have been validated in China before, except for the COVID-19 Stressful Life Events measure. Our team translated the measure into Chinese using the back-translation technique (Rose, 1985) to enhance cultural relevancy in the Chinese version. A bilingual graduate student translated the measure into Chinese, and a bilingual faculty back-translated the Chinese version into English. Then the team compared both versions to resolve any discrepancies in translation.

COVID stressful life events (SLE)

We used an existing six-item COVID-19 Stressful Life Events measure at T2 (Wang et al., 2022a, b, see appendix), which was modified based on some items from the Stressful Life Events during SARS measure (Main et al., 2011; Wong et al., 2007). Participants were asked to reflect on the

time since campus closure due to COVID-19 (in 2020) and indicate the frequency with which they experienced SLE (i.e., "Someone in my neighborhood was diagnosed with COVID-19", "I spent many hours reading negative news about COVID-19", and "I read about many new COVID-19 cases reported per day") on a 4-point scale (0 = never; 1 = once; 2 = occasionally; 3 = often). They were asked to rate the impact of these SLE (-2 = extremely bad impact, 0 = no impact, 2 = extremely good impact). We then recoded the impact score so that higher scores indicate more negative impact of the SLE. The mean score was obtained by averaging the score on each individual item; higher scores indicated more COVID-19-specific SLE. The measure demonstrated adequate internal consistency at T2 (0.700 for the frequency measure and 0.934 for the impact measure at T2). There were no missing data, and mean scores were used in the analysis.

Social connectedness

In order to measure social connectedness, we used the Social Connectedness Scale (Fan et al., 2015; Lee et al., 2001) at Time 1 (T1). The tool consists of 20 items (e.g., "I feel close to people"). Participants were asked to indicate the extent to which they agreed with each item on a 6-point scale (1 = strongly disagree, 2 = disagree; 3 = mildly disagree; 4 = mildly agree; 5 = agree, 6 = strongly agree). Certain items were reverse-scored. Mean scores were used; higher scores indicated higher levels of social connectedness. Previous research showed that the scale has strong psychometric properties in the U.S. sample (Lee et al., 2001) as well as in the Chinese sample (Fan et al., 2015). It has been used extensively in past research. In the current study, it demonstrated good internal consistency at T1 (α = 0.923).

Mental health

In order to measure symptoms of depression, we used the Patient Health Questionnaire – 9 items (PHQ-9; Kroenke et al., 2001; Li et al., 2011) at both T1 and T2. Participants were asked to read each item and indicate the frequency with which they experienced symptoms of depression on a 4-point scale (0 = not at all; 1 = on some days; 2 = more than half of the days; 3 = almost every day). At T1, participants rated their symptoms in the past two weeks. At T2, participants rated their symptoms since campus closure due to COVID-19. Sample items include, "Little interest or pleasure in doing things", and "Feeling down, depressed or hopeless." Sum scores were computed; higher scores indicated higher levels of depression. A total score of 10 or more indicates elevated depressive symptoms. The tool has good reliability and validity in the U.S. (Kroenke et al., 2001) and in China (Li et al., 2011). In the current study,

it demonstrated good internal consistency ($\alpha = 0.865$ at T1 and 0.909 at T2).

In order to measure life satisfaction, we used the 7-item Student's Life Satisfaction Scale (SLSS; Huebner, 1991; Zhong et al., 2013) at both T1 and T2. Participants were instructed to indicate the extent to which they agreed or disagreed with the statement on a 6-point scale ($1 =$ strongly disagree; $6 =$ strongly agree). Sample items include, "My life is going well." Some items were reverse-scored. Ratings on the individual items were then summed to obtain total scores. Higher scores indicated higher levels of life satisfaction. Prior research showed that the tool has good psychometric properties in the U.S. sample (Huebner, 1991) and in the Chinese sample (Zhong et al., 2013). In the current study, the tool showed good internal consistency ($\alpha = 0.823$ at T1 and 0.750 at T2).

In order to measure symptoms of anxiety, we used the Generalized Anxiety Disorder – 7 item scale (GAD-7; Spitzer et al., 2006; Qu & Sheng, 2015) at Time 2 (T2). Participants were instructed to read each item and indicate the frequency with which they experienced the symptoms of anxiety on a 4-point scale ($0 =$ not at all; $1 =$ on some days; $2 =$ more than half of the days; $3 =$ almost every day) since campus closure due to COVID-19. Sample items include, "Feeling nervous, anxious, on edge", and "Not being able to stop or control worrying." The sum score was used; higher scores indicated higher levels of anxiety. A total score of 10 or more indicates elevated anxiety. The tool has been found to have good reliability and validity in U.S. (Spitzer et al., 2006) and in China (Qu & Sheng, 2015). In the current study, it showed high internal consistency ($\alpha = 0.911$ at T2).

An open-ended question about view of life

To further understand how COVID-19 impacted students' life, participants were asked an open-ended question "How has COVID-19 changed your view of life?".

Data analytic plan

We removed one case with more than 50% missing data from the analysis. The other participants (119 Chinese students and 120 American students) did not have missing data on variables of interest. We used independent sample t-tests to examine group differences and used repeated measure t-tests to examine changes over time. For t-tests, we reported Cohen's d for the effect size. We considered Cohen's $d < 0.20$ as negligible, d between 0.2–0.39 as a small effect size, d between 0.5–0.79 as a medium effect size, and $d \geq 0.80$ as a large effect size as suggested by Cohen (1988). All other analyses were conducted using path analysis in *MPlus* 7.0.

We first tested the main effects of our predictors (the frequency and impact of SLE) and moderator (social connectedness). Then we added the two-way interactions. Before computing the interaction terms, the independent variables were mean-centered to reduce collinearity. We used simple slope tests to further examine significant moderation effects. We then used multi-group analysis to examine gender and culture differences (Hancock & Mueller, 2013). First, we compared the constrained model and the unconstrained model. In the constrained model, we imposed estimated parameters to be equal for males and females (or for Chinese vs. American students). In the unconstrained model, we allowed all paths to be freely estimated for males and females (or for Chinese vs. American students). Second, when there was a significant difference between constrained and unconstrained models, we calculated the path separately. Then we defined the "Difference" (e.g., the specific loading for males minus the loading for females) to compare the group differences on each path. Lastly, we reported the paths that were significantly different across groups.

We also analyzed the answers to the open-ended question using content analysis, an inductive approach in which coding categories are derived directly from the text data (Hsieh & Shannon, 2005). We calculated the frequencies (%) of each theme to shed insight into the importance of the themes.

Results

Descriptive results

In terms of prevalence of mental health difficulties, 30.54% of students (including 22.68% Chinese students and 38.33% American students) reported elevated depressive symptoms (PHQ-9 $\geq$ 10) at T1, and 35.15% of students (including 22.69% Chinese students and 47.50% American students) reported elevated depressive symptoms at T2. In addition, 30.13% of students (including 24.37% Chinese students and 35.83% American students) reported elevated anxiety symptoms (GAD7 $\geq$ 10) at T2. Independent sample t-tests showed that American students reported higher levels of depression ($t = 3.797$, $p < 0.001$, Cohen's $d = 0.49$, a small effect), anxiety ($t = 2.361$, $p = 0.019$, $d = 0.31$, a small effect), and lower levels of life satisfaction ($t = 3.189$, $p = 0.002$, $d = 0.41$, a small effect) than Chinese students at T2, although there were no significant differences in depression and life satisfaction between the two groups at T1. In addition, American students reported significantly higher frequencies of stressful life events ($t = 15.559$, $p < 0.001$, $d = 2.02$, a large effect), but less negative impact from the stressful life events ($t = 3.011$, $p = 0.003$, $d = 0.39$, a small effect) than Chinese students. Chinese students reported higher levels of social

Table 1 Mean, SD, and Correlations among Variables of Interest

	Mean (China)	SD (China)	Mean (U.S.)	SD (U.S.)	SC_T1	PHQ_T1	LSS_T1	SE_freq	SE_imp	GAD_T2	PHQ_T2	LSS_T2
SC_T1	4.392[a]	.819	4.149[b]	.835	1	-.470**	.596**	-.188*	.148	-.274**	-.312**	.297**
PHQ_T1	7.695	5.274	8.388	6.372	-.390**	1	-.610**	.098	.086	.463**	.616**	-.425**
LSS_T1	27.930	6.202	27.384	6.279	.596**	-.482**	1	-.092	-.087	-.311**	-.438**	.574**
SE_freq	1.221[aa]	.599	2.439[bb]	.611	-.188*	.212*	-.036	1	.191*	.271*	.199*	-.107
SE_imp	.737[aa]	.748	.443[bb]	.759	.148	-.075	.062	-.048	1	.203*	.157	-.181
GAD_T2	6.020[a]	5.495	7.728[b]	5.684	-.274**	.390**	-.282**	.080	.063	1	.756**	-.485**
PHQ_T2	7.146[aa]	5.481	10.107[bb]	6.525	-.312**	.381**	-.310**	.062	-.041	.740**	1	-.624**
LSS_T2	28.896[aa]	4.207	26.670[bb]	6.363	.297**	-.197*	.355**	-.099	.056	-.134	-.142	1

*$p < 0.05$. **$p < 0.01$. The correlations above the diagonal are based on the American sample (N = 120). The correlations below the diagonal are based on the Chinese sample (N = 119).

SC = Social connectedness, PHQ_T1 = Patient Health Questionnaire – 9 at T1. LSS_T1 = Life Satisfaction Scale at T1. SE_freq = Frequency of stressful life events. GAD_T2 = Generalized Anxiety Disorder at T2. PHQ_T2 = Patient Health Questionnaire – 9 at T2. PHQ_T2 = Patient Health Questionnaire – 9 at T2. LSS_T2 = Life Satisfaction Scale at T2. SE_imp = Impact of stressful life events. SE_imp = Impact of stressful life events.

[a] & [b] Indicate two groups were significantly different based on an independent sample t-test, $p < .05$

[aa] & [bb] Indicate two groups were significantly different based on an independent sample t-test, $p < .01$

connectedness than American students at T1 ($t = 2.267$, $p = 0.02$, $d = 0.30$, a small effect) (Table 1). Female students reported higher levels of depression ($t = 2.139$, $p = 0.03$, $d = 0.28$, a small effect), higher levels of anxiety ($t = 2.248$, $p = 0.03$, $d = 0.29$, a small effect), and lower levels of life satisfaction ($t = 2.244$, $p = 0.03$, $d = 0.29$, a small effect) than male students at T2, but there were no gender differences at T1. In addition, female students reported significantly higher frequency of stressful life events ($t = 2.874$, $p = 0.004$, $d = 0.37$, a small effect) than male students.

For the American students, there were significant increases in students' symptoms of depression ($t(1, 119) = 3.320$, $p < 0.001$, $d = 0.30$, a small effect size), but insignificant decreases in life satisfaction, ($t(1, 119) = -1.335$, $p = 0.184$, $d = 0.12$) from T1 (before the pandemic) to T2 (2 months into the pandemic). For the Chinese sample, there were no significant changes in students' life satisfaction ($t (1, 118) = 1.719$, $p = 0.088$, $d = 0.16$), or depression ($t(1, 118) = -1.012$, $p = 0.314$, $d = 0.09$), possibly because COVID-19 was under control in China at T2.

Correlations among variables of interest were consistent with our hypotheses (Table 1). Experiencing more stressful life events and lower levels of social connectedness were correlated with more depression, more anxiety, and less life satisfaction.

Main effects

We first tested the main effects of SLE (both frequency and impact) and social connectedness on mental health after controlling for prior levels of depression and life satisfaction. The model was saturated, $\chi^2 (0) = 0$, $p < 0.001$, AIC = 4194.343, CFI = 1, RMSEA = 0, 90% CI [0, 0], SRMR = 0. Consistent with our hypotheses, the frequency of SLE ($b = 1.176$. $p = 0.002$) and the impact of SLE ($b = 0.845$, $p = 0.04$) significantly predicted anxiety. In addition, the frequency of SLE significantly predicted depression ($b = 1.385$. $p < 0.001$) and life satisfaction ($b = -1.079$. $p = 0.003$). However, the impact of SLE did not significantly predict depression ($b = 0.294$. $p = 0.499$) or life satisfaction ($b = -0.440$. $p = 0.271$).
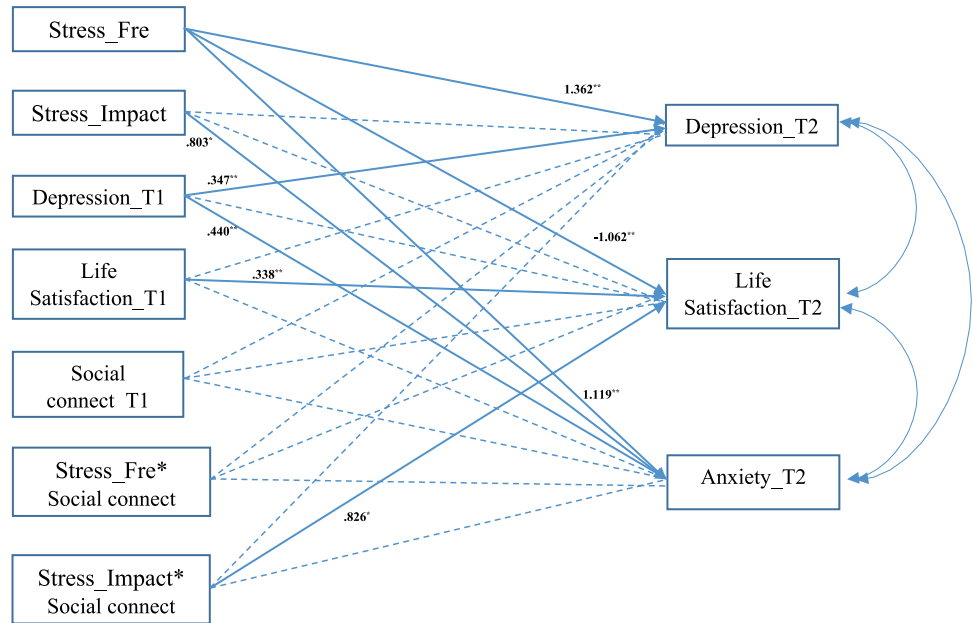
As for social connectedness, it did not significantly predict anxiety ($b = 0.257$. $p = 0.597$), depression ($b = -0.266$. $p = 0.597$) or life satisfaction ($b = 0.366$. $p = 0.427$). However, when we did not control for prior levels of depression and life satisfaction, social connectedness at T1 significantly predicted less anxiety ($b = -1.525$. $p < 0.001$), less depression ($b = -2.049$. $p < 0.001$) and more life satisfaction ($b = 2.110$. $p < 0.001$) at T2.

Moderation effects

We then added the interaction terms to test the moderation effects (Fig. 1). The model was saturated, $\chi^2 (0) = 0$,

Fig. 1 SLE on Life Satisfaction, Depression, and Anxiety. Note. *p < 0.05. **p < 0.01

*SLE on Life Satisfaction, Depression, and Anxiety*

$p < 0.001$, AIC = 4201.425, CFI = 1, RMSEA = 0, 90% CI [0, 0], SRMR = 0. The interaction between the impact of SLE and social connectedness significantly predicted life satisfaction, $b = 0.826$, $p = 0.047$. Other interactions were not significant. SLE frequency ($b = 1.119$, $p = 0.004$) and SLE impact ($b = 0.803$, $p = 0.048$) still significantly predicted anxiety.

We then conducted simple slope tests to further examine the moderation effects of social connectedness on life satisfaction (Fig. 2). For the group with low social connectedness, the relation between the impact of SLE and life satisfaction was significant and negative ($b = -0.956$, $p = 0.044$). However, for the group with high social connectedness, the relation between the impact of SLE and life satisfaction was not significant ($b = 0.307$, $p = 0.579$). Results indicated that social connectedness buffered the negative impact of COVID-19 SLE on life satisfaction.

Fig. 2 Moderation Effect of Social Connectedness

Moderation Effect of Social Connectedness
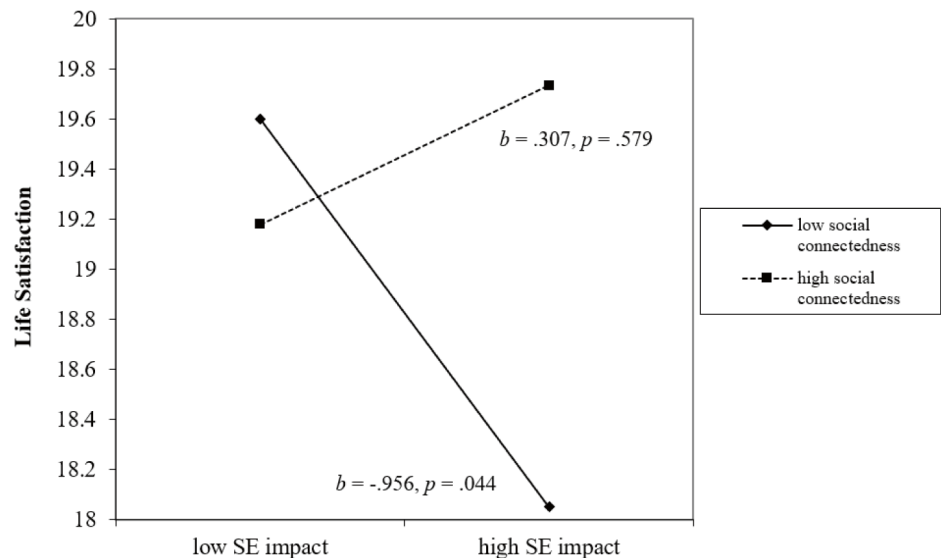
Cultural differences

Then, a multi-group path analysis was used to examine whether SLE and social connectedness associated with mental health outcomes differently impacted American students and Chinese students. Results showed insignificant differences between the constrained model, which constrained all paths to be equal between two groups (χ^2 (21) = 31.367, p = 0.07, AIC = 4189.867, CFI = 0.972, RMSEA = 0.064, 90% CI [0.000, 0.108], SRMR = 0.111.) and the unconstrained model (χ^2 (0) = 0, p < 0.001, AIC = 4200.501, CFI = 1, RMSEA = 0, 90% CI [0, 0], SRMR = 0.), $\Delta\chi^2$ = 31.367, Δdf = 21, p = 0.068.

Gender differences

Then, a multi-group path analysis was used to examine whether SLE and social connectedness associated with mental health outcomes differently impacted female students (n = 161) and male students (n = 78). Results showed a significant difference between the constrained model (χ^2 (21) = 33.475, p = 0.04, AIC = 4206.228, CFI = 0.973, RMSEA = 0.065, 90% CI [0.000, 0.109], SRMR = 0.106) and the unconstrained model (χ^2 (0) = 0, p < 0.001, AIC = 4216.754, CFI = 1, RMSEA = 0, 90% CI [0, 0], SRMR = 0.), $\Delta\chi^2$ = 33.475, Δdf = 21, p = 0.041. The frequency of stressful life events significantly predicted anxiety among females (b = 1.596, p < 0.001), but not among males (b = -0.044, p = 0.953), the difference between these two paths was approaching significance, Δb = 1.640, p = 0.06. The frequency of stressful life events significantly predicted more depression among females (b = 1.732, p < 0.001), but not among males (b = 0.716, p = 0.575), the difference between these two paths was significant, Δb = 1.016, p = 0.04.

Qualitative responses: view life differently

Participants were asked an open-ended question "How has COVID-19 changed your view of life?" Among 120 American students, 79 responded to this question. Among 119 Chinese students, 118 responded to the open-ended question. Three main themes emerged from the qualitative responses. First of all, about half of participants, specifically, 55 (46.6%) Chinese and 49 (62%) Americans, mentioned that COVID-19 made them rethink the meaning of life and that they wanted to live life differently. In the midst of the pandemic, some expressed feeling more grateful about things they had in life, treasured life more, and expressed not taking things (e.g., environment, health, family) for granted. Participants reported that they wanted to protect the environment and respect the nature more, be more optimistic and grateful, and spend more time with family and friends

to improve their life. Secondly, 15 (12.7%) Chinese and 17 (21.5%) U.S. participants reported a sense of uncertainty about life as a result of the COVID-19 pandemic.

In addition, some participants reported changes in their attitudes towards the governments and societies. Specifically, 15 (12.7%) Chinese participants realized the importance of being united during a crisis and becoming more aware of their social responsibility to serve the community (sacrifice their freedom to prevent the spread of the virus) during the crisis. Relatedly, 23 (19.5%) Chinese participants stated that they agreed with how the Chinese government handled the pandemic (e.g., quarantine) and recognized the positive roles of the government. On the other hand, only three (3.8%) U.S. participants mentioned being united during a crisis and their social responsibility to serve the community. Relatedly, three (3.8%) U.S. participants expressed concerns about the government's control over their lives (e.g., quarantine rules), and 6 (7.6%) stated becoming more aware of the existing problems in the U.S. healthcare system.

Discussion

Guided by the PPCT model, our study extended prior research on stressful life events (e.g., Wang et al., 2022a) and social connectedness (e.g., Diener et al., 2017) by using a longitudinal and cross-cultural design to examine how stressful life events (both frequency and impact) and social connectedness impact changes in college students' mental health (depression, anxiety and life satisfaction) from November 2019 to March 2020 among a sample of U.S. and Chinese college students. We also examined gender and cultural differences, and used qualitative data to further understand how COVID-19 changed students' views of life. Five main findings emerged. First, the frequency of experiencing COVID-19-related stressors predicted more depression and anxiety symptoms, and negatively predicted life satisfaction over time, while the impact of COVID-19-related stressors positively predicted anxiety symptoms. Second, social connectedness served as a buffer in the relation between the impact of COVID-19 stressors and life satisfaction. Third, no cultural differences on the relation between stressful life events, social connectedness and mental health overtime were found. Fourth, the frequency of stressful life events significantly predicted more depression and anxiety among females than males. Fifth, our qualitative data suggested that many college students were impacted by the pandemic, in that it helped them reflect on the meaning of life. As COVID-19 continues to impact many people's lives in 2022, our findings have both theoretical and practical implications.

The high prevalence rates of depression and anxiety in our sample were similar to other studies during the pandemic

(e.g., Chi et al., 2020; Wang et al., 2022a, b, 2020a, b). We also found a significant increase in depressive symptoms among American students from T1 to T2, empirically demonstrating the impact of pandemic on mental health over time. However, we did not find any significant changes in life satisfaction. Our qualitative results suggest that college students have engaged in meaning-making and finding benefits from the stressful events during the pandemic, which may buffer the negative impact of COVID-19 on their life satisfaction (e.g., about half of the participants reevaluated the meaning of life, and priority, and became more grateful about things they had in life). This may explain why life satisfaction did not decrease in the event of such stress. It is also possible that our sample at T2 may have been biased such that our sample was more likely to be consisted of students who adjusted well during COVID-19. Results may be different if we recruited a larger sample that included more at-risk students. Finally, at the time of data collection, COVID-19 was under control in Shanghai and many areas in China. Chinese students may have felt relatively optimistic about the pandemic, as a result reporting similar levels of life satisfaction as before the pandemic.

The synthesis of the increased depressive symptoms (among American students) and unchanged life satisfaction suggests the co-existence of mental health struggles and resilience during the pandemic. In other words, psychological distress and resilience can co-exist when individuals face adversity (Tang et al., 2021). This finding is consistent with some recent studies in Korea (Choi et al., 2021), in China (Tang et al., 2021) during COVID-19. For example, Choi et al. (2021) found that life satisfaction among elementary children in Korea did not change from pre-pandemic (2018 and 2019) to the pandemic in Spring, 2020. Similarly, Tang et al. (2021) found that 80% of Chinese children and adolescents reported the same or higher levels of life satisfaction during the pandemic (March, 2020) compared to before the pandemic (59.4% participants experienced no change in life satisfaction and 21.4% reported being more satisfied with their lives during the pandemic). Our findings may suggest that it is important to guide youth and young adults to view the pandemic constructively and to identify positive and meaningful aspects of life in order to cope with the stress related to the pandemic (Tang et al., 2021).

To add nuances to research related to stressful life events, we examined both the frequency and impact of COVID-19-related stressful life events in our longitudinal study. Consistent with some prior research (Wang et al., 2022a), the frequency of experiencing COVID-19-related stressors had detrimental effects on all mental health outcomes after controlling for depression and life satisfaction before the pandemic. However, the perceived impact of the stressors predicted only anxiety symptoms. This suggests that the number of stressors experienced and the impact of stressful life events affect mental health differently and it is important to examine both the frequency and the impact.

Our hypothesis that social connectedness would buffer the effects of COVID-19-related stressors on mental health outcomes was only partially supported. We found that social connectedness predicted better mental health outcomes during COVID-19 when we did not control for prior mental health. After controlling for prior levels of mental health, social connectedness still served as a buffer, but only in the relation between COVID-19-related stressors' impact and life satisfaction. Specifically, for individuals who scored low on social connectedness, their life satisfaction decreased as the negative impact of COVID-19-related stressors increased. However, for those individuals high on social connectedness, their life satisfaction was maintained, even when the negative impact of COVID-19-stressors increased. This finding is in line with previous studies that have found that social connectedness buffered the effects of stressful life events (e.g., discrimination, cyberbullying, homelessness) on mental health outcomes (e.g., McLoughlin et al., 2019; Sun et al., 2021). This finding is consistent with the PPCT theory and risk and resilience model, and highlights the reciprocal interactions between the person and the multiple systems in the environment(e.g., COVID-19 related stress and pre-pandemic social connectedness) to predict adjustment over time. Individuals with a high sense of social connectedness experienced greater closeness with their friends/support network, which appeared to be extremely beneficial during the pandemic. It is likely that these socially connected college students intentionally sought out support or made efforts to stay in contact with their network, something that may be difficult for individuals who had lower sense of social connectedness (before the pandemic) due to the restrictions imposed by the quarantine.

Cultural differences

Our findings highlighting cultural differences provide support for the importance of considering context when studying mental health outcomes as suggested by the PPCT theory. We found that American students reported higher levels of mental health difficulties than Chinese students. Depression scores increased for American students from T1 to T2, but not for Chinese college students. This may be explained by the fact that the pandemic started and evolved at different times in the U.S. and in China. The COVID-19 lockdown started on January 23, 2020 in China. By early April 2020, COVID-19 was largely under control in China, and almost all cities had lifted the quarantine order, although preventive measures, such as wearing face coverings in public and campus closure/virtual learning for all students, were still in place. While success in controlling the spread of the COVID-19 virus may explain the lower rates of depression

symptoms among Chinese students than among American students, it may also be an indicator of students' resilience, or the ability to bounce back after the initial struggle. On the other hand, during our data collection at T2, strict quarantine measures were implemented in the U.S., and all university campuses were closed around March 11, 2020. The significant increase in depression symptoms among American students may be a natural response to the unprecedented stress. Our study extended prior literature by demonstrating different patterns between U.S. and China using longitudinal data and comparing mental health before and during COVID-19.

Chinese students reported higher levels of social connectedness than American students before the pandemic. The finding is somewhat consistent with prior research showing that Americans tend to value individualism and independence (e.g., Hofstede, 1980), while Chinese often value interdependence, social harmony, and social relationships (Bond & Hwang, 1986; Markus & Kitayama, 1991).

Cultural similarities

Although Chinese students reported higher levels of social connectedness than American students before the pandemic, the relation between social connectedness and mental health outcomes was similar between the two groups. This may be because all human beings have a basic need to feel connected and this connectedness is beneficial for all human beings (Baumeister & Leary, 1995; Li, 2002). Researchers suggested that this need is rooted in evolution. For example, in order for our ancestors to survive, they had to form social bonds and to work together to support each other. Research has also shown that social belongingness is significantly and strongly related to mental health outcomes (Baumeister & Leary, 1995). This may explain why there were no cultural group differences in the relation among stressful life events, social connectedness and mental health.

Furthermore, although Chinese students and American students experienced different levels of COVID-19-related SLE, these events had similar impacts on mental health for both groups, highlighting the universality among us. Given the lack of cross-cultural research on the topic, future studies should continue to examine cultural similarities and differences.

Gender differences

We found no gender differences with relation to mental health at T1 (pre-pandemic). This finding is somewhat inconsistent with prior research suggesting that females experience higher levels of depression and anxiety than males (for a review, see Hankin & Abramson, 2001). However, consistent with prior research, we found that female students reported more depression, anxiety, and less life satisfaction than male students during the pandemic (T2). Relatedly, consistent with prior research (Rose & Rudolph, 2006), we found that female students reported significantly higher frequency of stressful life events. Furthermore, the frequency of stressful life events predicted more depression and anxiety among female than male students. Our findings suggest the stressful life events during the pandemic may have exacerbated gender differences, and females may be more susceptible to stressors. As a result, it is important to attend to the adjustment of female students who experience more stressful life events and are more impacted by such stressors during COVID-19.

Limitations

Our study had some limitations. First, all data were based on self-report, giving rise to the possibility of biased reporting and mono-method bias. Although research indicates that self-reports of mental health are valid and reliable because others may not be able to identify internal mental health symptoms (Lieberman et al., 2016), it will be important to corroborate the findings using additional informants like family members or friends. Second, participants were only recruited from two universities (one in the U.S. and one in China), and thus findings cannot be generalized to all American and Chinese college students. Future research should consider collecting data from more diverse samples (e.g., different geographic locations, different types of institutions). Third, we have collected longitudinal data from participants, but the sample size is relatively small. As a result, we used path analysis instead of SEM. Future studies should recruit more participants.

Implications

The findings of this study have several important implications for educators and mental health professionals, especially as COVID-19-related quarantine continues to impact students in 2022. As expected, we found that the frequency of COVID-19-related stressful life events negatively predicted the changes in mental health. While exposure to certain stressful events (e.g., getting COVID-19) cannot be controlled, other stressors may (e.g., reading about COVID-19 news and cases). Young adults should be encouraged to limit social media exposure of negative news related to COVID-19, and be encouraged to participate in other activities (e.g., physical activities/exercises; Margo et al., 2020; Maher et al., 2020; Zhang et al., 2020), stress management and self-care activities (Chen et al., 2020)), and be exposed to positive pandemic-related messages (Chen et al., 2020). It is also important for educators and university mental health providers to provide virtual training to promote resilience and stress management, such as mindfulness strategies (Chi

et al., 2020). In addition, given that social connectedness served as protective factor among college students in both countries, mental health professionals and educators should help students find ways to feel connected with their family, friends, campus community, and other networks to improve mental health. Similarly, as students return to campus, college campuses should organize events and programs to help students develop support networks and regain the personal connections lost during the quarantine. Because female students reported higher levels of stressful life events and mental health symptoms, and stressful life events significantly predicted more depression among females than male students, it is important to provide services specifically tailored for female students to encourage coping and instill hope (e.g., emphasize one can recover and grow from stressful life events).

Declarations

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