Associations between factors related to COVID-19 and depression: direct and indirect effects via mental distress due to COVID-19: an online cross-sectional survey conducted among students of 26 universities in 16 cities in China

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Abstract

Background: The COVID-19 epidemic may elevate mental distress in various populations in China.

Objective: The study investigated the levels of depression and negative psychological responses to COVID-19, and the associations between cognitive/behavioral/psychosocial factors and depression among university students in China.

Methods: A large-scale online cross-sectional study (16 cities in 13 provinces) was conducted among university students from February 1st to 10th, 2020 in China; 23,863 valid questionnaires were returned. Patient Health Questionnaire-9 was used to assess depression. Structural equation modeling was performed to test mediation/suppression effects.

Results: Of the participants, 47.1% reported high/very high levels of ? one type of negative psychological responses; 39.1% showed mild to severe depression. Negative psychological responses were positively associated with depression. All but one

factor (perceived infection risks, perceived chance of controlling the epidemic, home-staying, contacted people from Wuhan, and perceived discrimination) was significantly associated with negative psychological responses and depression. Negative psychological responses partially mediated/suppressed the associations between the studied factors and depression (effect size of 6.0% to 79.5%).

Conclusions: Both negative psychological responses to COVID-19 and depression were prevalent among university students in China; the former may increase the prevalence of the latter. The studied cognitive/behavioral/psychosocial factors related to COVID-19 may directly or indirectly (via negative psychological responses) affect depression. Interventions to modify such factors may reduce mental distress during the COVID-19 epidemic.

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Author's contribution: JTFL conceived the research questions, designed this study, assembled the team of collaborators, and supervised the Project's implementation; JTFL, YY, and RS conducted the

statistical analysis and drafted the manuscript; JTFL and YY finalized the manuscript. All authors assisted in questionnaire design, data collection, data interpretation, and gave comments to intellectual content of the manuscript. JTFL, YY, XM, RS, and SL have full access to all the data of the study, and are responsible for the integrity of the data and the accuracy of the data analysis.

Abstract

Background: The Coronavirus Disease 2019 (COVID-19) epidemic may elevate mental distress and depressive symptoms in various populations in China.

Objective: The study investigated the levels of depression and mental distress due to COVID-19, and the associations between cognitive/behavioral/psychosocial factors and depression/mental distress due to COVID-19 among university students in China.

Methods: A large-scale online cross-sectional study (16 cities in 13 provinces) was conducted among university students from February 1st to 10th, 2020 in China; 23,863 valid questionnaires were returned. The Patient Health Questionnaire-9 was used to assess depression. Structural equation modeling was performed to test mediation/suppression effects.

Results: Of the participants, 47.1% reported high/very high levels of ≥one type of mental distress due to COVID-19; 39.1% showed mild to severe depression. Mental distress due to COVID-19 was positively associated with depression. All but one factor (perceived infection risks, perceived chance of controlling the epidemic, home-staying, contacted people from Wuhan, and perceived discrimination) were significantly associated with mental distress due to COVID-19 and depression. Mental distress due to COVID-19 partially mediated/suppressed the associations between some of the studied factors and depression (effect size of 6.0% to 79.5%).

Conclusions: Both mental distress due to COVID-19 and depression were prevalent among university students in China; the former may have increased the prevalence of the latter. The studied cognitive/behavioral/psychosocial factors related to COVID-19 may directly or indirectly (via mental distress due to COVID-19) affect depression. Interventions to modify such factors may reduce mental distress and depressive symptoms during the COVID-19 epidemic.

Keywords: COVID-19; mental distress; depression; psychological responses; mediation; China; online survey

Introduction

The coronavirus disease 2019 (COVID-19) started in Wuhan, China since December 2019 [1], and has become a pandemic since March 11, 2020 [2]. As of January 10th, 2021, there were 87,364 and over 89.4 million confirmed cases in China and overseas [3]. In China, the initial phase of COVID-19 outbreak has induced numerous stressors, as it impacts almost every aspects of daily life, from work to entertainment to service utilization to social interactions [5]. For instance, entry to and exit from Wuhan and many cities/regions have been prohibited since the Chinese Lunar New Year (CNY). Other personal and public control measures include closure of offices and public areas (e.g., shopping areas, offices, and restaurants), massive quarantines, home-staying for a long period of time, suspension of school classes, and cancellation of events [5]. It is important to study the negative psychological responses potentially caused by the COVID-19 epidemic, as previous studies have reported high prevalence of depression and other mental health problems in various populations during the 2003 severe acute respiratory syndrome (SARS) epidemic, the 2009 novel influenza A (H1N1) pandemic, and the 2014-2016 Ebola outbreak [6-9]. Mental health problems have significant public health implications as they affected the public's use of measures for prevention [10]. The study of negative psychological responses and associated factors related to the COVID-19 outbreak in China allows global public health and mental health workers to assess related service demands and design effective interventions.

Although quite a number of studies have looked at the factors of depression during the COVID-19 period, fewer studies were conducted in the very initial phase of the outbreak, which started after the Chinese government declared its person-to-person transmission property on January 20th, 2020 and started the first controversial Wuhan lockdown three days after [11]. To our knowledge, no similar studies were conducted outside China around that period of time, as COVID-19 had not become a pandemic until March and gained less attention outside China in early February 2020. Psychological responses are context specific. The very initial phase of the COVID-19 outbreak (in terms of the first few weeks) in the world meant uncertainties and lack of information. It is imperative to document the community responses at the very initial stage of new emerging infectious diseases (especially those eventually become pandemic) to inform preparations for future outbreaks.

Furthermore, the first COVID-19 outbreak occurred in China during the CNY which involved high mobility, as billions of people were returning to their hometowns, and hence instilled very high risk of spreading the virus to the entire country. Mobile populations have special relevance in this special time/country context, one of which was university students, as the majority of whom were studying in cities different from their hometowns. This study investigated psychological responses of depression and associated factors among university students in China from the 10th to 20th days since COVID-19 was believed to involve person-to-person transmissions. Our literature search found only four similar university student studies conducted during the same time period [12-15]. While the present study covered 16 cities of 13 provinces (n=23,863), three of them covered only one or two cities/provinces; the fourth one claimed to involve 29 provinces but have a sample size of only 2,216. Besides, the present study was population-based while no sampling frame was mentioned in the four other studies.

Although factors of depression during the COVID-19 period have been widely reported. There are still substantial research gaps that were being filled out by the present study, besides the afore-mentioned fact that such studies were scarce during the initial weeks. Cognitive, behavioral, and psychosocial factors related to COVID-19 were all found to be potential determinants of depression [16-18]. Although a lot of studies have investigated associations between COVID-19-related cognitive factors and preventive behaviors [19 20], only a few studies have looked at COVID-19-related cognitive factors of depression. For instance, the four China university student studies conducted during the initial outbreak mainly mentioned life-style factors (e.g., sleep) and psychological attributes (e.g., resilience) but not COVID-19 cognitive factors [12-15]. Several studies of the general populations in China/overseas looked at cognitive factors such as perceived susceptibility/severity which were positively associated with depression [16 21-24].

According to the fear appeal theory, perceived threat comprises perceived susceptibility and perceive severity [25]. The theory provides a framework to include cognitive factors in this study. Perceived chances for oneself and/or one's significant others in contracting a disease (perceived susceptibility) [10] was significantly associated with psychological problems (e.g., depression) during the periods of SARS, H1N1 and Ebola outbreaks [6 8 9]. In general, perceived severity of a disease was significantly associated with negative psychological responses [8 9]. The general public's belief that H1N1 could cause severe irreversible bodily damage was associated with mental distress [8]. Anticipation about the likelihood and scale of a potential outbreak reflects perceived severity of the epidemic at community level. For instance, perceived chances of having large H1N1 and Ebola outbreaks were associated with mental health problems [6 8]. We contended that perceived chance of controlling the COVID-19 epidemic would be positively associated with depression, as such a perception may reduce perceived severity due to potential negative impacts (e.g., finance, work, and social relationship).

Misconceptions that H1N1 could be transmitted via some unconfirmed modes of transmission (e.g., waterborne transmissions) increase perceived susceptibility, which was associated with mental distress [9]. The association between misconceived mode of COVID-19 transmission and depression was less clear. One study conducted in the general population during the initial phase of COVID-19 in China found that the perceived mode of transmission via droplets increased risk of depression, while perceived transmission via contaminated objects/airborne was non-significant. As people were forming their perceptions on the risk/severity/mode of transmission during the initial outbreak phase amid uncertainties and lack of knowledge, their associations with depression might be different from those obtained from subsequent studies conducted during the later phases of the pandemic.

COVID-19-related behavioral factors of depression are also important as behavioral responses would occur during initial outbreaks of new emerging infectious diseases. An important and unprecedented response was staying at home during the CNY in China, keeping in mind that there were then no clear strict social distancing policies in China and there was then no penalty for going out in most of the Chinese cities. It is important to understand the level of home-staying during the critical initial outbreak phase as it had contributed to the control of COVID-19 in China by reducing social contacts. Research has found that quarantine was positively associated with depression [26] but staying at home

during the holidays were different from quarantine and working from home. Other studies found that social distancing, or more precisely, compliance to social distancing policies was positively associated with depression [27 28] while non-significant results were also reported (e.g., [29]). No study has looked at the association between voluntary home-staying and depression during the initial COVID-19 period in China. Another important unique behavioral factor was close contacts with people from Wuhan, which was the first and most important epicenter of COVID-19. At the time of the survey, a majority of the COVID-19 cases in China were detected from Wuhan, while many cases detected outside Wuhan were related to visitors of Wuhan [11]. Close contacts with such people was a unique stressor that was investigated only in the present study. The use of home-staying as a prevention strategy may reduce perceived susceptibility, as it lowers the likelihood of contracting COVID-19. Having closely contacted high-risk people (e.g., those who had travelled to Wuhan) may increase perceived susceptibility. Thus, it is essential to look at whether they have associations with depression after adjusting for perceived severity/susceptibility.

Potential psychosocial factors related to COVID-19 may be associated with mental distress at the community level. For instance, perceived discrimination is a risk factor of depression [30], and was associated with mental distress in SARS research [31]. Health-care workers and recovered SARS patients were discriminated by the general public [32]. As of January 10th, 2021, there were 50,340 confirmed COVID-19 cases in Wuhan and 17,809 in the rest of the Hubei province (where Wuhan is located) [33]. Five million people had traveled out of Wuhan during the CNY [34]. Those who had visited Wuhan/Hubei might encounter discrimination. Also, people at-risk of contracting the virus were prone to encountering discrimination (e.g., hospital workers and those being close contacts, family members, co-workers, and neighbors of infected cases). No study has looked at COVID-19-related discrimination and its potential effect on depression during the COVID-19 outbreak in China. It is a uniqueness of this study.

Mental distress due to COVID-19 (e.g., panic, anxiety, and emotional agitation) is potentially associated with depression. It is understandable that prevalence of depression among university students prior to the COVID-19 outbreak was not low; not all depressive symptoms were caused by COVID-19 although the pandemic could have inflated the risk of depression. The present study thus has the novelty of measuring both general depressive symptoms and the level of self-reported mental distress directly attributed to COVID-19, based on a scale used in understanding mental distress due to SARS and H1N1 [8 35 36]. It is imperative to understand the associations between cognitive/behavioral/psychosocial factors and both mental distress due to COVID-19 and depressive symptoms, which were tested in the present study.

Another research gap is that very few studies have looked at the mechanisms between COVID-19-related factors and depression during the pandemic period. According to the Common Sense Model (CSM) of illness representation, cognitive perceptions, how a person feels about a disease (i.e., emotional representation), and his/her coping responses (e.g., behavioral responses) would determine health outcomes, including mental health status [37 38]. Thus, it is contended that cognitive/behavioral/psychosocial factors and mental distress due to COVID-19 would be positively associated with depression. Furthermore, the present study tested the mediation

hypothesis that emotional responses (i.e., mental distress due to COVID-19) mediated between the studied cognitive factors (e.g., perceived bodily damages and perceived infection risk of COVID-19)/behavioral factors (home-staying and close contacts with people having visited Wuhan)/psychosocial factors (e.g., perceived discrimination related to COVID-19) and depressive symptoms. No study has looked at such mediations and the research hence contributed to literature of mental distress during the initial COVID-19 period.

The present study investigated the level of depression among 23,863 university students of 26 universities located at 16 cities of 13 provinces in China 10 days after the official recognition of person-to-person transmission by the Chinese government and during the 8th to 17th days of the CNY in China, which was the initial rising phase of COVID-19. Based on literature search, besides background and contextual factors, the study investigated the associations between the following factors and both mental distress due to COVID-19 and depression: i) *cognitive factors* (i.e., misconceptions about modes of transmission, perceived risks of contracting COVID-19 for self/family members/classmates, perceived permanent bodily damages of COVID-19, and perceived chance in controlling the epidemic in China in the coming six months), ii) *behavioral factors* (i.e., home-staying behavior during CNY and close contacts with people who had visited Wuhan before CNY), and iii) *psychosocial factors* (i.e., perceived discrimination) related to COVID-19. We further tested the hypothesis that mental distress due to COVID-19 would mediate between the afore-mentioned cognitive/behavioral/psychosocial factors and depression. The literature has not reported similar studies.

Methods

Participants and procedure

The cross-sectional study was conducted during the 8th to 17th days of the CNY (February 1st to 10th, 2020). Data were collected from 26 universities of 16 cities in 13 out of the 32 provinces/municipalities/autonomous regions in the country. A total of 681 classes were sampled by convenience within a number of faculties (arts, sciences, social sciences, engineering, medicine/public health, and others). The median and inter-quartile range of the number of students selected per university were 1,165 and 2,271, respectively. All students of the selected classes were sent a QR-code through Wechat to access an anonymous online questionnaire which took about 10-15 minutes to complete. They were informed about the study's background, anonymity, restriction to academic use, and that return of the completed questionnaire implied informed consent. A lucky draw gave out five prizes of RBM 50-200 (about 7-28 USD) per city, while half of the students randomly received a symbolic CNY 'lucky money' (red pocket) of 1 RMB.

A total of 36,560 invitations were sent out; 25,647 completed questionnaires were returned, 1,197 (4.7%) of which did not pass the consistency checks and were excluded from data analysis, together with 47 (0.2%) others who were diagnosed COVID-19 positive, 515 (2.0%) being quarantined, and 25 (0.1%) who stayed outside mainland China. The effective sample size was 23,863 (93.0%). The response rate [the number of returned questionnaires (26,547) divided by the number of invitations sent out (25,647)] was 71.5%.

The study was approved by the Survey and Behavioral Research Ethics Committee

of the Chinese University of Hong Kong (No. SBRE-19-400).

Measures

Personal background: Such information included socio-demographic data (i.e., sex), school-related information (i.e., grades and faculty), and self-reported physical health status.

Contextual factors: Such information included: i) living arrangement during CNY (i.e., whether staying at their university's cities, ii) whether staying with their families at the survey time, iii) whether their localities of stay were 'shut down' by the local government during CNY, and iv) the number of confirmed COVID-19 cases detected in the provinces that the participants' localities of stay belonged to.

Depression: Depression was assessed by using the 9-item Patient Health Questionnaire (PHQ-9). It has been validated in Chinese populations and showed good psychometric properties [39]. The items asked about the frequency that some symptoms occurred during the past two weeks; sample items involved "little interest or pleasure in doing things" and "feeling down, depressed, or hopeless". Each item was rated with a four-point Likert scale (0: not at all to 3: nearly every day). Summative scores of 5, 10, 15, and 20 represent cut-off points for defining mild, moderate, moderately severe and severe depression, respectively. The Cronbach's alpha of the PHQ-9 was 0.92 in the present study.

Mental distress due to COVID-19: Three items were used to assess the levels of mental distress due to COVID-19 (i.e., panic, anxiety, and emotional agitation). The items were rated with a four-point Likert scale (1: very low to 4: very high); higher levels of the summative score indicate higher levels of mental distress due to COVID-19. The summative scale had been used in a number of H1N1 studies [8 9]. The Cronbach's alpha was 0.93 in the present study.

Cognitive factors related to COVID-19: 1) Airborne transmission: The item was "COVID-19 can be transmitted long distance through air" (1: yes; 2: no; 3: uncertain); the responses were recoded into two groups (1: yes; 0: no or uncertain). 2) Perceived infection risk: Three items were used to assess the levels of perceived infection risk of COVID-19 in the coming one year for oneself, family members, and classmates (1: very low to 4: very high; 5: don't know or not applicable); the responses were firstly recoded into two groups (1: very high/high; 0: else). The Perceived Infection Risk Indicator was then formed by counting the number of '1' (range of 0 to 3). 3) Perceived permanent bodily damage: The item was "COVID-19 will easily cause severe permanent bodily damage" (1: agree; 2: disagree; 3: don't know); the responses were recoded into two groups (1: agree; 0: disagree or don't know). 4) Perceived chance of controlling the COVID-19 epidemic in China: The item was "What is the chance that the COVID-19 epidemic will be controlled in China in the coming six months" (1: definitely yes to 6: definitely no; 7: uncertain); the responses were recoded into two groups (1: definitely yes/very high; 0: else).

Behavioral factors related to COVID-19: 1) Home-staying: One item assessed the total number of hours went out during the 7-day CNY (0/1-4/5-10/11-14/≥15 hours). 2) Close contacts with people who had visited Wuhan: The item was "Have you closely contacted people who had visited Wuhan within the two weeks before CNY?". The response was recoded into two groups (1: yes; 0: no/don't know).

Perceived discrimination: One item assessed the level of perceived discrimination encountered due to COVID-19 (1: very low to 4: very high).

Statistical analysis

The summative score of the PHQ-9 was used as the continuous dependent variable. The associations between the background personal/contextual variables and depression were analyzed by simple regression models; Spearman correlation coefficients were derived to assess the correlations among the studied cognitive/behavioral/psychosocial factors, the potential mediator (i.e., negative psychological responses to COVID-19), and the dependent variable (i.e., depression). Collinearity diagnosis of the above-mentioned independent variables and mediators was conducted by examining the variance inflation factor (VIF); VIF value>5 would suggest existence of collinearity. By using structural equation modeling (SEM) with Maximum Likelihood estimation, the potential mediation/ suppression effects of mental distress due to COVID-19 between the cognitive/behavioral/psychological factors and depression were tested, adjusted for all studied background personal/contextual variables. Three latent variables were created for the SEM analysis: perceived infection risk (derived from the original three items), mental distress due to COVID-19 (derived from the original three items), and depression (derived from three parcels that were randomly grouped from the original nine items). The random parceling approach has been recommended for SEM analysis [40]. Other independent variables were represented by single items. The recommended model fit index included: Comparative Fit Index (CFI) ≥0.90, Normed-fit Index (NFI) ≥0.90, Tucker-Lewis Index (TLI) ≥0.90, and Root Mean Square Error of Approximation (RMSEA) ≤0.08. The SEM was conducted by using AMOS 17.0, while other analyses were performed by using SPSS 21.0. Significant level was defined as two-tailed $p<0.05$.

Results

Descriptive statistics

Descriptive statistics are presented in Table 1. Percentage distributions of cognitive variables are: perceived airborne transmissions (23.4%), perceived high/very high risk of contracting COVID-19 for oneself (11.2%), family members (11.8%), or classmates (18.3%); perceived permanent bodily damage (35.7%); perceived high chance of controlling COVID-19 in China in the coming six months (70.0%). Behaviorally, 49.3% stayed at home all the time during the 7-day CNY period (the modal response); 4.9% reported that they had had close contacts with people having visited Wuhan two weeks prior to the CNY. Regarding the psychosocial factor, 21.5% perceived high/very high levels of discrimination due to COVID-19.

Regarding psychological responses, 47.1% reported high/very high levels of ≥1 type of mental distress: panic (39.8%), anxiety (35.5%) or emotional agitation (33.7%) due to the COVID-19 epidemic; the composite variable of mental distress due to COVID-19

summed up the item scores of these three types of responses; its mean (SD, range) was 6.9 (2.2, 3-12). Furthermore, about 40% of the participants showed mild to severe depression (mild: 24.6%, moderate/severe: 14.5%). The mean (SD, range) of the PHQ-9 score was 4.6 (5.5, 0-27). (see Table 2)

Table 1 Background variables of the participants (n=23,863)

Variables	Percentages (%)
Socio-demographics	
Sex	
Male	31.9
Female	68.1
School-related information	
Grade	
First-year	37.8
Second-year	26.9
Third-year	21.2
Fourth-year	9.6
Fifth-year	2.3
Master or above	2.3
Faculty	
Medicine	45.5
Arts	17.7
Science	16.4
Engineering	7.6
Social science	3.6
Others	9.3
Living arrangement during CNY	
Staying at the university's city	
No	46.6
Yes	53.4
Staying with family	
No	6.5
Yes	93.5
Self-reported physical health status	
Moderate/poor/very poor	20.6
Good/very good	79.4
Information about participants' localities of stay at the time of survey	
Local entry/exit control during CNY ('shutdown')	
No	29.4
Yes	70.6
Number of confirmed COVID-19 cases in the provinces of the localities of stay#	
0-50 cases	20.8
51-150 cases	35.1
151-300 cases	23.4
>300 cases	20.6

Note: #, The number of cumulative confirmed COVID-19 cases refers to the national data reported by the launch day of the present study (i.e., February 1st, 2020).

Table 2 Descriptive statistics of the independent variables, the mediator, and the dependent variable (n=23,863)

Variables	Percentages (%)
Cognitive factors	
Perceived airborne transmission	
No/don't know	76.6
Yes	23.4
Perceived Infection Risk Indicator#	
0	78.7
1	7.7
2	7.2
3	6.4
Perceived permanent bodily damage	
Disagree/don't know	64.3
Agree	35.7
Perceived chance of controlling the epidemic within six months	
Else	30.0
Definitely yes/very high	70.0
Behavioral factors	
Home-staying (Total number of hours going out during CNY)	
≥15 hours	5.4
11-14 hours	5.2
5-10 hours	17.4
1-4 hours	22.7
Nil	49.3
Close contacts with people who had visited Wuhan two weeks before CNY	
No or don't know	95.1
Yes	4.9
Psychosocial factors	
Perceived discrimination due to COVID-19	
Very low	41.9
Low	36.7
High	15.5
Very high	6.0
Mental distress to COVID-19¶ (mean, SD)	6.9, 2.2
0	52.9
1	12.1
2	8.0
3	27.0
Depression (PHQ-9) (mean, SD)	4.6, 5.5
Normal	60.9
Mild	24.6
Moderate/moderately severe/severe	14.5

Notes: #, The Perceived Infection Risk Indicator counted the number of endorsement of "high/very high" for three items about perceived risk of infection for oneself, family members, and classmates; ¶, The indicator counted the

number of endorsement of “high/very high” for three items measuring negative psychological responses to COVID-19; details were described in the Methods of the text.

Associations between background variables and depression

Such associations are presented in Table 3. Females showed more depressive symptoms than males, but the difference did not reach statistical significance (0.05<p<0.10). Several contextual factors were significantly associated with lower risks of depression, including staying at the city of the university, staying with the family, and self-perceived physical health, while the number of confirmed cases (>300 cases) detected in the province where the participants were staying at the time of the survey was positively associated with depression symptoms (i.e., higher scores of PHQ-9). Whether the city had been ‘shut down’ was, however, not associated with depression. The background variables were adjusted for in the SEM analysis.

Table 3 Linear regression analyses on the associations between background variables and depression (n=23,863)

Variables	Depression	
	beta	p
Socio-demographics		
Sex		
Male	-	-
Female	-0.01	0.066
School-related information		
Grade		
First-year	-	-
Second-year	0.02	0.005
Third-year	-0.01	0.110
Fourth-year	-0.01	0.510
Fifth-year	-0.01	0.413
Master or above	0.01	0.404
Faculty		
Medicine	-	-
Arts	0.04	<0.001
Science	0.01	0.041
Engineering	0.01	0.155
Social science	0.02	0.009
Others	-0.01	0.271
Living arrangement during CNY		
Staying at the university’s city		
No	-	-
Yes	-0.02	0.022
Staying with family		
No	-	-
Yes	-0.04	<0.001
Self-reported physical health status		
Moderate/poor/very poor	-	-
Good/very good	-0.28	<0.001
Information about participants’ localities of stay at the time of survey		

Local entry/exit control during CNY ('shutdown')		
No	-	-
Yes	-0.01	0.845
Number of confirmed COVID-19 cases in the provinces of the localities of stay#		
0-50 cases	-	-
51-150 cases	0.01	0.480
151-300 cases	0.01	0.040
>300 cases	0.03	<0.001

Note: #, The number of cumulative confirmed COVID-19 cases refers to the national data reported by the launch day of the present study (i.e., February 1st, 2020).

The mediation analysis

Correlations among variables

A number of variables were positively correlated with depression, including: Perceived Infection Risk Indicator (r=0.11, p<0.001), having close contacts with people who had visited Wuhan two weeks prior to CNY (r=0.05, p<0.001), perceived discrimination due to COVID-19 (r=0.14, p<0.001), and mental distress due to COVID-19 (r=0.25, p<0.001). Some variables were negatively correlated with depression, including perceived chance of putting the epidemic under control in China within six months (r=-0.13, p<0.001) and home-staying (r=-0.08, p<0.001). Perceived airborne transmission (r=-0.01, p=0.286) and perceived permanent bodily damage (r=0.01, p=0.442) were NOT significantly associated with depression; mediation analyses were hence not performed for these two associations. (see Table 4)

Table 4 Spearman correlations among the independent variables, the mediator, and depression (n=23,863)

Variables	Depression	
	r	p
Cognitive factors		
Perceived airborne transmission	-0.01	0.286
Perceived Infection Risk Indicator	0.11	<0.001
Perceived permanent bodily damage	0.01	0.442
Perceived chance of controlling the epidemic within six months	-0.13	<0.001
Behavioral factors		
Home-staying	-0.08	<0.001
Close contacts with people who had visited Wuhan two weeks before CNY	0.05	<0.001
Psychosocial factors		
Perceived discrimination due to COVID-19	0.14	<0.001
Mediating variables		
Mental distress due to COVID-19 (the summative score)	0.25	<0.001

Note: Please refer to the footnote of Table 2 for the description of variables.

Testing mediation/suppression effects of negative psychological responses between the studied factors and depression

The SEM model's fit index was satisfactory (CFI: 0.95; NFI: 0.94; TLI: 0.94; RMSEA: 0.04); the range of factor loadings for the three latent variables was 0.70-0.97 (all p<0.001). No collinearity was detected with the VIF values of all studied variables ranging from 1.00 to 1.37 (VIF>5 indicates the existence of collinearity). In Figure 1, mental distress due to COVID-19 partially mediated or suppressed the association: i) between perceived infection risk and depression (mediation effect size=27.4%, p of Sobel test<0.001), ii) between perceived discrimination and depression (mediation effect size=79.5%, p of Sobel test<0.001), iii) between perceived chance of epidemic control and depression (suppression effect size=6.0%, p of Sobel test<0.001), and iv) between home-staying behavior and depression (suppression effect size=9.8%, p of Sobel test<0.001). The non-significant mediator was close contacts with people who had visited Wuhan; p of Sobel test=0.318). The beta values are shown in Figure 1.

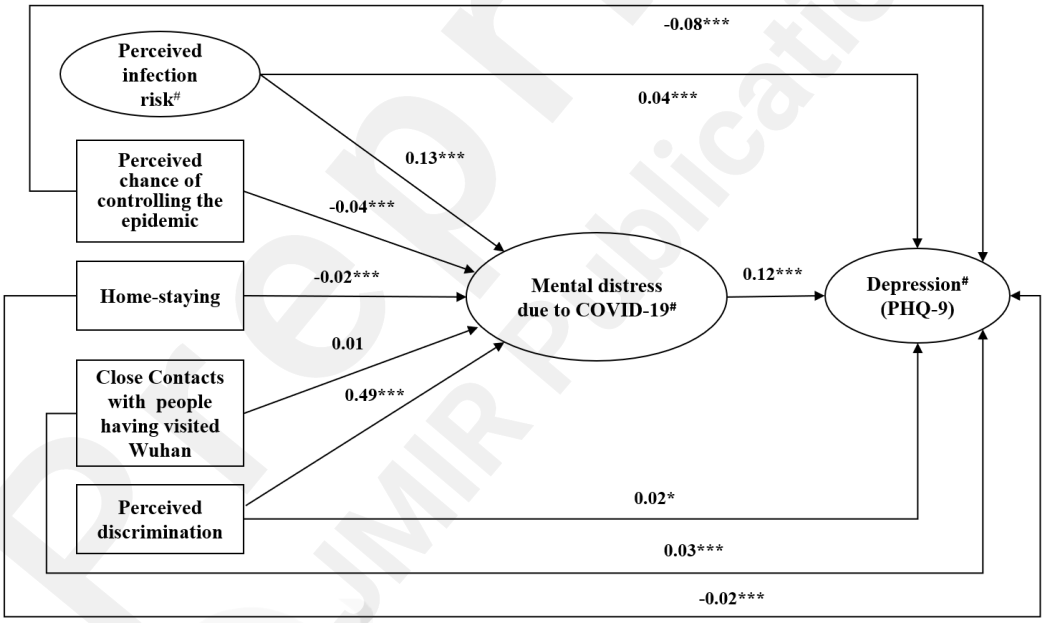

Figure 1 The mediation effect of mental distress due to COVID-19 on the associations between the independent variables and depression (Notes: The SEM model was adjusted for background variables, including sex, school-related information, living arrangement during CNY, self-reported physical health status, and information about participants' localities of stay at the time of survey; #, latent variables, details are described in the Methods of the text; *, p<0.05; **, p<0.01; ***, p<0.001).

Discussion

The present population-based study that covered 26 universities of 16 cities of 13 provinces in China revealed a relatively high level of depressive symptoms among university students during the very initial phase of the COVID-19 outbreak in China (10-

20 days since official recognition of the person-to-person transmission property of COVID-19). This study identified a number of significant COVID-19-related cognitive (i.e., perceived infection risk and perceived controllability of the epidemic), behavioral (i.e., home-staying behavior and close contacts with people from Wuhan), and psychosocial (i.e., perceived discrimination) factors of both mental distress due to COVID-19 and depressive symptoms; non-significant factors included perceived airborne transmission and perceived permanent bodily damage. As expected, mental distress due to COVID-19 was significantly and positively associated with depressive symptoms; it further mediated the associations between some of the cognitive/behavioral/psychosocial factors and depressive symptoms. The findings present a rough snapshot of what happened in the country and shed lights on how people may react emotionally to new emerging infectious diseases, and how various types of responses (e.g., cognitive and behavioral responses) would be associated with such emotional responses.

The devastating COVID-19 pandemic has affected people's mental health. The findings reveal prevalent mild-to-severe depression of 40%, according to PHQ-9, among university students in China. The prevalence obtained from studies among university students in China prior to the COVID-19 period seemed lower, (e.g., 23.8% among Chinese university students reported in a meta-analysis [41] and 29.5% reported during SARS among Chinese university students [42]), but such prevalence was not exactly comparable as different tools and sampling methods were used. Three of the four Chinese university student studies conducted during a similar time period also used PHQ-9. The two of which conducted in Guangzhou [12] and 29 Chinese provinces [15] presented prevalence of moderate to severe depression (PHQ-9≥10) of 7.7% and 23.3%, respectively, compared to the 14.5% of this study, hence denoting geographical variations in addition to differences in sampling methods. The present study has the strength that it was population-based and had a class-based sampling frame, while the others were distributed conveniently online. [43]

All in all, depressive symptoms were prevalent among university students at the very initial phase of the COVID-19 outbreak in china, which can also be seen from the high levels of self-reported mental distress directly attributed to COVID-19, which is understandable as uncertainties and the Wuhan lockdown were alarming and worrisome. Furthermore, mental distress due to COVID-19 was positively associated with depressive symptoms. Thus, the mental distress directly attributed to COVID-19 might have increased the already high level of depression among university students during the initial phase of the epidemic in China. As mental distress and depression affect preventive behaviors [10] and individual well-being [44], and acute stress may turn into chronic depression [45] [46], health care workers need to integrate mental health promotion with prevention of COVID-19 at initial stages of outbreaks of new emerging infectious diseases.

The context of the study was unique and relevant as it was conducted during the CNY and soon after the first outbreak/lockdown in Wuhan. It is seen that students who stayed at the 'university's cities' and with family members were less likely than others to be depressed. They might have received better support from their significant others, while social support and coping resources are protective against mental health problems [47] [48]. The perceived number of confirmed cases in the 'province of stay' was positively associated with depression; it is plausible that the perception might increase perceived

susceptibility and perceived severity of the epidemic and thus depression. It is interesting that travel restriction of entering/exiting from the city of stay, which was then a 'new' preventive measure, was not significantly associated with depression. The findings suggest that such drastic restriction, if implemented orderly and with good support, does not necessarily cause substantial panic or negative impacts on mental distress. A number of countries implemented even more severe lockdowns (e.g., banning going out) soon after the completion of this study (e.g., Italy), which was followed by many countries (e.g., parts of the U.K., France, and Australia). In some countries, the strict social distancing measures were associated with depression [28 49]. Future studies should review this 'new' measure and identify ways to minimize its adverse mental health effects. The study hence documented very initial responses to preliminary lockdown measures in the COVID-19 pandemic.

The study has interesting findings that involve interpretations in the context of the initial outbreak, and in comparisons with other studies. Spearman analysis and the SEM showed that some COVID-19-related cognitions (perceived chance of controlling COVID-19 and perceived risks of infection) were significantly associated with both mental distress due to COVID-19 and depressive symptoms; such findings corroborate other studies [16 21-24]. However, it is unexpected that perceived bodily damages (a reflection of perceived severity) and perceived airborne transmission (possibly a misconception) were not significantly correlated with mental distress due to COVID-19 and depression, while such correlations were significant in similar H1N1 research [8 9]. It is plausible that the study was conducted in the very early pre-pandemic phase of the COVID-19 when no clear information was given about long-term harms and modes of transmission of COVID-19.

The behavioral factors of self-reported mental distress due to COVID-19 and depressive symptoms also illustrated the uniqueness of the study. The duration of staying at home during the CNY was protective against depression, which has not been reported in the global literature (except one general population study found a non-significant result [16]). However, other studies have reported positive associations between social distancing and isolation/depression [28 49]. It has some special implications as there were then no clear and strict social distancing policies in China (except in Wuhan) and people could leave home without facing penalties. The government, however, pledged for national support to contain COVID-19; home-staying during the CNY hence might involve altruism and social responsibility, which were negatively associated with depression [50]. People may also feel safer at home. Thus, a short period of staying at home (during the 7-day holidays) during the very initial outbreak period of a new emerging infectious disease may not cause mental distress but was instead, protective. It seems that social distancing policies need to be exercised as early as possible during new outbreaks of important emerging infectious diseases to increase effectiveness and minimize distress. Second, we found that close contacts with people coming from Wuhan people was a risk factor of depression. To our knowledge, no study has looked at this variable, although other studies looked at visits to Wuhan (e.g., [14]). The finding has important implications as Wuhan was the epicenter where the first outbreak occurred, and the virus was spread to other regions. The variable became non-significant in the SEM, possibly because of controlling for a potential confounder of perceived discrimination (see below).

The study also investigated the psychosocial factor of perceived discrimination.

Over half (58.1%) of the participants perceived discrimination related to COVID-19, possibly because of their traveler status. Associations between perceived discrimination and depression was similarly reported in previous studies related to SARS/H1N1 [8 9 51]. In fact, the association with depression was the strongest one among all the studied factors of this study. Thus, university students may feel more depressed during the COVID-19 epidemic, not only because of related perceived susceptibility and severity, but also the way being treated by others. To our knowledge, only one Canadian general population study had looked at such an association but found a non-significant finding [17]. The situation in China was unique. The country faced strong international pressure during the study period; Wuhan was accused of being spreading the disease to other regions. Indeed, COVID-19 was initially labelled as the 'Wuhan virus'. Travelers might be regarded as potential carriers of the virus; discrimination found a fertile ground to grow and might have a powerful negative effect on mental distress. It is imperative to investigate whether perceived discrimination related to epicenters has caused mental distress in the later phase of the pandemic. For instance, there were over 22 million detected cases in the U.S. as of January 10th, 2021, and a new viral strain of higher infectivity was found in the U.K. where the incidence of COVID-19 is soaring. The level of perceived discrimination and its association with depression might be country specific due to politicization. When facing outbreaks of new emerging infectious diseases in the future, stigma needs to be removed from the location of the outbreak. The effects of the generalized perceived discrimination need to be investigated.

This is one of the few studies that looked at the mechanisms behind the associations between COVID-19-related factors and depression during the COVID-19 period. The findings suggest that COVID-19-related cognitive/behavioral/psychosocial factors and mental distress directly attributed to COVID-19 were all associated with depression, while the relationships between some of the COVID-19 cognitive/behavioral/psychosocial factors and depression may be partially mediated/suppressed through mental distress due to COVID-19. Specifically, perceived risk and perceived discrimination may have indirect effect on depression via mental distress due to COVID-19; such risk factors might have increased mental distress due to COVID-19, which would in turn increase risk of depression. In addition, confidence in controlling the epidemic and home-staying could potentially be protective against depression via reduction of mental distress due to COVID-19, which was in turn positively associated with depression. Interventions to improve these cognitions/preventive behaviors may thus reduce depression directly or via reduction of mental distress due to COVID-19. Moreover, the mediation and suppression model presented in Figure 1 are being supported by the CSM theory [37], which suggests that diseases (COVID-19 in this case) as stimuli, trigger off cognitive representations (perceptions related to COVID-19) and emotional representations (negative psychological responses to COVID-19). The two types of responses would in parallel determine the coping process and health outcomes (depression in this case). Also, the theory postulates that the cognitive responses would have an effect on the emotional responses. The findings and the model suggest that both cognitive and emotional outcomes are important in jointly determining mental distress during the COVID-19 period. No study has tested the contention. Future longitudinal studies are warranted to

test the full CSM in the context of the COVID-19 epidemic.[8 9 51]

The study has the strength of covering a large number of university students who were staying in most of the provinces in China. The data thus presents a crude 'national' scenario. The study has some limitations. Firstly, it did not have a national coverage. Selection bias may exist, as classes and departments were not randomly selected. Secondly, we did not cover important inter-personal factors (e.g., subjective norms and social support), which were associated with many health-related behaviors.[52 53] Thirdly, the relatively mild magnitudes of some mediation/suppression effects of mental distress due to COVID-19 imply existence of other unstudied mechanisms. Lastly, the cross-sectional study design does not allow for causal inferences, as depression may also change perceptions. Longitudinal studies are needed to confirm the contentions.

Conclusions

The findings suggest that mental distress due to COVID-19 and depression were prevalent among university students in China during the very initial COVID-19 outbreak period. The former may have further increased the prevalence of the latter. Various cognitive, behavioral, and psychosocial responses to COVID-19 showed both direct and indirect effects (via mental distress due to COVID-19) on depression. Thus, interventions to improve such multi-dimensional factors might reduce mental distress during the initial COVID-19 outbreak period. The associations between some of the studied factors and depression may change over time as more information and experiences were obtained by the public, signifying of early investigation of community responses to avoid mental distress, which would be spilled over to later phases and affect prevention behaviors. Some of the findings may shed light on handling new emerging infectious diseases that occur in the future. It is important to validate the findings in general and specific populations in China and in other countries.

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Conflicts of Interest

None declared.

Abbreviations

COVID-19: Coronavirus disease 2019
CNY: Chinese Lunar New Year
SARS: Severe acute respiratory syndrome
H1N1: The 2009 novel influenza A
CSM: The Common Sense Model
SD: Standard deviation
PHQ-9: The 9-item Patient Health Questionnaire
SEM: Structural equation modeling
CFI: Comparative Fit Index
NFI: Normed-fit Index
TLI: Tucker-Lewis Index
RMSEA: Root Mean Square Error of Approximation

References

1. Zhou P, Yang X-L, Wang X-G, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature* 2020:1-4. doi: 10.1038/s41586-020-2012-7
2. World Health Organization. WHO Timeline- COVID-19. https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19. accessed on May 7, 2020. 2020
3. World Health Organization. Coronavirus disease (COVID-19) Weekly Epidemiological Update and Weekly Operational Update. 2020
4. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report-95, 2020.
5. State Council of the People's Republic of China. Prevention and control of COVID-19 http://www.gov.cn/fuwu/zt/yqfwzq/gdfk.htm#62020 [
6. Jalloh MF, Li W, Bunnell RE, et al. Impact of Ebola experiences and risk perceptions on mental health in Sierra Leone, July 2015. *BMJ Global Health* 2018;3(2):e000471. doi: 10.1136/bmjgh-2017-000471
7. Wu P, Fang Y, Guan Z, et al. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. *The Canadian Journal of Psychiatry* 2009;54(5):302-11.
8. Gu J, Zhong Y, Hao Y, et al. Preventive Behaviors and Mental Distress in Response to H1N1 Among University Students in Guangzhou, China. *Asia Pac J Public Health* 2015;27(2):NP1867-NP79. doi: 10.1177/1010539512443699
9. Lau JT, Griffiths S, Choi KC, et al. Avoidance behaviors and negative psychological responses in the general population in the initial stage of the H1N1 pandemic in Hong Kong. *BMC Infect Dis* 2010;10(1):139.
10. Cowling BJ, Ng DM, Ip DK, et al. Community psychological and behavioral responses through the first wave of the 2009 influenza A (H1N1) pandemic in Hong Kong. *The Journal of infectious diseases* 2010;202(6):867-76.
11. Lau H, Khosrawipour V, Kocbach P, et al. The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. *J Travel Med* 2020:taaa037.
12. Chen R-n, Liang S-w, Peng Y, et al. Mental health status and change in living rhythms among college students in China during the COVID-19 pandemic: A large-scale survey. *J Psychosom Res* 2020;137:110219.
13. Chi X, Becker B, Yu Q, et al. Prevalence and psychosocial correlates of mental health outcomes among chinese college students during the coronavirus disease (covid-19) pandemic. *Frontiers in psychiatry* 2020;11:803.
14. Wang Z-H, Yang H-L, Yang Y-Q, et al. Prevalence of anxiety and depression symptom, and the demands for psychological knowledge and

interventions in college students during COVID-19 epidemic: A large cross-sectional study. *J Affect Disord* 2020;275:188-93.
15. Xiao H, Shu W, Li M, et al. Social distancing among Medical students during the 2019 Coronavirus disease pandemic in China: Disease awareness, anxiety disorder, depression, and behavioral activities. *Int J Environ Res Public Health* 2020;17(14):5047.
16. Wang C, Pan R, Wan X, et al. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav Immun* 2020
17. Miconi D, Li ZY, Frounfelker RL, et al. Ethno-cultural disparities in mental health during the COVID-19 pandemic: a cross-sectional study on the impact of exposure to the virus and COVID-19-related discrimination and stigma on mental health across ethno-cultural groups in Quebec (Canada). *BJPsych Open* 2021;7:e14.
18. Chen B, Sun J, Feng Y. How have COVID-19 isolation policies affected young people's mental health?–evidence from chinese college students. *Front Psychol* 2020;11
19. Ning L, Niu J, Bi X, et al. The impacts of knowledge, risk perception, emotion and information on citizens' protective behaviors during the outbreak of COVID-19: a cross-sectional study in China. *BMC Public Health* 2020;20(1):1-12.
20. Ye Y, Wang R, Feng D, et al. The recommended and excessive preventive behaviors during the COVID-19 pandemic: a community-based online survey in China. *Int J Environ Res Public Health* 2020;17(19):6953.
21. Ding Y, Xu J, Huang S, et al. Risk perception and depression in public health crises: Evidence from the COVID-19 crisis in China. *Int J Environ Res Public Health* 2020;17(16):5728.
22. Kim AW, Nyengerai T, Mendenhall E. Evaluating the mental health impacts of the COVID-19 pandemic: perceived risk of COVID-19 infection and childhood trauma predict adult depressive symptoms in urban South Africa. *Psychol Med* 2020:1-13.
23. Olagoke AA, Olagoke OO, Hughes AM. Exposure to coronavirus news on mainstream media: The role of risk perceptions and depression. *Br J Health Psychol* 2020:e12427.
24. Bressington DT, Cheung TCC, Lam SC, et al. Association Between Depression, Health Beliefs, and Face Mask Use During the COVID-19 Pandemic. *Frontiers in psychiatry* 2020;11
25. Peters G-JY, Ruiter RA, Kok G. Threatening communication: a critical re-analysis and a revised meta-analytic test of fear appeal theory. *Health Psychol Rev* 2013;7(sup1):S8-S31.
26. Xin M, Luo S, She R, et al. Negative cognitive and psychological correlates of mandatory quarantine during the initial COVID-19 outbreak in China. *Am*

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27. Marroquín B, Vine V, Morgan R. Mental health during the COVID-19 pandemic: Effects of stay-at-home policies, social distancing behavior, and social resources. *Psychiatry Res* 2020;293:113419.
28. Abel T, McQueen D. The COVID-19 pandemic calls for spatial distancing and social closeness: not for social distancing. *Int J Public Health* 2020;65:231.
29. Bryan C, Bryan AO, Baker JC. Associations among state-level physical distancing measures and suicidal thoughts and behaviors among US adults during the early COVID-19 pandemic. 2020
30. Finch BK, Kolody B, Vega WA. Perceived discrimination and depression among Mexican-origin adults in California. *J Health Soc Behav* 2000:295-313.
31. Peng EY-C, Lee M-B, Tsai S-T, et al. Population-based post-crisis psychological distress: an example from the SARS outbreak in Taiwan. *J Formos Med Assoc* 2010;109(7):524-32.
32. Person B, Sy F, Holton K, et al. Fear and stigma: the epidemic within the SARS outbreak. *Emerg Infect Dis* 2004;10(2):358.
33. National Health Commision of the People's Republic of China. Statistic update for COVID-19 on March 4, 2020 http://www.nhc.gov.cn/xcs/yqtb/202003/6e02433f7786402d8ea162fb5b80b5a0.shtml2020 [
34. Hubei Provincial Goverment. The fifth news press about the prevention and control of COVID-19 https://www.hubei.gov.cn/hbfb/xwfbh/202001/t20200127_2015320.shtml2020 [
35. Lau JT, Yang X, Tsui H, et al. Positive mental health-related impacts of the SARS epidemic on the general public in Hong Kong and their associations with other negative impacts. *J Infect* 2006;53(2):114-24.
36. Yeung NC, Lau JT, Choi KC, et al. Population responses during the pandemic phase of the influenza A (H1N1) pdm09 Epidemic, Hong Kong, China. *Emerg Infect Dis* 2017;23(5):813-15.
37. Diefenbach MA, Leventhal H. The common-sense model of illness representation: Theoretical and practical considerations. *Journal of social distress and the homeless* 1996;5(1):11-38.
38. Moss-Morris R, Weinman J, Petrie K, et al. The revised illness perception questionnaire (IPQ-R). *Psychology and health* 2002;17(1):1-16.
39. Zhang YL, Liang W, Chen ZM, et al. Validity and reliability of Patient Health Questionnaire-9 and Patient Health Questionnaire-2 to screen for depression among college students in China. *Asia-Pacific Psychiatry* 2013;5(4):268-75.
40. Matsunaga M. Item parceling in structural equation modeling: A primer. *Communication Methods and Measures* 2008;2(4):260-93.

41. Lei X-Y, Xiao L-M, Liu Y-N, et al. Prevalence of depression among Chinese University students: a meta-analysis. *PLoS One* 2016;11(4):e0153454.
42. Yueqin H, Weimin D, Zhaorui L. Psychosocial Aspects in Three Universities during SARS Epidemic in Beijing. *Chinese Mental Health Journal* 2003;17(8):521-23.
43. Wu KK, Chan SK, Ma TM. Posttraumatic stress, anxiety, and depression in survivors of severe acute respiratory syndrome (SARS). *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies* 2005;18(1):39-42.
44. Beekman AT, Penninx BW, Deeg DJ, et al. The impact of depression on the well-being, disability and use of services in older adults: a longitudinal perspective. *Acta Psychiatr Scand* 2002;105(1):20-27.
45. Kendler KS, Karkowski LM, Prescott CA. Causal relationship between stressful life events and the onset of major depression. *Am J Psychiatry* 1999;156(6):837-41.
46. Bogdan R, Pizzagalli DA. Acute stress reduces reward responsiveness: implications for depression. *Biol Psychiatry* 2006;60(10):1147-54.
47. Brown GW, Andrews B, Harris T, et al. Social support, self-esteem and depression. *Psychol Med* 1986;16(4):813-31.
48. Swindle RW, Cronkite RC, Moos RH. Life stressors, social resources, coping, and the 4-year course of unipolar depression. *J Abnorm Psychol* 1989;98(4):468-77.
49. The U.S. Centers for Disease Control and Prevention. Coping with stress. Available at: https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/managing-stress-anxiety.html. Accesedd on June 26, 2020. 2020
50. Post SG. Altruism, happiness, and health: It's good to be good. *Int J Behav Med* 2005;12(2):66-77.
51. Leppin A, Aro AR. Risk perceptions related to SARS and avian influenza: theoretical foundations of current empirical research. *Int J Behav Med* 2009;16(1):7-29.
52. Allgöwer A, Wardle J, Steptoe A. Depressive symptoms, social support, and personal health behaviors in young men and women. *Health Psychol* 2001;20(3):223.
53. Cheng C, Ng AK. Psychosocial factors predicting SARS-preventive behaviors in four major SARS-affected regions. *J Appl Soc Psychol* 2006;36(1):222-47.

Supplementary Files

Figures