

Internet Addiction Increases in the General Population During COVID-19: Evidence From China

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Background and Objectives: COVID-19-related quarantine and stress have likely escalated the crisis of Internet addiction. This study aimed to determine the impact of the COVID-19 pandemic on Internet use and related risk factors among the general public in China.

Methods: A large-sample cross-sectional online survey was conducted from March 24 to April 30, 2020, in China, and 20,472 participants completed the survey. We investigated the prevalence and severity of Internet addiction based on the Internet Addiction Test (IAT), and explored the risk factors related to increases in time spent on Internet use and severity of Internet addiction, as well as severe Internet addiction.

Results: The overall prevalence of Internet addiction was 36.7% among the general population during the pandemic, and that of severe Internet addiction was 2.8%, according to IAT scores. Time spent on recreational Internet use had significantly increased during the pandemic, and almost half of participants reported increases in the severity of Internet addiction. Risk factors for increases in time spent on Internet use and severity of Internet addiction and severe Internet addiction included having fewer social supporters, perceiving pressure and impact on mental health status due to COVID-19, and being over-engaged in playing videogames.

Discussion and Conclusions: The COVID-19 pandemic adversely impacted Internet use and increased the prevalence and severity of Internet addiction among the general population in China, especially in vulnerable populations.

Scientific Significance: This study provides evidence for policymakers to refine public health policies to control the pandemic and make efforts to provide population-specific prevention and interventions for people at risk of developing Internet addiction. (*Am J Addict* 2021;30:389–397)

INTRODUCTION

The Internet brings a wide variety of information and provides a convenient platform for communication, and Internet use has grown significantly in the recent two decades.¹ As of March 2020, approximately 4.57 billion people worldwide were using the Internet, with around one million new users daily.² However, excessive or unlimited use can lead to Internet addiction, also termed “problematic Internet use” or “pathological Internet use,” which can result in marked distress and functional impairments in daily life, and have comorbid psychiatric disorders, including substance abuse, attention deficit and hyperactivity disorder, and depression.^{3,4} Internet addiction has become a serious issue for mental health in many countries, including China (16.4%), South Korea (20%), and other parts of Asia, such as Vietnam (21.2%) and Philippines (21%), and its prevalence is evolving in America and Western European countries.⁵⁻⁸

The COVID-19 pandemic has had unprecedented social, economic, and healthcare impacts and induced widespread psychological problems, and relatively high rates of symptoms of anxiety (6.33%-50.9%), depression (14.6%-48.3%), and posttraumatic stress disorder (7%-53.8%) were

Received October 16, 2020; revised January 3, 2021; accepted January 26, 2021.

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reported in the general population during the COVID-19 pandemic.⁹⁻¹² These trauma-related emotional responses are risk factors for the development of addictive behaviors and relapse, including substance and behavioral addictions.¹³ Disasters, such as massive accident disasters and economic crises, have increased rates of Internet addiction, especially among adolescents.^{14,15} When exposed to stressful or traumatic events, adolescents who have dysfunctional coping abilities are more prone to develop Internet addiction.¹⁶ Social isolation strategies for controlling the pandemic also may lead to increased Internet use and pose risks for vulnerable people to greatly increase their Internet use and develop addiction.¹⁷

Thus, since the COVID-19 pandemic may have increased the risk for Internet addiction, we conducted an online survey to address the prevalence of Internet addiction among the general public during the pandemic and find the risk factors for increases in Internet addiction in China.

METHODS

Participants and Procedure

Individuals aged 15 years or above were recruited online to complete a self-report questionnaire from March 24 to April 30, 2020. Questionnaires were delivered via the website of JD.com (one of the most popular e-commerce websites in China), WeChat (a commonly used messaging and calling application in China), and Microblog (a popular social networking service in China). A convenience sampling method was used to collect data from all 34 province-level regions in China. We totally recruited 24,402 participants in the survey and excluded 95 participants younger than 15 years old. We minimized subjects making repeated responses by limiting each account to a single questionnaire response and excluded 1632 duplicated responses by checking contact information. Furthermore, 2298 questionnaires with answers that did not correspond to the questions and contained apparently conflicting answers were excluded, leaving 20,472 participants available for final analysis. The Institutional Review Board of Peking University Health Science Center approved the study. Participants were recruited on a voluntary basis, informed consents were received online before the respondents answered the questionnaire, and confidentiality of data was ensured.

Measures

The participants answered questions about demographic characteristics, Internet use and substance use characteristics, mental health status and living conditions during the pandemic, as well as COVID-19 infection.

Demographic Characteristics

We collected information about gender, age, education level, occupation, and monthly family income, as well as parenting style (democratic, authoritarian, permissive, and uninvolved parenting style), number of social supporters, family relationships during childhood, negative life events, and

coping ability. We assessed personality attributes using five questions involving extroversion, openness, agreeableness, conscientiousness, and neuroticism.¹⁸ Each item used a 4-point Likert scale ranging from 0 (do not fit this attribute at all) to 4 (strongly fit this attribute), and a higher score indicated a better fit for the personality attribute.

Internet Use Characteristics

We asked the participants about their total time spent on Internet use and time spent on recreational Internet use before and after the outbreak of COVID-19 in the questionnaire, so we have both the present data and the recalled pre-pandemic data, and could judge whether their time spent on Internet use increased during the pandemic. Their main varieties of online activities during the pandemic were also collected. We assessed Internet addiction during the pandemic with the Chinese version of the Internet Addiction Test (IAT), the most widely used questionnaire for the assessment of Internet addiction.¹⁹ IAT includes 20 items on 5-point Likert scales and has good psychometric properties. The score ranges from 0 to 100, with the severity of Internet addiction categorized as normal (0-30), mild (31-49), moderate (50-79), and severe (80-100). We used the IAT scores to establish the prevalence of Internet addiction, and we also asked about changes in the severity of Internet addiction compared with that before the pandemic. Furthermore, we investigated risk factors for increases in time spent on Internet use and severity of Internet addiction before and after the outbreak of COVID-19, as well as severe Internet addiction.

Other Pandemic-Related Situations

This section included perceived pressure and impact on mental health status due to the COVID-19, place of residence, number of cohabitants, living space, and satisfaction with living conditions during the pandemic. We assessed symptoms of depression and anxiety during the pandemic with the 9-item Patient's Health Questionnaire (PHQ-9) and the 7-item Generalized Anxiety Disorder (GAD-7) scales. All items were scored on a 4-point Likert scale, ranging from 0 (not at all) to 3 (nearly every day). We used the cutoff scores of 10 for the PHQ-9 and 10 for the GAD-7 to indicate significant depression and anxiety.^{20,21} We also asked about smoking and drinking behaviors, and surveyed whether they were infected with COVID-19, had close contacts with people infected, and participated in rescues (ie, working on emergency medical response or treatment teams).

Statistical Analysis

We used descriptive statistics for all variables with mean, standard deviation, counts, and percentages. We used the Wilcoxon matched-pairs signed ranks test to measure changes in time spent on Internet use before and after the outbreak of COVID-19. Multivariable logistic regression analyses (forward LR) were used to assess related factors for increases in time spent on Internet use and severity of Internet addiction, and severe Internet addiction. Some (14,374)

participants reported their infectious status, and we used the χ^2 test for association between the increased use time/enhanced severity of Internet addiction/severe Internet addiction and COVID-19 infection-related factors. We statistically analyzed data using SPSS24.0 with $P < .05$ set as significant.

RESULTS

Demographic Characteristics

We collected 20,472 valid questionnaires (male/female: 43.5%/56.5%, age: 33.63 ± 9.53) during the pandemic, including 5.2% Hubei residents and 12.5% students. More than half of the participants (57.5%) were less than 35 years old, 54.4% had some college education, 38.4% reported lack of social support and 11.7% perceived family disharmony in childhood. Some participants had experienced negative life events (33.2%). In terms of personality attributes, people scored higher on extraverted personality (2.80 ± 0.83) and lower on neuroticism personality (1.93 ± 0.84).

During the pandemic, 12.0% of participants smoked, 33.5% drank alcohol, 20.2% had depression symptoms, and 13.8% had anxiety symptoms. A small proportion (6.2%) of participants reported a severe effect of COVID-19 on their mental health, 15.7% perceived big pressure, and 19.3% were dissatisfied with their living conditions during the pandemic. Only 0.3% of participants reported infection with COVID-19 or had close contacts with people infected (Table 1).

Internet Use Characteristics During the COVID-19 Pandemic

The Internet was mostly used for chatting or communication (44.1%) and playing videogames (8.8%). The overall prevalence of Internet addiction was 36.7%, and that of moderate and severe addiction was 33.9% and 2.8%, according to the IAT. Almost half of the participants (43.8%) reported increases in the severity of Internet addiction (Table 1). Time spent on recreational Internet use and total time spent on Internet use had significantly increased during the pandemic compared with that before the pandemic ($P < .001$) (Table 2).

Factors Associated With Increased Time Spent on Internet Use During the Pandemic

More time spent on recreational Internet use was associated with being a student (odds ratio [OR] = 1.19, 95% confidence interval [CI] = 1.01-1.41), having fewer social supporters (OR = 1.13, 95% CI = 1.01-1.18), and experience of negative life events (OR = 1.14, 95% CI = 1.04-1.24). Pandemic-related variables significantly associated with increased recreational Internet use included infection with COVID-19 or close contacts with people infected ($P = .016$), living in Hubei Province (OR = 1.59, 95% CI = 1.30-1.94), occasional smoking (OR = 1.23, 95% CI = 1.03-1.47), and perceived impact on mental health status due to the COVID-19 (OR = 2.79, 95% CI = 2.33-3.34).

Engaging mainly in playing videogames (OR = 1.42, 95% CI = 1.23-1.63), and having moderate (OR = 1.74, 95% CI = 1.59-1.90) or severe (OR = 2.48, 95% CI = 2.01-3.06) Internet addiction assessed by the IAT were also risk factors for increased time spent on recreational Internet use. Satisfaction with living conditions during the pandemic was a protective factor for increased recreational Internet use (OR = 0.89, 95% CI = 0.79-0.99) (Table 1). Increases in total time spent on Internet use were significantly associated with living in Hubei Province, being students, perceived pressure and impact of the pandemic on mental health, dissatisfaction with living conditions, and playing videogames online.

Factors Associated With Increased Severity of Internet Addiction During the Pandemic

Risk factors for increases in the severity of Internet addiction included being female (OR = 1.17, 95% CI = 1.09-1.26), being a student (OR = 1.20, 95% CI = 1.05-1.38), and having fewer social supporters (OR = 1.12, 95% CI = 1.03-1.21). Pandemic-related variables significantly associated with increased severity of Internet addiction included infection with COVID-19 or close contacts with people infected ($P = .001$), living in Hubei Province (OR = 1.44, 95% CI = 1.21-1.73), alcohol drinking (OR = 1.35, 95% CI = 1.12-1.62), depression symptoms (OR = 1.23, 95% CI = 1.13-1.35), perceived impact on mental health status (OR = 2.73, 95% CI = 2.32-3.22), and living with 3 or more cohabitants (OR = 1.10, 95% CI = 1.02-1.19). Satisfaction with living conditions during the pandemic was a protective factor for increased severity of Internet addiction (OR = 0.81, 95% CI = 0.74-0.88). Increases in the severity of Internet addiction were also associated with engaging mainly in playing videogames (OR = 1.15, 95% CI = 1.03-1.29), and having moderate (OR = 2.90, 95% CI = 2.70-3.11) or severe (OR = 5.40, 95% CI = 4.38-6.65) Internet addiction according to the IAT (Table 1).

Factors Associated With Severe Internet Addiction During the Pandemic

Risk factors for severe Internet addiction included fewer social supporters (OR = 1.45, 95% CI = 1.10-1.91), neuroticism personality (OR = 1.48, 95% CI = 1.33-1.65), symptoms of depression (OR = 3.17, 95% CI = 2.44-4.11) and anxiety (OR = 1.43, 95% CI = 1.11-1.84), severe effect of COVID-19 on mental health (OR = 1.99, 95% CI = 1.43-2.77), and playing videogames online (OR = 1.75, 95% CI = 1.38-2.22). Age over 45 (OR = 0.51, 95% CI = 0.34-0.76) was a protective factor for severe Internet addiction.

DISCUSSION

This study provides evidence of the adverse effects of the COVID-19 pandemic on Internet use and related risk factors. The prevalence of Internet addiction among the general population in China during the COVID-19 pandemic was remarkably high, with more than one-third of subjects

TABLE 1. Characteristics of participants and factors associated with increased time spent on recreational Internet use and severity of Internet addiction during the pandemic

Variables	N (%) / M ± SD	Factors associated with increased time spent on recreational use		Factors associated with increased severity of Internet addiction	
		Adjusted OR (95% CI) ^a /χ ²	P value	Adjusted OR (95% CI) ^a /χ ²	P value
Gender					
• Male	8902 (43.5)	*	*	1 [Reference]	–
• Female	11,570 (56.5)	*	*	1.17 (1.09-1.26)	<.001
Age					
• 15-24 years	3683 (18.1)	1 [Reference]	–	1 [Reference]	–
• 25-34 years	8076 (39.4)	0.93 (0.80-1.08)	.315	0.97 (0.87-1.09)	.646
• 35-44 years	5944 (29.0)	1.02 (0.87-1.20)	.784	0.98 (0.86-1.10)	.692
• ≥45 years	2770 (13.5)	1.20 (1.00-1.44)	.049	1.19 (1.04-1.37)	.001
Location					
• Non-Hubei	19,421 (94.8)	1 [Reference]	–	1 [Reference]	–
• Hubei (non-Wuhan)	629 (3.1)	1.59 (1.30-1.94)	<.001	1.44 (1.21-1.73)	<.001
• Wuhan	422 (2.1)	1.20 (0.93-1.56)	.157	1.18 (0.95-1.46)	.128
Education					
• Lower than junior college	9336 (45.6)	1 [Reference]	–	1 [Reference]	–
• Junior college and college	9277 (45.3)	1.11 (1.01-1.22)	.031	1.15 (1.07-1.23)	<.001
• Postgraduate	1859 (9.1)	1.42 (1.22-1.64)	<.001	1.15 (1.02-1.29)	.020
Occupation					
• Company staff	6862 (33.5)	1 [Reference]	–	1 [Reference]	–
• Students	2555 (12.5)	1.19 (1.01-1.41)	.048	1.20 (1.05-1.38)	.008
• Factory workers	1375 (6.7)	0.98 (0.81-1.18)	.836	0.83 (0.72-0.95)	.006
• Farmers	278 (1.4)	1.27 (0.90-1.81)	.179	0.68 (0.52-0.90)	.007
• Individual private entrepreneurs	1710 (8.4)	1.15 (0.98-1.34)	.079	0.94 (0.83-1.06)	.309
• Technical personnel	2027 (9.9)	1.12 (0.97-1.30)	.109	1.13 (1.01-1.26)	.028
• Freelancers	928 (4.5)	0.92 (0.75-1.13)	.422	1.06 (0.91-1.23)	.492
• Service personnel	515 (2.5)	0.97 (0.74-1.27)	.837	1.01 (0.83-1.24)	.892
• Public institution personnel/ civil servants/government personnel	2232 (10.9)	0.95 (0.82-1.10)	.474	0.99 (0.89-1.10)	.827
• Unemployed/retired	1620 (7.9)	0.78 (0.65-0.94)	.007	0.85 (0.76-0.97)	.013
• Other	370 (1.8)	0.76 (0.54-1.09)	.132	0.89 (0.71-1.13)	.343
Parenting style					
• Democratic	14,608 (71.4)	*	*	*	*
• Authoritarian, permissive, and uninvolved	5864 (28.6)	*	*	*	*
Family monthly income					
• <5000	2958 (14.4)	1.17 (1.02-1.33)	.025	*	*
• 5000-10,000	7385 (36.1)	1.24 (1.08-1.42)	.002	*	*
• 10,000-30,000	7773 (38.1)	1.10 (0.93-1.31)	.268	*	*
• >30,000	2328 (11.4)	1 [Reference]	–	*	*
Social supporter					
• 0-2	7858 (38.4)	1.13 (1.01-1.18)	.015	1.08 (0.99-1.17)	.099
• 3-5	8360 (40.8)	0.94 (0.84-1.05)	.256	1.12 (1.03-1.21)	.009
• ≥6	4254 (20.8)	1 [Reference]	–	1 [Reference]	–
Family harmony during childhood					
• Good	8154 (39.8)	*	*	*	*
• Medium	9920 (48.5)	*	*	*	*
• Bad	2398 (11.7)	*	*	*	*

(Continued)

TABLE 1. Continued

Variables	N (%) / M ± SD	Factors associated with increased time spent on recreational use		Factors associated with increased severity of Internet addiction	
		Adjusted OR (95% CI) ^a /χ ²	P value	Adjusted OR (95% CI) ^a /χ ²	P value
Negative life event experience					
• Yes	6794 (33.2)	1.14 (1.04-1.24)	.005	*	*
• No	13,678 (66.8)	1 [Reference]	–	*	*
Coping ability					
• Good	8455 (41.3)	1 [Reference]	–	1 [Reference]	–
• Medium	9937 (48.5)	1.18 (1.06-1.30)	.002	1.10 (1.03-1.19)	.007
• Bad	2080 (10.2)	1.06 (0.91-1.23)	.483	0.91 (0.81-1.02)	.110
Personality					
• Extroversion	2.57 ± 0.84	*	*	*	*
• Openness	2.51 ± 0.81	*	*	*	*
• Agreeableness	2.80 ± 0.83	1.16 (1.09-1.24)	<.001	*	*
• Conscientiousness	2.65 ± 0.80	1.08 (1.01-1.15)	.019	*	*
• Neuroticism	1.93 ± 0.84	0.86 (0.82-0.91)	<.001	*	*
Smoking					
• Nonsmokers	17,182 (83.9)	1 [Reference]	–	*	*
• Ex-smokers	828 (4.1)	1.18 (0.99-1.42)	.050	*	*
• Occasional smokers	877 (4.3)	1.23 (1.03-1.47)	.026	*	*
• Regular smokers	1585 (7.7)	0.90 (0.78-1.06)	.214	*	*
Drinking					
• Nondrinkers	12,710 (62.1)	*	*	1 [Reference]	–
• Ex-drinkers	902 (4.4)	*	*	1.09 (0.93-1.27)	.296
• Occasional drinkers	6239 (30.5)	*	*	1.15 (1.07-1.24)	<.001
• Regular drinkers	621 (3.0)	*	*	1.35 (1.12-1.62)	.002
PHQ-9					
• <10	16,334 (79.8)	*	*	1 [Reference]	–
• ≥10	4138 (20.2)	*	*	1.23 (1.13-1.35)	<.001
GAD-7					
• <10	17,648 (86.2)	*	*	*	*
• ≥10	2824 (13.8)	*	*	*	*
Perceived pressure					
• No	7413 (36.2)	1 [Reference]	–	1 [Reference]	–
• Small	9842 (48.1)	1.34 (1.18-1.52)	<.001	1.41 (1.30-1.53)	<.001
• Big	217 (15.7)	1.55 (1.33-1.82)	<.001	1.73 (1.53-1.94)	<.001
Impact on mental health					
• No	10,167 (49.7)	1 [Reference]	–	1 [Reference]	–
• Small	9029 (44.1)	1.78 (1.60-1.99)	<.001	1.96 (1.81-2.11)	<.001
• Big	1276 (6.2)	2.79 (2.33-3.34)	<.001	2.73 (2.32-3.22)	<.001
Number of cohabitants					
• <3	6162 (30.1)	*	*	1 [Reference]	–
• 3	6681 (32.6)	*	*	1.13 (1.04-1.22)	.003
• >3	7627 (37.3)	*	*	1.10 (1.02-1.19)	.012
Living space					
• <90 m ²	7517 (36.7)	*	*	*	*
• 90-120 m ²	6727 (32.9)	*	*	*	*
• >120 m ²	6219 (30.4)	*	*	*	*

(Continued)

TABLE 1. Continued

Variables	N (%) / M ± SD	Factors associated with increased time spent on recreational use		Factors associated with increased severity of Internet addiction	
		Adjusted OR (95% CI) ^a /χ ²	P value	Adjusted OR (95% CI) ^a /χ ²	P value
Satisfaction with living conditions					
• Low satisfied	3950 (19.3)	1 [Reference]	–	1 [Reference]	–
• Medium satisfied	7901 (38.6)	1.00 (0.90-1.12)	.992	0.93 (0.85-1.01)	.072
• Highly satisfied	8621 (42.1)	0.89 (0.79-0.99)	.042	0.81 (0.74-0.88)	<.001
COVID-19 ^{b,c}					
• None of the following situation	13,438 (93.4)				
• People infected or had close contacts with people infected	34 (0.3)	8.28	.016	13.15	.001
• Participation in rescues	902 (6.3)				
Main online activity					
• Chatting/communication	9019 (44.1)	1 [Reference]	–	1 [Reference]	–
• Playing online games	1809 (8.8)	1.42 (1.23-1.63)	<.001	1.15 (1.03-1.29)	.014
• Watching video/live broadcast/ audio	2214 (10.7)	1.41 (1.24-1.61)	<.001	1.10 (0.99-1.22)	.072
• Online shopping	1983 (9.7)	1.00 (0.86-1.17)	.993	1.09 (0.98-1.22)	.117
• Browsing web pages/news/ forums/Weibo	3900 (19.1)	1.23 (1.10-1.37)	<.001	1.07 (0.98-1.16)	.141
• Learning/searching for information	1547 (7.6)	0.99 (0.84-1.17)	.895	0.91 (0.81-1.03)	.136
IAT score					
• 0-49	12,955 (63.3)	1 [Reference]	–	1 [Reference]	–
• 50-79	6937 (33.9)	1.74 (1.59-1.90)	<.001	2.90 (2.70-3.11)	<.001
• 80-100	580 (2.8)	2.48 (2.01-3.06)	<.001	5.40 (4.38-6.65)	<.001

Bold values indicate a statistically significant difference with a P value of less than .05.

95% CI = 95% confidence interval; GAD-7 = Generalized Anxiety Disorder; IAT = Internet Addiction Test; OR = odds ratio; PHQ-9 = Patient's Health Questionnaire.

^aAdjusted for gender, age, location, education, occupation, parenting style, family monthly income, number of social supporters, family harmony during childhood, negative life event experience, coping ability, personality, smoking, drinking, symptoms of depression and anxiety, perceived pressure and impact on mental health, number of cohabitants, living space, satisfaction with living conditions, main online activity, and IAT score.

^bNumber of responders were 14,374.

^cχ² tests.

*Variables that were not statistically significant in the multivariable regression model.

TABLE 2. Time of Internet use before and after the outbreak of COVID-19

Time	Before the outbreak of COVID-19, N (%)	After the outbreak of COVID-19, N (%)	Z	P value
Time of daily recreational Internet use				
• <2 hours	6753 (33.0)	5872 (28.7)	–26.14	<.001
• 2-3 hours	5746 (28.0)	5616 (27.4)		
• 3-5 hours	4989 (24.4)	5452 (26.6)		
• >5 hours	2984 (14.6)	3532 (17.3)		
Total time of daily Internet use				
• <3 hours	5480 (26.8)	4450 (21.7)	–33.09	<.001
• 3-5 hours	6253 (30.5)	6090 (29.7)		
• 5-10 hours	6995 (34.2)	7762 (38.0)		
• >10 hours	1744 (8.5)	2170 (10.6)		

Bold values indicate a statistically significant difference with a P value of less than .05.

classified as having a moderate or severe level of Internet addictive behaviors on the IAT. Total time spent on Internet use and time spent on recreational Internet use had significantly increased during the pandemic, and almost half of participants reported increased severity of Internet addiction. We also identified vulnerable people with a higher risk for increases in time spent on recreational Internet use and severity of Internet addiction and severe Internet addiction during the pandemic, included having fewer social supporters, perceiving pressure and impact on mental health status due to COVID-19, and being over-engaged in playing videogames. These vulnerable people who reported increases in Internet use time and Internet addiction severity may have a higher tendency for developing subsequent addiction during the COVID-19 pandemic. In addition, the pandemic produced severe impacts on those who had been addicted to the Internet. These findings provide a detailed overview of the impact of COVID-19 on Internet use among the general public in China, which will be important for providing advice or guidelines on population-specific Internet use management and addiction intervention strategies.

Although previous studies have documented that posttraumatic stress or social isolation is associated with increased addictive behavior, including Internet addiction,²² limited studies have reported the prevalence of Internet addiction related to trauma. Previous studies showed that the prevalence of Internet addiction based on IAT in different population groups and regions in China was from 8.1% to 31.0% in recent years.²³ The present study showed the overall prevalence of Internet addiction during the pandemic was about 36.7%, with 33.9% for moderate addition, and 2.8% for severe addiction, which was higher than before the pandemic, indicating that the COVID-19 pandemic has exacerbated this public health problem in China. Internet addiction might be related to stress response to the outbreak of COVID-19, encouragement of staying at home for maintaining social distancing, more free time during quarantine, and increased needs in seeking information regarding the pandemic on the Internet or simply playing videogames.^{17,24} Besides, participants who had perceived pressure and impact on their mental health status due to COVID-19 and fewer social supporters may attempt to use the Internet to reduce stress, alleviate mood, and self-medicate,²⁵ and thus had higher risks for increases in Internet use and Internet addiction.

On the other hand, we found playing videogames is also a risk factor for Internet addiction. Internet use has indeed played a positive role in the control of the pandemic during social isolation. People seek health information about COVID-19 mainly via the Internet during the pandemic.²⁶ Meanwhile, the World Health Organization (WHO) launched the “Play Apart Together” campaign on March 31, 2020, encouraging people to play videogames at home for reducing disease transmission.²⁷ Affected by the pandemic, the number of users of many web applications increased dramatically in China, which posed risks of Internet

addiction, especially for vulnerable individuals, including adolescents.²⁸ Although WHO has released guidance about healthy screen time and gaming at home in April 2020,²⁹ and prevention and therapeutic interventions related to Internet addiction behaviors, especially among adolescents, have been published in China;^{30,31} our findings showed that COVID-19 had greatly enhanced the Internet addiction crisis. Furthermore, among all online activities, playing videogames contributed most to the increases in time spent on recreational Internet use and severity of Internet addiction, as well as severe Internet addiction during the pandemic. Considering that Internet-based games have gradually become one of the most popular forms of entertainment, it is important to devise and develop appropriate types of online games and promote balanced approaches to gaming during the COVID-19 pandemic.

Most risk factors for increases in time spent on recreational Internet use and severity of Internet addiction are consistent, such as being a student, substance use, infection with COVID-19 or close contacts with people infected, living in Hubei Province, and dissatisfaction with living conditions. Students have been reported to be more prone to develop Internet addiction in previous studies,³² and as expected, in the present study, they reported longer time spent on recreational Internet use and increased severity of Internet addiction during the pandemic. However, Internet use among farmers and unemployed/retired people were not greatly affected, probably due to lower Internet penetration. Therefore, it is crucial to provide age- and occupation-specific support and interventions for various groups to prevent excessive Internet use during the pandemic. The findings also showed an association between substance use and increased Internet addiction. A number of studies have demonstrated that different types of addictive behaviors overlap in etiology, phenomenology, and underlying psychological and biological mechanisms.³³ On the other hand, people who experience stressful life events or disasters are more prone to develop Internet addiction.²² During the pandemic, people are facing serious threats from SARS-CoV-2 infection, and meanwhile, a series of control measures were taken, including quarantine and lockdown in some areas such as Hubei Province, and thus people might be suffering from greater psychological distress and stress. Furthermore, COVID-19 has caused negative effects on the economic status and quality of life of citizens. As expected, the results of the present study showed that people infected with or closely exposed to COVID-19 and residents in Hubei Province had greater increases in time spent on the Internet and severity of Internet addiction. In addition, dissatisfaction with living conditions was also a risk factor for increased time spent using the Internet and the severity of Internet addiction during the pandemic, which may be related to a surge in family conflicts.³⁴

We found that lower monthly family income was a specific risk factor for increases in time spent on recreational Internet use, probably because people with lower income have fewer work hours and more free time to entertain themselves on the Internet. Females reported increases in

severity of Internet addiction during the pandemic, probably because females are more sensitive to traumatic stress.³⁵ In addition, some factors included neuroticism personality, and nondemocratic parenting style were specific risk factors for severe Internet addiction. Previous studies have demonstrated that these factors may be related to addiction per se, and we speculate that they were probably not related to increased Internet use caused by stressful events.

This study had some limitations. First, since the survey was conducted online, those who frequently use Internet and are actively involved in browsing e-commerce websites were more likely to be attracted to the survey, which inevitably produced response bias, and thus the participants may not be representative of the whole population. Second, data about Internet use characteristics before the pandemic might have recall bias. Third, the evaluation of Internet addiction relied on self-reported information from the IAT scale instead of clinical diagnoses. Fourth, causal relationships between COVID-19 and Internet addiction could not be determined based on the existing data. Fifth, we did not specifically inquire about the time spent on searching health information from the Internet, which may be a common activity for Internet users during the pandemic, and can also lead to increases in total time spent on Internet use. Finally, the results only reflect Internet use characteristics during the pandemic, and further longitudinal follow-up studies should be conducted to explore the long-term effect of the pandemic on Internet use and mental health.

In conclusion, the COVID-19 pandemic greatly enhanced the Internet addiction crisis in China. We provide a comprehensive profile of the COVID-19-related effects on Internet use in the general population in China and express concerns about the impacts of the pandemic on vulnerable populations who may be more prone to develop Internet addiction under crisis conditions. Targeted early prevention is needed for vulnerable populations, and treatment such as cognitive behavioral therapies should be delivered to those with Internet addiction and other comorbid psychiatric problems. The current study could provide evidence for policymakers to refine public health policies to control the pandemic and make efforts to provide culture-specific and evidence-based interventions to reduce Internet addiction during the pandemic.

This study was supported by grants from the National Natural Science Foundation of China (U180220091, 81761128036, 81901352), Beijing Municipal Science & Technology Commission (Z181100001518005), Special Research Fund of PKUHSC for Prevention and Control of COVID-19 (BMU2020HKYZX008), and Youth Elite Scientists Sponsorship Program by CASR (CSTQT2017002).

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper, and the content and results have not been submitted and/or published elsewhere.

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