Internet Addiction and Related Psychological Factors Among Children and Adolescents in China During the Coronavirus Disease 2019 (COVID-19) Epidemic

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Background: The Coronavirus disease 2019 (COVID-19) is an infectious disease presenting a major threat to public health. This study aims to assess Internet use characteristics and objectively examine the potential psychological factors associated with Internet addiction (IA) during the COVID-19 epidemic.

Methods: A cross-sectional, anonymized, self-reported survey was conducted among Chinese children and adolescents aged 6 to 18 years old. Participants completed questionnaires containing Young’s Internet Addiction Test (IAT) and the Depression, Anxiety, and Stress Scale (DASS-21), and questions regarding demographic information and Internet use characteristics.

Results: A total of 2050 participants (mean age: 12.34 ± 4.67 years old, female: 48.44%) were enrolled. Fifty-five (2.68%) participants met the criterion for addictive Internet use (IAT ≥ 70), while 684 (33.37%) participants were classified as problematic Internet users (69 ≥ IAT ≥ 40). Internet usage had grown during the COVID-19 epidemic, including the frequency and duration of recreational Internet use, and the frequency of stay-up Internet use. A linear regression analysis showed female gender (β = -0.091, p < 0.001), age (β = 0.066, p = 0.001), depression (β = 0.257, p < 0.001), and stress (β = 0.323, p < 0.001) were significantly correlated with the IAT total scores (R = 0.539, R² = 0.291, p < 0.001).

Conclusions: We observed excessive Internet use among Chinese children and adolescents during the outbreak of COVID-19. Age, gender, depression, and stress were the potential key factors affecting IA. Extended family and professional support should be considered for vulnerable individuals during these unprecedented times.

Keywords: Internet addiction (IA), children and adolescents, depression, anxiety, stress
INTRODUCTION

In December 2019, the Coronavirus disease 2019 (COVID-19) was first reported in Wuhan city, Hubei province, China (1). The COVID-19 is an extremely contagious disease with high infectivity, fast transmitting speed, susceptibility of all-age groups, and damage to public health. The emergency response and massive vigorous actions taken by the Chinese government have slowed down the epidemic. However, the Chinese people were facing enormous pressure and a grim challenge of prevention and control. The ministry of education of China issued notices in January, the extension of the opening of the spring semester in 2020, requiring all primary and secondary schools to delay school opening and students to stay at home (2) and learn via online courses (3). As an unprecedented, nationwide, even worldwide public health emergency, the epidemic of COVID-19 is bound to have a corresponding impact on the psychology and behaviors of school-age children and adolescents, who deserves more attention.

The rapid rise of the Internet age has popularized Internet use in China. More and more children and adolescents spend time on the Internet to study, play online games, shop, watch movies, use social media, and chat. These activities are often used to reduce stress and anxiety or to alleviate depressed mood. As there are 588 million Internet users in China (including 287 million teenagers) that account for 20% of all Internet users worldwide (4). Internet use in a reasonable way is beneficial, but excessive and uncontrolled Internet use may develop into Internet addiction (IA), which is defined as an individual’s inability to control his/her use of the Internet. IA is a serious public health problem in the world, especially in Asia (5). In China, the prevalence of IA has been reported as 2.4% to 10% (6, 7).

The COVID-19 outbreak is an excellent opportunity to study the association between stressful life events, its consequent psychological responses, and addictive behaviors. Previous studies have confirmed stress, depression, and anxiety are correlated with IA (8–12). We hypothesized that the increased level of stress, anxiety, and depression caused by the crises of the COVID-19 outbreak might change Internet use behaviors. Research data are needed to develop evidence-driven strategies to reduce adverse psychological impacts on Internet use. So this population-based epidemiological study screened, described, and compared the Internet addictive behaviors and identified risk factors of IA among school-aged children and adolescents in China in response to the outbreak.

METHODS

Study Design
The popularization of Internet services and smartphones have enabled mental health professionals to provide online mental health investigation and assistance during the COVID-19 outbreak. As the Chinese Government recommended that the public to minimize face-to-face interaction, we conducted a cross-sectional study and electronically invited participants to participate in this survey. We recruited through the anonymous online questionnaire, designed by the first author and reviewed by senior psychiatrists. The admission criteria: (1) 6-18 years old, male or female, (2) voluntary participation in this survey, (3) ability to complete the online survey or with the help of parents, (4) being a student in primary or middle school, (5) signing informed consent online. The exclusion criteria: diagnosed with cognitive impairment, organic brain diseases, or severe mental disorders. The research protocol and consent procedures were approved by the Human Ethics Committee of the Xiangya Hospital of Central South University (the ethical approval number: 202003034), which conformed to the principles embodied in the Declaration of Helsinki.

Samples
School-age children and adolescents from these three areas were recruited through the anonymous online questionnaire, designed by the first author and reviewed by senior psychiatrists. The admission criteria: (1) 6-18 years old, male or female, (2) voluntary participation in this survey, (3) ability to complete the online survey or with the help of parents, (4) being a student in primary or middle school, (5) signing informed consent online. The exclusion criteria: diagnosed with cognitive impairment, organic brain diseases, or severe mental disorders. The research protocol and consent procedures were approved by the Human Ethics Committee of the Xiangya Hospital of Central South University (the ethical approval number: 202003034), which conformed to the principles embodied in the Declaration of Helsinki.

Measures
We obtained demographic data, including gender, date of birth, whether they were an only child or not, current study section, growth environment in the past three years, family income in the past one year, and educational level of participants’ mother and father. Participants were asked if they had ever been diagnosed with cognitive impairment, organic brain diseases, or mental disorders (schizophrenia, depression, bipolar disorders, obsessive-compulsive disorder, anxiety disorder, or substance use disorders) in their lifetime. If the answer was yes, they were excluded from the study.

We included several measures of Internet use, the primary electronic device of Internet use (smartphones or tablets, Internet protocol television (IPTV), computers, others), the frequency of recreational use of electronic devices (several times per day, once per day, 4-6 times per week, 1-3 times per week, no use); the duration of recreational use of electronic devices (>6 hours per day, 4-6 hours per day, 2-4 hours per day, <2 hours per day, no use); the frequency of recreational use of electronic devices after 00:00/week (>4 times per week, 3 times per week, twice per week, once per week, no use); the frequency of recreational use of electronic devices overnight/week (>4 times per week, 3 times per week, twice per week, once per week, no use); the degree of addiction to electronic devices (self-rating, 0-100 scores) during and before the epidemic of COVID-19.
The Chinese version of Young’s Internet Addiction Test (IAT) was used to screen symptoms of IA. It is a self-rated test with 20 items, and each item is scored on a scale of 1-5. According to Young et al.’s criteria (13), participants whose IAT total scores 70 or above were classified as addictive Internet users (AIU) who had encountered significant life problems due to Internet use. Participants with an IAT total score of 40-69 were classified as problematic Internet users (PIU) who had encountered general life problems due to Internet use. Participants with an IAT score of 39 or below were classified as normal Internet users (NIU), who only had some or no problems controlling Internet use. Adequate reliability of IAT in Chinese languages compared with English (Cronbach alpha=0.82) (14, 15).

The mental state was assessed using the Chinese version of Depression, Anxiety, and Stress Scale (DASS-21). DASS-21 is a screening tool to measure depression, anxiety, and stress in the reference period of “past one week.” Questions 3, 5, 10, 13, 16, 17, and 21 formed the depression subscale. The total depression subscale score was divided into normal (0–9), mild to moderate depression (10–14), severe depression (15–21). Questions 2, 4, 7, 9, 15, 19, and 20 formed the anxiety subscale. The total anxiety subscale score was divided into normal (0–7), mild to moderate anxiety (8–14), severe anxiety (15–22). Questions 1, 6, 8, 11, 12, 14, and 18 formed the stress subscale. The total stress subscale score was divided into normal (0–10), mild to moderate stress (11–25), severe stress (26–42). The Chinese version of DASS-21 has been demonstrated to be a good psychometric screening tool with good validity and reliability in the Chinese population (16), even in adolescents (17, 18) and research during the severe acute respiratory syndrome (SARS) outbreak (19).

Statistical Analysis
Data online was exported in.sav format. Simple descriptive statistics were expressed as ‘mean and standard deviation’ for continuous variables, ‘frequency and percentage’ for categorical variables. Differences in demographics, Internet use, and DASS-21 variables among groups were tested using t-test, ANOVA test, Pearson’s $\chi^2$ test, or Fisher’s exact test. The binary logistic regression with the ‘enter’ method was used to evaluate if factors significant in univariate analysis were strongly associated with AIU and PIU. We also used linear regression analysis to investigate the associations between demographic characteristics, the subscales of the DASS-21 (depression, anxiety, and stress) and IAT total scores. The odds ratios (OR), corresponding to 95% confidence intervals (CI), standardized coefficient $\beta$ values were generated for each variable. All tests were two-tailed, with a significance level of $p<0.05$. To adjust for multiple post-hoc test the significance level was set to $p<0.014$ ($\alpha'=(2^k\alpha)/n^*(n-1)+1$, $n=3$). Statistical analysis was performed using SPSS Statistic 21.0 (IBM SPSS Statistics, New York, United States).

RESULTS
Of the 2270 surveys administered, 39 surveys were interrupted because they did not agree to participate in this research, and 181 surveys were removed, belonging to respondents who were less than 6 years old or more than 18 years old. The final participants were 2050 children and adolescents aged 6–18 years old from three different areas (660 from Hunan province, 651 from Shandong province, and 739 from Inner Mongolia Autonomous Region). The mean age of participants was 12.34 (SD: 4.67) years old (males, 12.44 (SD: 5.45) years old, n=1057; girls, 12.24 (SD: 3.661) years old, n=993).

Incidence of Addictive, Problematic Internet Use and Demographic Characteristics
The mean score of total IAT was 36.83 (SD, 13.80); Male, 37.86 (SD, 14.53); Female, 35.72 (SD, 12.89). Based on total IAT scores, 2.68% (Male: 3.50%; Female: 1.81%) and 33.37% (Male, 35.10%; Female, 31.52%) of the participants were classified as addicted and excessive Internet users, respectively. The mean IAT score was 78.96 (SD, 7.303) in the AIU, 49.38 (SD, 7.603) in the PIU, and 28.51 (SD, 6.275) in the NIU. We found age, gender, and education status were significantly different among AIU, PIU, and NIU ($p<0.001$). There were no significant differences in the rate of the only child, residence, annual family income, or mother or father’s education level in the three groups (see Table 1).

Electronic Device Use During and Before the Epidemic of COVID-19
Smartphones or tablets were the primary electronic devices (AIU, 90.91%; PIU, 91.23%; NIU, 83.30%), followed by IPTV (AIU, 3.64%; PIU, 4.97%; NIU, 9.31%), computers (AIU, 3.64%; PIU, 3.51%; NIU, 5.95%) and other devices (AIU,1.82%; PIU, 2.92%; NIU, 1.45%). For AIU, PIU and NIU groups, the frequency of recreational use of electronic devices online, the duration of recreational use of electronic devices online, the frequency of use of electronic devices after 00:00/week, and the degree of addiction to electronic devices (self-rating, 0–100 scores) during the epidemic of COVID-19 were all increased than before. However, the frequency of use of electronic devices overnight/week increased only in NIU, but not in AIU and PIU (Table 2, Figure 1).

Prevalence of Depression, Anxiety, and Stress During the Epidemic of COVID-19
The prevalence of depression, anxiety, and stress were found to be 17.66% (n=362), 15.54% (n=298), and 7.07% (n=145), respectively. The prevalence of different levels of depression, anxiety, and stress in the past one week differed significantly among the three groups ($p<0.001$). Post-hoc analyses respectively showed differences between the AIU and PIU, AIU and NIU, as well as the PIU and NIU in Table 3 ($p<0.014$).

Associations Between Demographic Characteristics, Depression, Anxiety, Stress, and Addictive, Problematic Internet Use
We used two statistical models to explore the factors which may contribute to Internet addiction. As shown in Table 4, the binary logistic regression analysis shows that male gender (OR=1.491,
Prevalence of AUI and PUI Among Chinese Children and Adolescents

To the best of our knowledge, there is limited information available on an overview study of IA and related risk factors of children and adolescents in a particular situation of stress and isolated condition. In the present study, 2.68% and 33.37% of the participants were classified as addicted and possibly addicted to the Internet. Several studies using the same criteria by the IAT reported with 1.2%~6.2% addicted Internet users and 12.5%~46.0% problematic Internet users in China mainland, Hong Kong, Japan, South Korea, Malaysia, Philippines, Nigeria, and Greece (7, 20, 21). We found the prevalence was relatively higher than those reported earlier in China (2.2%/17.1%). The possible reason is that more students spent time in Internet use during this investigation. The fear resulting from the COVID-19 disease, and the consequences of lockdown, depression, and stress have been mounting affecting individuals’ behaviors. It may also be explained by methodological differences (cross-sectional versus longitudinal study designs), and different statistical approaches (correlations versus time-lag models).

**DISCUSSION**

**Prevalence of AUI and PUI Among Chinese Children and Adolescents**

To the best of our knowledge, there is limited information available on an overview study of IA and related risk factors of children and adolescents in a particular situation of stress and isolated condition. In the present study, 2.68% and 33.37% of the participants were classified as addicted and possibly addicted to the Internet. Several studies using the same criteria by the IAT reported with 1.2%~6.2% addicted Internet users and 12.5%~46.0% problematic Internet users in China mainland, Hong Kong, Japan, South Korea, Malaysia, Philippines, Nigeria, and Greece (7, 20, 21). We found the prevalence was relatively higher than those reported earlier in China (2.2%/17.1%). The possible reason is that more students spent time in Internet use during this investigation. The fear resulting from the COVID-19 disease, and the consequences of lockdown, depression, and stress have been mounting affecting individuals’ behaviors. It may also be explained by methodological differences (cross-sectional versus longitudinal study designs), and different statistical approaches (correlations versus time-lag models).

**Age and IA**

The results also showed that IA grew with age. Our research had a young group aged from 6 to 9 years old, and the incidence of
AUI and PUI was 1.67% and 28.10%, respectively. Until now, most studies focused on the population of teenagers and young adults on Internet use (22). However, the onset use of the Internet in China has become earlier. The research report on the situation of Internet use among children and adolescents in China pointed out that the daily electronic devices (followed by mobile phones and tablets, followed by computers and televisions) exposure rate of Chinese children over 3 years old reached 92% (4). The average days of Internet use every week in children aged 3-8 years old in China are 3.7 (4). IA, just as Internet gaming disorder and gambling disorder, is a kind of addictive behavior without psychoactive substances. Behavioral addiction is generally developed incrementally and characterized by a change from fun, through losing control, to obsession (22).

Internet use has its popularity and accessibility, so we should start to prevent IA in children according to the findings of this study.

Gender and IA

Gender difference is an essential issue in terms of IA. The proportion of males in AUI was much higher than that of females, which is consistent with previous studies (21, 23, 24). Boys who recreationally use the Internet prefer massive multiplayer online role-playing games (MMORPGs) (25) and violent games (26). In contrast, girls’ online activities are mostly focused on playing time-killing games, socializing, texting, and online shopping, but less violent games (27–30). Girls present with shorter durations of online gaming and shorter online

A: Difference in addictive Internet users during and before the epidemic of COVID-19.
P: Difference in problematic Internet users during and before the epidemic of COVID-19.
N: Difference in average Internet users during and before the epidemic of COVID-19.

*P < 0.05,**P < 0.01, ***P < 0.001.

| Recreational use of electronic devices | Addictive Internet Users (n = 55) | Problematic Internet Users (n = 684) | Normal Internet Users (n = 1311) | Comparison |
|--------------------------------------|----------------------------------|-------------------------------------|----------------------------------|------------|
|                                    | During the epidemic | Before the epidemic | During the epidemic | Before the epidemic | During the epidemic | Before the epidemic |
| Frequency, n (%)                    |                                    |                                     |                                    |            |
| several times per day               | 48 (87.27)                      | 27 (49.09)                         | 468 (68.42)                      | 236 (34.50) | 473 (36.08)                      | 215 (16.40)           |
| once per day                        | 2 (3.64)                        | 10 (18.18)                        | 146 (21.35)                      | 178 (26.02) | 493 (37.60)                      | 400 (30.51)           |
| 4-6 times per week                  | 3 (5.45)                        | 4 (7.27)                           | 27 (3.95)                        | 53 (7.75)   | 92 (7.02)                        | 100 (7.63)            |
| 1-3 times per week                  | 1 (1.82)                        | 7 (12.73)                          | 34 (4.97)                        | 160 (23.39) | 159 (12.13)                      | 358 (27.31)           |
| no use                              | 1 (1.82)                        | 7 (12.73)                          | 9 (1.32)                         | 57 (8.33)   | 94 (7.40)                        | 238 (18.15)           |
| Duration per day, n (%)             |                                    |                                     |                                    |            |
| >6 hours                            | 28 (50.91)                      | 18 (32.73)                         | 129 (18.86)                      | 66 (9.65)   | 87 (6.64)                        | 49 (3.74)             |
| 4-6 hours (including 6 hours)       | 9 (16.36)                       | 3 (5.45)                           | 140 (20.47)                      | 90 (13.16)  | 134 (10.22)                      | 84 (6.41)             |
| 2-4 hours (including 4 hours)       | 11 (20.00)                      | 11 (20.00)                         | 222 (32.46)                      | 138 (20.18) | 317 (24.18)                      | 173 (13.20)           |
| <2 hours                            | 5 (9.09)                        | 15 (27.27)                         | 184 (26.90)                      | 321 (46.93) | 676 (51.56)                      | 707 (53.93)           |
| no use                              | 2 (3.64)                        | 8 (14.55)                          | 9 (1.32)                         | 69 (10.09)  | 97 (7.40)                        | 298 (22.73)           |
| Frequency of use after 00:00, n (%) |                                    |                                     |                                    |            |
| >4 times per week                   | 23 (41.82)                      | 12 (21.82)                         | 85 (12.43)                       | 50 (7.31)   | 40 (3.05)                        | 26 (1.98)             |
| 3 times per week                    | 8 (14.55)                       | 2 (3.64)                           | 43 (6.29)                        | 23 (3.36)   | 28 (2.14)                        | 18 (1.37)             |
| twice per week                      | 3 (5.45)                        | 5 (9.09)                           | 76 (11.11)                       | 54 (7.89)   | 62 (4.73)                        | 37 (2.82)             |
| once per week                       | 2 (3.64)                        | 11 (20.00)                         | 89 (13.01)                       | 83 (12.13)  | 122 (9.31)                       | 98 (7.48)             |
| no                                  | 19 (34.55)                      | 25 (45.45)                         | 391 (57.16)                      | 474 (69.30) | 1069 (80.78)                     | 1132 (86.35)          |
| Frequency of use overnight, n (%)   |                                    |                                     |                                    |            |
| >4 times per week                   | 12 (21.82)                      | 4 (7.27)                           | 35 (5.12)                        | 26 (3.80)   | 27 (2.06)                        | 12 (0.92)             |
| 3 times per week                    | 2 (3.64)                        | 1 (1.82)                           | 31 (4.53)                        | 15 (2.19)   | 17 (1.30)                        | 10 (0.76)             |
| twice per week                      | 2 (3.64)                        | 2 (3.64)                           | 30 (4.39)                        | 26 (3.80)   | 23 (1.75)                        | 20 (1.53)             |
| once per week                       | 4 (7.27)                        | 7 (12.73)                          | 36 (5.26)                        | 45 (6.58)   | 72 (5.49)                        | 60 (4.57)             |
| no                                  | 39 (68.44)                      | 41 (74.55)                         | 552 (80.70)                      | 572 (83.63) | 1172 (89.40)                     | 1209 (92.22)          |
| Degree of addiction to electronic devices/mean (SE) | 55.92 (3.21) | 41.97 (2.90) | 31.54 (3.27) | 23.44 (2.95) | 24.38 (1.10) | 18.53 (0.99) |

TABLE 2 | Recreational use of electronic devices among subsamples of addictive, problematic, and normal Internet use during and before the epidemic of COVID-19.
FIGURE 1 | Characteristic of recreational use of electronic devices online during and before the epidemic of COVID-19.

TABLE 3 | Prevalence of depression, anxiety, and stress among subsamples of addictive, problematic, and normal Internet users.

|                      | Addictive Internet Users (n = 55) | Problematic Internet Users (n = 684) | Normal Internet Users (n = 1311) | χ²  | p     | Paired comparisons |
|----------------------|-----------------------------------|-------------------------------------|----------------------------------|-----|-------|-------------------|
| Depression, n (%)    |                                   |                                     |                                  |     |       |                   |
| Severe               | 15 (27.27)                        | 49 (7.16)                          | 7 (0.53)                        | 331.00 | <0.001 | 1*;2*;3*          |
| Mild to moderate     | 17 (30.91)                        | 182 (26.61)                       | 92 (7.02)                       |     |       |                   |
| No                   | 23 (41.82)                        | 453 (66.23)                       | 1212 (92.45)                    |     |       |                   |
| Anxiety, n (%)       |                                   |                                     |                                  |     |       |                   |
| Severe               | 15 (27.27)                        | 52 (7.60)                         | 6 (0.46)                        | 267.66 | <0.001 | 1*;2*;3*          |
| Mild to moderate     | 9 (16.36)                         | 138 (20.18)                      | 78 (5.95)                       |     |       |                   |
| No                   | 31 (56.36)                        | 494 (72.22)                      | 1227 (93.59)                    |     |       |                   |
| Stress, n (%)        |                                   |                                     |                                  |     |       |                   |
| Severe               | 11 (20.00)                        | 32 (4.68)                         | 3 (0.23)                        | 207.58 | <0.001 | 1*;2*;3*          |
| Mild to moderate     | 9 (16.36)                         | 67 (9.80)                         | 23 (1.75)                       |     |       |                   |
| No                   | 35 (63.64)                        | 566 (85.53)                       | 1285 (98.02)                    |     |       |                   |

*a²=2*a/[3*(3-1)+1]=0.014
1: Addictive Internet Users vs Problematic Internet Users
2: Addictive Internet Users vs Normal Internet Users
3: Problematic Internet Users vs Normal Internet Users
*p < 0.014.
TABLE 4 | Logistic regression analysis of risk factors of addictive, problematic Internet use.

| Variables | OR (95% CI)       | P       |
|-----------|-------------------|---------|
| Male      | 1.491 (1.220–1.822) | <0.001  |
| Age       | 1.073 (1.037–1.111) | <0.001  |
| Depression |                   |         |
| Severe    | 3.672 (1.579–8.543) | 0.003   |
| Mild to moderate | 2.881 (2.095–3.965) | <0.001  |
| Anxiety   |                   |         |
| Severe    | 2.095 (0.899–4.884) | 0.087   |
| Mild to moderate | 1.831 (1.285–2.609) | 0.001   |
| Stress    |                   |         |
| Severe    | 4.500 (1.266–15.995) | 0.020   |
| Mild to moderate | 2.058 (1.198–3.534) | 0.009   |

OR, odds ratio; CI, confidence interval.
*Analyzed by multiple logistic regression model.

TABLE 5 | Linear regression of the relationships between research variables and IAT total score.

| Variables | Standardized coefficient β | P       |
|-----------|-----------------------------|---------|
| Female    | -0.091                      | <0.001  |
| Age       | 0.066                       | 0.001   |
| Depression | 0.257                       | <0.001  |
| Anxiety   | -0.048                      | 0.168   |
| Stress    | 0.323                       | <0.001  |

screen times (31). The possible reason is girls are better in self-control and emotional regulation and physically and psychologically mature earlier, which can reduce pathological Internet use, especially when negative events occur (32, 33).

Internet Use and Mental State During the Epidemic of COVID-19

This study discovered that the frequency and duration of recreational electronic devices use, the frequency of electronic devices use after 00:00, and the self-score of addiction to electronic products were all significantly higher than those before the epidemic in all the groups. It is worth noting that the frequency of use overnight/week in NIU was higher than that before the epidemic, which might indicate risks in developing IA. Considerable attention should be paid to all children and adolescents, including those who have not yet reached the standard of IA.

Our data showed that a number of participants experienced significant depression, anxiety, and stress during the outbreak. In this particular period, due to the suspension of schools, the closure of living environments, the reduction of outdoor activities, and the increase of epidemic pressure, the mental health of school-age children and adolescents were threatened. The uncertainty and potentially adverse effect of a loss of academic progression could have a harmful impact. Furthermore, children and adolescents were not psychologically independent and still in the stage of psychological development, and also faced the challenge of massive online courses. Although guidance and handbooks for mental health care for Chinese people were posted and free online or telephone psychological counseling was widely promoted during the COVID-19 outbreak, there was little relative professional psychological assistance for children and adolescents. However, worth noting that we only assessed the psychological status once in the early phase of the outbreak. Given the ongoing pandemic, further studies on mental health over time and confirmation of psychological status development are needed.

Our study confirmed the role of depression and stress in IA in response to this outbreak, and these findings were inconsistent with the previous studies (8, 34–36). It is well-known that adverse experiences are associated with higher depression and stress levels (37). Internet is entertaining and easy to access, which may be a common way for children and adolescents to release emotions and stress and escape from reality (38). The Internet, especially online games, can stimulate individuals to have a sense of energy and autonomy and enhance self-esteem. Excessive users will be more focused on Internet and less interested in real life (39). Future studies are needed to assess whether expanding online consulting, particularly during the outbreak, effectively reduces depression and stress among children and adolescents, and indirectly prevents the development of IA.

Limitations

Several limitations should be noted in the present study. Firstly, the cross-sectional survey does not allow a conclusion to be drawn from the risk factors to IA among children and adolescents, so the results should be interpreted carefully. Secondly, IA lacks definite diagnostic criteria and is not determined by psychiatrists internationally. Young’s Internet Addiction Test reflects mainly the DSM-IV’s criteria of addiction, and the results may differ if other assessments were used. Thirdly, this study was based on the subjects’ self-report, and pre-epidemic assessment may lead to memory bias. At last, as a response to the COVID-19 pandemic, the Chinese government has introduced steps of spatial distancing and “staying at home” to curb its spread and impact. So the sample was taken by a convenient sampling method to investigate mental health status and Internet use characteristics by online questionnaires. Despite these limitations, our findings still have important implications for research and intervention.

Conclusion

This study is a timely and large sample size investigation of Internet use in the representative areas of China in the COVID-19 outbreak. The findings provide substantial evidence of excessive Internet use among Chinese children and adolescents during this outbreak. Internet use is mainly influenced by the COVID-19 epidemic in various ways, including frequency and duration of recreational Internet use, and the rate of stay-up use. This study also represents a preliminary step towards understanding the relationship between IA and potentially related factors (male gender, age, depression, and stress). Therefore, it is necessary to provide preventive measures and strengthen education on IA for children and adolescents in countries experiencing or recovering from the epidemic. Further investigation is justified into whether reducing depression and stress can prevent IA among children and adolescents.
adolescents. Nevertheless, because of the cross-sectional design of this study, large-scale prospective studies are warranted to confirm these associations.

DATA AVAILABILITY STATEMENT
The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT
The studies involving human participants were reviewed and approved by The research protocol and consent procedures were approved by the Human Ethics Committee of the Xiangya Hospital of Central South University (the ethical approval number: 202003034). Written informed consent to participate in this study was provided by the participants’ legal guardian/next of kin. Written informed consent was obtained from the individual(s), and minor(s)’ legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

REFERENCES
1. Phelan AL, Katz R, Gastin LO. The Novel Coronavirus Originating in Wuhan, China: Challenges for Global Health Governance. JAMA (2020) 323:709–10. doi: 10.1001/jama.2020.1097
2. The ministry of education of China. The extension of the opening of the spring semester in 2020. (2020). Available at: http://www.moe.gov.cn/jyb_xwb/gdzt_gdzt/s5987/202001/20200127_416672.html
3. The ministry of education of China. Using the network platform, classes suspended but learning continues. (2020). Available at: http://www.moe.gov.cn/jyb_xwb/gdzt_gdzt/s5987/202001/20200129_416993.html
4. Iresearch. Report on the current situation of Internet use among Chinese teenagers and children. (2015). Available at: https://www.iresearch.com.cn/Detail/report?id=2383&isfree=0.
5. Christakis DA. Internet addiction: a 21st century epidemic? BMC Med (2010) 8:61. doi: 10.1186/1714-7015-8-61
6. Cao F, Su L. Internet addiction among Chinese adolescents: prevalence and psychological features. Child Care Health Dev (2007) 33(3):275–81. doi: 10.1111/j.1365-2214.2006.00715.x
7. Mak KK, Lai CM, Watanabe H, Kim DJ, Bahar N, Ramos M, et al. Epidemiology of internet behaviors and addiction among adolescents in six Asian countries. Cyberpsychol Behav Soc Netw (2014) 17(11):720–8. doi: 10.1089/cyber.2014.0139
8. Yang L, Sun L, Zhang Z, Sun Y, Wu H, Ye D. Internet addiction, adolescent depression, and the mediating role of life events: finding from a sample of Chinese adolescents. Int J Psychol (2014) 49(5):342–7. doi: 10.1002/ijop.12063
9. Carli V, Durkee T, Wasserman D, Hadlaczky G, Despalins R, Kramarz E, et al. The association between pathological internet use and comorbid psychopathology: a systematic review. Psychopathology (2013) 46(1):1–13. doi: 10.1159/000337971
10. Lai CM, Mak KK, Watanabe H, Jeong J, Kim D, Bahar N, et al. The mediating role of Internet addiction in depression, social anxiety, and psychosocial well-being among adolescents in six Asian countries: a structural equation modelling approach. Public Health (2015) 129(9):1224–36. doi: 10.1016/j.puhe.2015.07.031
11. Lau JTF, Walden DL, Wu AMS, Cheng KM, Lau MCM, Mo PKH. Bidirectional predictions between Internet addiction and probable depression among Chinese adolescents. J Behav Addict (2018) 7(3):633–43. doi: 10.1556/2006.2018.7.2018.87
12. Zhang HX, Jiang WQ, Lin ZG, Du YS, Vance A. Comparison of psychological symptoms and serum levels of neurotransmitters in Shanghai adolescents with and without internet addiction disorder: a case-control study. PloS One (2013) 8(5):e63089. doi: 10.1371/journal.pone.0063089
13. Young KS. Caught in the Net: how to recognize the signs of Internet addiction and a winning strategy for recovery. New York: John Wiley (1998).
14. Yu L, Shek DT. Internet addiction in Hong Kong adolescents: a three-year longitudinal study. J Pediatr Adolesc Gynecol (2013) 26(3 Suppl):510–7. doi: 10.1016/j.jpag.2013.03.007
15. Chi X, Liu X, Guo T, Wu M, Chen X. Internet Addiction and Depression in Chinese Adolescents: A Moderated Mediation Model. Front Psychiatry (2019) 10:816. doi: 10.3389/fpsyt.2019.00816
16. Wang K, Shi HS, Geng FL, Zou LQ, Tan SP, Wang Y, et al. Cross-cultural validation of the Depression Anxiety Stress Scale-21 in China. Psychol Assess (2016) 28(5):e88-e100. doi: 10.1037/pas0000207
17. Wang YY, Long J, Liu YH, Liu TQ. Billieux J. Factor structure and measurement invariance of the problematic mobile phone use questionnaire-short version across gender in Chinese adolescents and young adults. BMC Psychiatry (2020) 20(1):34. doi: 10.1186/s12888-020-2449-0
18. Shaikh BM, Doke PP, Gothankar JS. Depression, anxiety, stress, and stressors among rural adolescents studying in Pune and a rural block of Nanded district of Maharashtra, India. Indian J Public Health (2018) 62(4):311–4. doi: 10.4103/ijph.IJPH_174_17
19. McAlonan GM, Lee AM, Cheung V, Cheung C, Tsang KW, Sham PC, et al. Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers. Can J Psychiatry (2007) 52(4):241–7. doi: 10.1177/070674370705200406
20. Pisoni V, Floros G, Geroukalidis D, Ioannidi N, Farkonas N, Sergentani E, et al. Internet addiction in the island of Hippocrates: the associations between internet abuse and adolescent off-line behaviours. Child Adolesc Ment Health (2012) 17(1):37–44(8). doi: 10.1111/j.1475-3588.2011.00605.x
21. Adiele I, Olatokun W. Prevalence and determinants of Internet addiction among adolescents. Comput Hum Behav (2014) 31:100–10. doi: 10.1016/j.chb.2013.10.028

AUTHOR CONTRIBUTIONS
HD: writing of article, acquisition of data, and analysis/interpretation. FY: contributed to the conception and design, analysis/interpretation, and final approval for publication. XL: contributed to acquisition of data. WH: contributed to the analysis/interpretation, and final approval for publication.

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SUPPLEMENTARY MATERIAL
The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2020.00751/full#supplementary-material
22. Paulus FW, Ohmann S, von Gontard A, Popow C. Internet gaming disorder in children and adolescents: a systematic review. *Dev Med Child Neurol* (2018) 60(7):549–59. doi: 10.1111/dmcn.13754

23. Frangos CC, Fragkos KC, Kioshos A. Internet Addiction among Greek University Students: Demographic Associations with the Phenomenon. Using the Greek Version of Young's Internet Addiction Test. *Int J Economic Sci Appl Res* (2010) 3(1):49–74.

24. Chakraborty K, Basu D, Vijaya Kumar KG. Internet addiction: consensus, controversies, and the way ahead. *East Asian Arch Psychiatry* (2010) 20 (3):123–32.

25. Kardefelt-Winther D. Problematizing excessive online gaming and its psychological predictors. *Curr Pharm Design* (2014) 20(25):4026–52. doi: 10.2174/13816128113199990617

26. Kuss DJ, Griffiths MD, Karila L, Billieux J. Internet addiction: a systematic review of epidemiological research for the last decade. *Curr Pharm Des* (2014) 20(25):4026–52. doi: 10.2174/13816128113199990617

27. Schou Andreassen C, Billieux J, Griffiths MD, Kuss DJ, Demetrovics Z, Mazzoni E, et al. The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychol Addict Behav* (2016) 30(2):252–62. doi: 10.1037/adb000160

28. Andreassen CS, Griffiths MD, Gjertsen SR, Krossbakken E, Kvam S, Pallesen S. The relationships between behavioral addictions and the five-factor model of personality. *J Behav Addict* (2013) 2(2):90–9. doi: 10.1556/JBA.2.2013.003

29. Chiu SI, Hong FY, Chiu SL. An Analysis on the Correlation and Gender Difference between College Students’ Internet Addiction and Mobile Phone Addiction in Taiwan. *ISRN Addict* (2013) 2013:360607. doi: 10.1155/2013/360607

30. van Deursen AJAM, L.Bolle C MS, Hegner AMP. Kommers. Modeling habitual and addictive smartphone behavior The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Comput Hum Behav* (2015) 45(apr):411–20. doi: 10.1016/j.chb.2014.12.039

31. Wei HT, Chen MH, Huang PC, Bai YM. The association between online gaming, social phobia, and depression: an internet survey. *BMC Psychiatry* (2012) 12:92. doi: 10.1186/1471-244X-12-92

32. Li D, Zhang W, Li X, Zhen S, Wang Y. Stressful life events and problematic Internet use by adolescent females and males: A mediated moderation model. *Comput Hum Behav* (2010) 26(5):1199–207. doi: 10.1016/j.chb.2010.03.031

33. Schülle DP, Realo A, Voracek M, Allik J. Why can’t a man be more like a woman? Sex differences in Big Five personality traits across 55 cultures. *J Pers Soc Psychol* (2008) 94(1):168–82. doi: 10.1037/0022-3514.94.1.168

34. Tang J, Yu Y, Du Y, Ma Y, Zhang D, Wang J. Prevalence of internet addiction and its association with stressful life events and psychological symptoms among adolescent internet users. *Addict Behav* (2014) 39(3):744–7. doi: 10.1016/j.addbeh.2013.12.010

35. Zhao F, Zhang Z-H, Bi L, Wu X-S, Wang W-J, Li Y-F, et al. The association between life events and internet addiction among Chinese vocational school students: The mediating role of depression. *Comput Hum Behav* (2017) 70:30–8. doi: 10.1016/j.chb.2016.12.057

36. Fayazi M, Hasani J. Structural relations between brain-behavioral systems, social anxiety, depression and internet addiction: With regard to revised Reinforcement Sensitivity Theory (r-RST). *Comput Hum Behav* (2017) 72:441–8. doi: 10.1016/j.chb.2016.12.057

37. Tortella-Feliu M, Fullana MA, Perez-Vigil A, Torres X, Chamorro J, Littarelli SA, et al. Risk factors for posttraumatic stress disorder: An umbrella review of systematic reviews and meta-analyses. *Neurosci Biobehav R* (2019) 107:154–65. doi: 10.1016/j.neubiorev.2019.09.013

38. Kwon JH. Toward the Prevention of Adolescent Internet Addiction. In: *Internet Addiction*. John Wiley & Sons, Inc. (2012). doi: 10.1002/9781118013991.ch13

39. King DL, Delfabbro PH. Internet gaming disorder treatment: a review of definitions of diagnosis and treatment outcome. *J Clin Psychol* (2014) 70 (10):942–55. doi: 10.1002/jclp.22097

**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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