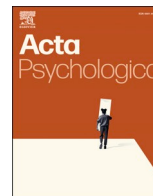




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The relationship between internet addiction and aggressive behavior among adolescents during the COVID-19 pandemic: Anxiety as a mediator

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ARTICLE INFO

Keywords:

Internet addiction
Aggressive behavior
Anxiety
Depression
Mediator

ABSTRACT

The COVID-19 pandemic has brought unprecedented challenges for adolescents, who tended to experience more emotional instability, impulsivity, and aggressive behavior driven by the fear of infection and the uncertainty of network information. In the present study, we investigated the relationship between Internet addiction and aggressive behavior, and the mediating effects of depression and anxiety. There were differences in Internet addiction and aggressive behavior in gender, thus the moderating role of gender between them were explored. A total of 1148 middle school students were invited to complete the Buss Perry Aggression Questionnaire, the Internet Addiction Scale, the Self-rating Depression Scale (SDS), and the Self-rating Anxiety Scale (SAS) separately. The results suggested that 1) there was a significant positive correlation between Internet addiction and aggressive behavior; 2) anxiety, but not depression, mediated the effect of Internet addiction on aggressive behavior; 3) gender did not moderate the effect of Internet addiction on aggressive behavior. The practical implication of the current findings on boosting adolescents' mental health was discussed and further suggestions were provided.

1. Introduction

The outbreak of COVID-19 has brought huge damage to the society. The lifestyle transformation and fear of the pandemic may cause individuals' psychological distress and symptoms of mental illness, especially for young adolescents. As adolescents are immature in their psychological development, they may develop a series of inevitable psychological and emotional distress such as anxiety, depression, and fear in the face of an outbreak (Chen et al., 2020). Given the policy of blockade the pandemic had restricted people's daily going out and the public's Internet use time became longer, which tended to cause some mental health problems. These negative emotions might lead to negative behaviors, even aggressive behaviors, which had a bad impact on public life.

1.1. Aggressive behavior

The Blockade policy of the pandemic had effectively controlled the spread of the virus. It gave people more time to get along with their

families. However, as the time became longer, the possibility of conflict increased. Studies found that during the period of COVID-19, domestic violence and other incidents were frequent, and people's aggression increased (Mazza et al., 2020). Killgore et al. (2021) compared the aggressiveness of the public in lockdown and non-lockdown status, and found that people who was restricted from outgoing showed a higher level of aggressiveness. Especially for young adults, their aggressive behavior increased as well during the pandemic (Parola et al., 2020; Wang et al., 2021; Ye et al., 2021). For example, Wang et al. (2021) found that students in primary and middle school showed increased aggressive behaviors during the COVID-19 pandemic.

Moreover, studies revealed that the males were more aggressive than females (Buss & Perry, 1992; Hongyu & Lei, 2006), especially in terms of the physical aggression behavior, whereas there was generally no gender difference in hostility or anger (Fengshi & Shuhong, 2019; Junsheng et al., 2009). However, other studies showed that females had higher levels of anger expression than males (Chuanmei, 2020; Hejing, 2018).

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1.2. Internet addiction

Due to the concern and fears of the pandemic, the public spends a lot of time focusing on relevant information over the Internet. Given that most students had to study online, their network usage time greatly increased, accompanied by the high risk of Internet addiction (Sun et al., 2020). Lin (2020) investigated the Internet addiction among 1060 junior high school students, and found that the detection rate of Internet addiction was 24.4%, which was higher than that of samples of the same age before the pandemic. Similarly, with a sample of 2050 children and adolescents, Dong et al. (2020) found that the prevalence rate of Internet addiction increased as the pandemic went on.

In addition, there was a difference in gender in Internet addiction. Males showed higher Internet Addiction rate than females (Fam, 2018; Zhao Yanqing et al., 2011), which might be attributed to the social expectations on different genders (Na, 2016).

1.3. Mental health under pandemic situation

During the pandemic, People showed obvious emotions such as anxiety, depression, compulsion and fear, among which anxiety and depression were the most common manifestations. Rong et al. (2020) conducted a sampling survey throughout China in the early stage of the pandemic and found that among 3087 respondents, the detection rate of anxiety symptoms was 13.35% and the detection rate of depression was 14.09%. Dan et al. (2020) investigated the mental health status of the national people during the outbreak of the pandemic and found that among the 14,592 respondents, the detection rate of depressive symptoms was 53.5% and the detection rate of anxiety symptoms was 44.6%. The results might vary when different sample sizes were surveyed with different measurement tools in different periods, but the mental health status of the people reflected by the existing survey was worrying.

1.4. The relationship among aggressive behavior, internet addiction, anxiety and depression

1.4.1. The relationship between aggressive behavior and Internet addiction

Previous studies showed that Internet overuse was strongly associated with aggression in adolescents (Kim, 2013; Obeid et al., 2019). Dhaka and Naris (2019) explored the relationship between Internet addiction and aggressive behavior among the university students and found a positive correlation between the two variables. Lim et al. (2015) collected 714 students' data and found those who with IAD (Internet addiction disorder) were prone to aggressive behaviors. Internet had the characteristics of anonymity, so people would become more individualistic and reduced their self-awareness when using the Internet, resulting in increased aggression. Furthermore, when using the Internet, people would be exposed to some violent games and other related contents, which would trigger their negative emotions or thoughts, as well as aggressive behaviors (Obeid et al., 2019). For high school students, in the face of great academic pressure and changes in adolescence, they would have higher feeling seeking, which would positively predict aggressive behavior through online game addiction (Chenxi, 2022).

Taken together, there is a close relationship between aggressive behavior and Internet addiction. Furthermore, according to previous studies, males and females differ in aggressive behavior and Internet addiction, thus we assume that gender may play a moderating role on the relationship between aggressive behavior and Internet addiction.

1.4.2. The relationship among aggressive behavior, anxiety and depression

Previous studies reported close associations between anxiety, depression and aggressive behavior (Roberts et al., 2010; Tanaka et al., 2010). Chung et al. (2019) divided students into anxiety group and control group, then compared their aggression scores. The result demonstrated that anxiety group showed more aggression than control group. A study of 50 families by Tanaka et al. (2010) showed that

children with high anxiety levels showed higher aggression and more family conflicts.

Depression is also one of the emotions closely related to aggressive behavior. The positive correlation between depression and explicit aggression had been investigated by Wanyeh and Yuede (2018). A study by Roberts et al. (2010) showed that depression was associated with verbal aggression. In general, there was a complex correlation between anxiety, depression and aggression.

1.4.3. The relationship among Internet addiction, anxiety and depression

Studies showed that Internet addicts had higher anxiety (Yang et al., 2007) and depression levels (Obeid et al., 2019) than non addicts (Minfang, 2008). It has been revealed that the moderate use of computers and mobile phones during the COVID-19 pandemic period was helpful to alleviate the anxiety symptoms, but long time would increase the risk of anxiety (Tianhao et al., 2020) and depression symptoms (Neill et al., 2021; Yi et al., 2020). Chen et al. (2020) indicated that electronic entertainment was positive associated with anxiety and depression among adolescents during the outbreaks. In sum, there was a close relationship between Internet addiction and anxiety and depression.

1.5. Aim and hypothesis

In the present study, we established a mediation model to explore the relationship among Internet addiction, aggressive behavior, anxiety and depression during the COVID-19 pandemic period. In addition, Internet addiction and aggressive behavior showed significant differences in gender, so we also explored the moderating role of gender between them. We hypothesized that: 1) Aggressive behavior during the COVID-19 was positively related to Internet addiction, anxiety and depression; 2) Anxiety and depression mediated the effects of Internet addiction on aggressive behavior during the pandemic period; 3) Gender moderated the effects of Internet addiction on aggressive behavior.

2. Method

2.1. Participants

A total of 1148 students in high schools located in Shanxi Province, China, were invited to complete a set of online questionnaires. All of them provided with written informed consent. After deleting 149 invalid data with regular rhythmic or incomplete responses (the exclusion criteria: 1. all fill in the same option; 2. the missing option exceeds 20%), the data utilized for further analysis was 999 (485 females), and the valid recovery rate was 87.02%. The average age of the sample was 17.01 ± 0.77 years. The distribution of participants in the current study is shown in Table 1. All participants were asked to provide information on demographic variables, frequency of network usage, Internet addiction, aggression, anxiety and depression.

2.2. Measures and procedure

All data were collected in July 2020 through a web-based survey. With the help of teachers, students filled in the questionnaire online using computers in the computer room of the school. Each questionnaire has clear instructions, which guided students to answer each question. All students signed an informed consent form before filling in the questionnaire.

Table 1
Demographic distribution of the participants.

	Male	Female	Total	Mean Age
Senior 1	293	273	566	16.92
Senior 2	221	212	433	17.13
Total	514	485	999	

The self-report questionnaires used in this study were the:

- Basic information table, which including demographic variables, and frequency of network usage.
- Buss Perry Aggression Questionnaire (Buss & Perry, 1992).
- Internet Addiction Scale (Min-fang, 2008).
- The Self-rating Anxiety Scale (Zung, 1965).
- The Self-rating Anxiety Scale (Zung, 1971).

2.2.1. Aggressive behavior

Buss Perry Aggression Questionnaire is a self-rating scale composed of 29 items presented in Likert-5. The score ranging from 1 (completely inconsistent) to 5 (completely consistent). There are four subscales: physical aggression (9 items), verbal aggression (5 items), anger (7 items), and hostility (8 items). Examples of items were, “I will use force to protect my rights when necessary” (physical aggression), “When I disagree with my friends, I will tell them publicly” (verbal aggression), “My friends think I am a man with a bad temper” (anger) and “When people are especially nice to me, I doubt their real purpose” (hostility). The total score denotes an index of trait aggression. The Cronbach's α coefficient was 0.912. The Cronbach's α coefficient of physical aggression, verbal aggression, anger, hostility subscales were 0.777, 0.666, 0.715 and 0.834 respectively.

2.2.2. Internet addiction

Internet addiction was assessed by the Internet Addiction Scale, which is a self-rating scale composed of 28 items and is scored on 0 (No) or 1 (Yes). Factor analysis of the items showed there are two subscales: addictive symptoms (6 items about tolerance, 6 items about withdrawal response) and Internet addiction related problems (5 items about Interpersonal relationship, 8 items about time management). Examples of items are, “I tried to spend less time on the Internet, but I failed” (tolerance), “I feel uncomfortable as long as I don't surf the Internet for a period of time” (withdrawal response), “Due to the Internet, I have spent less time with my parents, teachers and classmates” (Interpersonal relationship) and “More than once, I had less than five hours of sleep because of the Internet” (time management). The total score denotes an index of Internet addiction and the higher scores indicate higher possibility of Internet addiction. The Cronbach's α coefficient was 0.918. We calculated a composite score of the Internet addiction, following the rules in previous studies which treated the Internet addiction as one unitary dimension (Lin, 2020; Min-fang, 2008).

2.2.3. Depression

The Self-rating Depression Scale (SDS) is a 20-item self-report scale, which is scored on 4-point ranging from 1 (occasionally) to 4 (constantly). Examples of items were, “I feel down-hearted and blue” and “I have crying spells or feel like it”. Higher scores indicate higher levels of depression. The Cronbach's α coefficient was 0.796.

2.2.4. Anxiety

The Self-rating Anxiety Scale (SAS) was utilized to assess anxiety. The SAS consists of 20 questions that assess how participants felt during the previous week. Participants need to answer each question on a Likert-4 scale. The score ranging from 1 (occasionally) to 4 (constantly). Examples of items were, “I feel more nervous or anxious than usual” and “I am scared for no reason”. Higher scores indicate higher levels of anxiety. The Cronbach's α coefficient was 0.829.

2.3. Data analyses

SPSS 24.0 and PROCESS macro for SPSS were used to analyze the data. First, we computed descriptive statistics to assess the demographic characteristics. Second, correlation analysis was used to analyze the correlation between variables. Third, *t*-test was used to analyze gender and grade differences. Fourth, we used model 1 to test the mediating effect of depression and anxiety, and model 4 to test the moderating

effect of gender on the relationship between Internet addiction and aggressive behavior. The bootstrap method was used, and the bias-corrected 95% confidence intervals of 5000 resamples of the data were detected.

3. Result

3.1. Common method bias test

Since the self-report questionnaires were adopted, there may be common method bias (Podsakoff et al., 2003). Therefore, we used the Harman single-factor test to solve the issue. All the variables measurement items in unrotated factor analysis were combined. If only one factor remains or the first factor explains the vast majority of the variation, there is severe common method bias. In addition, the proportion of the variation explained by the first principle component should not exceed 40%. A total of 19 factors were obtained and together explained 56.38% of the variance in the current study. The proportion of the variation explained by the first principle component was 18.19%, which did not exceed the critical value (40%). Thus, common method bias did not seriously affect the results in this study.

3.2. Descriptive statistics

The frequency of network usage was detailed in Table 2. During the pandemic period, students frequently used mobile phones or other network tools, and more than half of them used the tools for over six hours a day. As shown in Table 5, network usage had a close association with Internet addiction ($r = 0.16, p < 0.01$). As expected, aggression was positively related to Internet addiction ($r = 0.43, p < 0.01$), anxiety ($r = 0.39, p < 0.01$) and depression ($r = 0.32, p < 0.01$). As shown in Table 3, the results indicated that male students scored higher than females on Internet addiction [$t(997) = 3.15, p < 0.01$], physical aggression [$t(997) = 3.98, p < 0.001$]. However, no gender difference was found in aggression, verbal aggression, anger, hostility, anxiety and depression (all $p > 0.05$). The grade differences were showed in Table 4. We found that grade 8 students scored higher than grade 7 students on physical aggression [$t(997) = -2.21, p < 0.05$], anxiety [$t(997) = -2.68, p < 0.01$]. However, no grade difference was found in Internet addiction, aggression, verbal aggression, anger, hostility and depression (all $p > 0.05$).

3.3. Mediating effect test

Regression analysis was used. All data were standardized. The result was shown in Table 6. Anxiety ($\beta = 0.39, p < 0.001$), depression ($\beta = 0.32, p < 0.001$) and Internet addiction ($\beta = 0.43, p < 0.001$) were all significant predictors of aggression. To examine the mediation hypothesis, this study used the PROCESS macro (model 4) to estimate the model parameters. Internet addiction, aggression, anxiety and depression were entered into the model. Gender and grade as covariates to control their influences on the results. The regression analysis (Table 7) showed that the total indirect effect for two mediators was 0.24, and the 95%

Table 2
Frequency of network usage.

	Grade 7		Grade 8		Total
	Male	Female	Male	Female	
Within 1 h	8	12	14	5	39
1–2 h	27	32	22	31	112
3–4 h	50	48	34	33	165
5–6 h	42	42	22	39	145
Above 6 h	166	139	129	104	538
Total	293	273	221	212	999
	566		433		

Table 3
Gender differences in internet addiction, aggression, physical aggression, verbal aggression, anxiety, anger, hostility, anxiety and depression.

	Total (N = 999)	Male (n = 514)	Female (n = 485)	t	p
	M(SD)	M(SD)	M(SD)		
Internet addiction	7.85(6.73)	8.50(7.33)	7.17(5.98)	3.15	0.002**
Aggression	72.78 (18.07)	72.94 (18.21)	72.61 (17.93)	0.29	0.772
Physical aggression	18.69 (5.32)	19.34 (5.49)	18.01 (5.05)	3.98	<0.001***
Verbal aggression	12.82 (3.82)	12.83 (3.99)	12.81 (3.65)	0.08	0.939
Anger	15.27 (5.61)	15.23 (5.61)	15.31 (5.61)	-0.22	0.823
Hostility	20.82 (6.71)	21.13 (6.56)	20.49 (6.87)	1.49	0.136
Anxiety	35.38 (6.58)	35.16 (6.56)	35.62 (6.61)	-1.10	0.273
Depression	42.23 (6.90)	41.84 (6.93)	42.65 (6.85)	-1.84	0.066

Note.
** $p < 0.01$.
*** $p < 0.001$.

Table 4
| Grade differences in Internet addiction, aggression, physical aggression, verbal aggression, anxiety, anger, hostility, anxiety and depression.

	Total (N = 999)	Grade 7 (n = 566)	Grade 8 (n = 433)	t	p
	M(SD)	M(SD)	M(SD)		
Internet addiction	7.85(6.73)	7.96(6.45)	7.71(7.09)	0.59	0.552
Aggression	72.78 (18.07)	72.25 (18.08)	73.47 (18.06)	-1.06	0.289
Physical aggression	18.69 (5.32)	18.37(5.21)	19.12(5.44)	-2.21	0.028*
Verbal aggression	12.82 (3.82)	12.67(3.80)	13.01(3.85)	-1.39	0.166
Anger	15.27 (5.61)	15.40(5.60)	15.09(5.62)	0.88	0.379
Hostility	20.82 (6.71)	20.85(6.66)	20.78(6.79)	0.18	0.860
Anxiety	35.38 (6.58)	34.89(6.34)	36.02(6.84)	-2.68	0.007**
Depression	42.23 (6.90)	42.18(7.08)	42.30(6.66)	-0.26	0.792

Note.
* $p < 0.05$.
** $p < 0.01$.

Table 5
Correlations of Internet addiction, frequency of network usage, aggression, anxiety and depression.

Variables	1	2	3	4	5	6	7	8	9
1. Internet addiction	1								
2. Frequency of network	0.16***	1							
3. Aggression	0.43***	0.12***	1						
4. Physical aggression	0.36***	0.09**	0.79***	1					
5. Verbal aggression	0.29***	0.07*	0.78***	0.49***	1				
6. Anger	0.06	0.20	0.26***	0.17***	0.18***	1			
7. Hostility	0.13***	0.08*	0.26***	0.17***	0.16***	0.61***	1		
8. Anxiety	0.29***	0.06	0.39***	0.34***	0.19**	0.13***	0.12***	1	
9. Depression	0.26***	0.08*	0.32***	0.26***	0.11***	0.12***	0.12***	0.71***	1

Note: N = 999.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

confidence intervals [0.17, 0.32] did not include zero. Therefore, the mediating effect was significant. In the path of Internet addiction → anxiety → aggression, the mediating effect of anxiety was 0.21, and the confident interval was [0.13, 0.30], which indicated that, when anxiety acts as a mediator, the mediating path was established and it played a partial mediating role in this path. In the path of Internet addiction → depression → aggression, the mediating effect of depression was 0.04, and the confidence interval was [-0.02, 0.10], including zero; thus, the mediating path was not established, and depression had no mediating effect in Internet addiction and aggression of senior high school students. Taken together, we could conclude that anxiety played a mediating role in the relationship between Internet addiction and aggression

Table 6
Regression of aggression with anxiety, depression and Internet addiction.

Dependent Variable	Predictive Variable	β	t	F	R ²	ΔR^2
Aggression	Anxiety	0.39	13.50***	182.34***	0.16	0.15
	Depression	0.32	10.72***	114.90***	0.10	0.10
	Internet addiction	0.43	14.82***	219.64***	0.18	0.18

Note.
*** $p < 0.001$.

Table 7
Mediation analysis of anxiety and depression in the relationship between Internet addiction and aggression.

	Effect	Boot SE	LLCI	ULCI
Direction effect				
Internet addiction → aggression	0.91	0.08	0.76	1.06
Indirect effect				
Anxiety	0.21	0.04	0.13	0.30
Depression	0.04	0.03	-0.02	0.10
Total	0.24	0.04	0.17	0.32

Note: 5000 bootstrap samples; N = 999; standardization of all variables.

Table 8
Moderation analysis of gender in the relationship between Internet addiction and physical aggression.

Physical aggression	Effect	SE	t	p
Gender	-0.96	0.31	-3.04	<0.01
Internet addiction	0.28	0.07	4.02	<0.001
Gender × internet addiction	-0.002	0.05	-0.04	0.97
R ²	0.00			
F	0.001			
p	0.97			

Table 9
Mediation analysis of anxiety in the relationship between Internet addiction and physical aggression in gender.

	Effect	Bootstrap SE	LLCI	ULCI
Male				
Direct effect				
Internet addiction → physical aggression	0.22	0.03	0.16	0.29
Indirect effect				
Anxiety	0.06	0.02	0.03	0.09
Total	0.06	0.01	0.03	0.09
Female				
Direct effect				
Internet addiction → physical aggression	0.21	0.04	0.13	0.28
Indirect effect				
Anxiety	0.07	0.02	0.03	0.12
Total	0.07	0.02	0.04	0.11

Note: 5000 bootstrap samples; Male, n = 514; Female, n = 485; standardization of all variables.

among high school students, while depression did not. The results are shown in Fig. 1.

3.4. Moderating effect test

To examine the moderation hypothesis, this study used PROCESS macro (model 1) to estimate the model parameters. According to the results of independent sample *t*-test, only the two variables of Internet addiction and physical aggression showed differences in gender, so we further explored the moderating role of gender between Internet addiction and physical aggression, and established a simple moderation model. The continuous variables were centralized. Internet addiction, physical aggression and gender were put into the model. The results were shown in Table 8, the interaction effect between Internet addiction and gender on physical aggression was not significant ($\beta = -0.002, p > 0.05$). Therefore, the moderating effect on this path was not significant. Gender didn't play a moderating role between Internet addiction and physical aggression.

We further explored the role between Internet addiction and physical aggression, and analyzed the mediating role of anxiety in the relationship between Internet addiction and physical aggression by gender separately. PROCESS macro (model 4) was used to establish a simple mediation model. The result was shown in Table 9, anxiety played a partial mediating role in Internet addiction and physical aggression for both males ($\beta = 0.06; CI [0.03, 0.09]$) and females ($\beta = 0.07; CI [0.03,$

0.12]). The results revealed that Internet addiction partially affected physical aggression through anxiety both in male and female.

4. Discussion

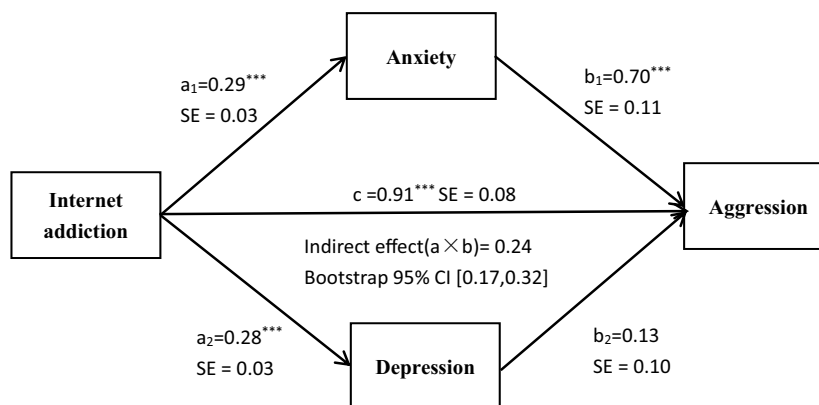
Anxiety and fear brought about by COVID-19 pandemic caused more impulsive and aggressive behaviors, especially among adolescents. The present study explored the causes and underlying mechanisms behind adolescent aggressive behavior during the COVID-19 pandemic. The results suggested that adolescents' aggressive behavior during the COVID-19 was positively related to Internet addiction, anxiety and depression. Furthermore, anxiety but not depression mediated the effects of Internet addiction on aggressive behavior during the pandemic period. Besides, we explored the moderating role of gender between Internet addiction and aggressive behavior. The results showed differences in Internet addiction and physical aggression in terms of gender, but the gender did not play the moderator role. These findings provided additional evidence on the relationship between Internet addiction and aggression, and showed the mediating effect of anxiety among adolescents during the COVID-19.

4.1. The relationship between internet addiction and aggressive behavior during the COVID-19 pandemic

During the COVID-19 pandemic, the aggression of adolescents was increased (Killgore et al., 2021; Parola et al., 2020). Individuals, especially adolescents showed greater tendencies to lose temper, verbally or even physically attack others when faced with negative events. The influence of Internet information and media is one of the most key factors for adolescents' aggressive behaviors.

Out of fear of infection and uncertainty of information, high school students spent longer time on the Internet. With the increase of Internet usage time, the possibility of Internet addiction was also increased.

In the current study, the correlational analyses revealed that there was a significant positive correlation between Internet addiction and aggressive behavior of high school students during the pandemic. Through further regression analysis, we found that Internet addiction could significantly predict aggression. These results were consistent with previous studies research which found that adolescents with internet addiction, especially those in high school, were more inclined to have aggressive behaviors, and Internet addiction may strengthen their aggressive behaviors (Kim et al., 2008; Ko et al., 2012; Ko et al., 2009; Park et al., 2013). Therefore, during the COVID-19 pandemic, the excessive use of Internet, or using the Internet addictively, may easily leads to aggressive behaviors. The fear of the pandemic and the panic caused by the spread of fake news have made many netizens emotionally



*** $p < 0.001$ (standardized regression coefficients with 5000 Bootstrap Samples)

Fig. 1. The mediating path of anxiety and depression between Internet addiction and physical aggression. *** $p < 0.001$ (standardized regression coefficients with 5000 Bootstrap Samples).

unstable, resulting in a chaotic and hostile network environment. In addition, the network has the characteristics of anonymity, which may stimulate peoples' tendency of aggression, especially for high school students whose emotions are unstable.

4.2. The mediating role of anxiety between internet addiction and aggressive behavior

We found that anxiety played a mediating role between Internet addiction and aggression in teenagers. Berkowitz (1989) proposed the reformulated frustration-aggression hypothesis, which suggested that if a desired goal was frustrated, individuals were inclined to have a negative emotion and further led to verbal and physical aggressive behaviors.

In the present study, students' increasingly anxious emotion during the pandemic might be a very important reason for aggressive behavior (Chen et al., 2020; Tang et al., 2021). Longstanding media exposure, particularly in the period of public emergencies, would aggregate one's anxiety (Alasousi et al., 2020; Wheaton et al., 2012). During the pandemic, there were mass information about the virus published on the Internet every day. However, it was mixed with a lot of fake information, which might cause people's misunderstanding and panic (Yi et al., 2020). Especially for the high school students with insufficient judgment ability, blindly browsing the relevant information and credulous rumors would cause their anxiety.

Moreover, some students might not adapt to online teaching (Huan et al., 2020), which caused low learning efficiency and further led to academic anxiety.

In summary, due to the fear and uncertainty of the pandemic, adolescents were inclined to search on the Internet for information. However, the complex network information triggered adolescent anxiety, which further led to aggressive behaviors.

Moreover, the present study implied that although there was a significant correlation between depression and aggressive behaviors, depression did not act as a mediator. Previous studies found that individuals with depression symptoms reported more Internet addiction and aggressive behaviors (Pettit, 1997; Yen et al., 2007). Although anxiety and depression could be the two salient negative emotions generated during the pandemic, it is more likely that the panic over the pandemic and the uncertainty of mass online information led to more anxiety than depression among adolescents, and the difficulty of anxiety release further led to aggressive behaviors.

4.3. The moderating role of gender between internet addiction and aggression

We found that there were differences in Internet addiction and aggression between males and females. These results were consistent with previous studies (Junsheng et al., 2009; Fengshi & Shuhong, 2019). Males were significantly higher than females in Internet addiction and physical aggression, but there was no significant difference in the dimension of overall aggression which was inconsistent with previous studies (Buss & Perry, 1992; Hongyu & Lei, 2006). We further established a gender moderation model between Internet addiction and physical aggression, and found that the moderation effect was not significant. Thus, the moderation model was not established.

The influence of Internet addiction on physical aggression had been further explored. We found that neither for males nor for females, Internet addiction would affect physical aggression through anxiety. This revealed that the effect of Internet addiction on physical aggression may be achieved through the same underlying mechanism in males and females, and anxiety may be one of the explanations for the effect.

4.4. Suggestion

Based on our findings, we suggest that 1) The government should

establish an official information website and update and release accurate information about the pandemic situation on the website in time. In addition, government should strengthen the supervision and management of network media public opinion in public emergencies during the COVID-19 pandemic, and create a healthy network environment to reduce public, especially adolescents' anxiety and panic; 2) Adolescents should use the Internet rationally, control the time of suffering the Internet, and examine the information on the Internet. Adolescents should not believe or spread rumors. Pay more attention to themselves mental health and ask parents and teachers for help in time when they need. Find a way to vent reasonably negative emotions, such as reading, indoor sports, listening to songs or making a diary; 3) In public emergencies, counseling psychologists should provide professional guidance and help to the public, especially teenagers. Such as setting up psychological hotlines, spreading science psychological knowledge. Counseling psychologists should help the public reduce their negative emotions such as anxiety, and guide to correctly identify, manage and regulate their emotions in the stress events.

4.5. Limitations and future research

In this study, there was no follow-up study on the situation of high school students, and we couldn't determine whether students had Internet addiction before. In addition, the pandemic situation in each place was different. This study investigated high school students in Shanxi, which was not representative of the whole country. It can be used as a reference to explore the relationship between Internet addiction and aggression of adolescents in low-risk areas.

The pandemic situation continues. This research in the pandemic situation has great reference value for the psychological assistance to the public in public health emergencies. Future research can carry out follow-up research to explore the relationship between public psychological status, Internet addiction and aggression under different pandemic situations. In addition, future researchers can also explore the situation of the public in different risk areas and conduct cross-sectional exploration. In this way, when we encounter public health emergencies, we can take actions more appropriately and quickly to protect the public's mental health.

5. Conclusion

In summary, the present research suggested that Internet addiction was an important cause of adolescents' aggressive behavior during the COVID-19 pandemic. In addition, the mediation analysis showed that anxiety mediated the effect of Internet addiction and aggressive behavior, which was consistent with the reformulated frustration-aggression hypothesis. Our findings implied that interventions on adolescent aggressive impulsivity/behaviors should pay attention to Internet use during the COVID-19.

Funding

The research was supported by the Natural Science Foundation of Zhejiang Province (LQ22C090001) and National Natural Science Foundation of China (32100836).

CRediT authorship contribution statement

XW designed the experiment and supervised the research procedure. YZ performed the experiment. YZ analyzed the data. YZ, ZH, SW, XL and MH wrote the manuscript. XW approved the final submission. XW, YZ, ZH, SW, XL and MH revised the manuscript.

Declaration of competing interest

The authors have no potential conflicts of interest.

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