



The more developmental assets, the less internet gaming disorder? Testing the cumulative effect and longitudinal mechanism during the COVID-19 pandemic

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Abstract

The COVID-19 pandemic has triggered the dramatical development and prosperity of online games, while worldwide people are suffering from it. Considering the high prevalence, serious impacts, and huge development potential of internet gaming disorder (IGD), it is extremely necessary to develop a protective model to prevent and intervene with it among young people. Based on the developmental assets theory, the present study adopted a two-wave longitudinal design to evaluate the cumulative effects of developmental assets on IGD, as well as the underlying mechanisms during this specific period. Data were collected from a sample of 1023 adolescents in Hubei province, Central China through self-report questionnaires. The results indicated that (1) developmental assets were negatively associated with adolescents' IGD concurrently and longitudinally; (2) the overall developmental assets had cumulative effects in linear patterns on adolescents' IGD, concurrently and longitudinally; and (3) internal developmental assets mediated the relationship between external developmental assets and adolescents' IGD longitudinally. Theoretically, the present study supports the developmental assets theory and expands the literature about developmental assets and IGD in younger generations. Practically, the present study provides guidance for prevention and intervention of IGD among adolescents during and after the COVID-19 pandemic. Comprehensive measures should be taken to assist in developing positive internal and external resources to promote youth thriving.

Keywords COVID-19 · Developmental assets · Internet gaming disorder · Cumulative effect · Longitudinal mediation · Chinese adolescent

Introduction

With the rapid development of the internet and mobile devices, there were 4.95 billion active internet users around the world at the start of 2022, more than half of the global population (62.5%; DataReportal, 2022). The population of Chinese internet users has climbed to 1.03 billion, 17.6%

were children and adolescents, and 53.6% were internet game users (CNNIC, 2022). Internet games provide a new form of entertainment for the public, but also bring many public health issues into modern society, such as internet gaming disorder (IGD). According to the fifth revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), IGD can be diagnosed with endorsing at least five of the following nine criteria in the past one year: (1) preoccupation with internet games; (2) withdrawal symptoms when internet gaming is inaccessible; (3) the need to spend increasing amounts of time on internet games; (4) unsuccessful attempts to control the participation in internet games; (5) loss of interest in previous hobbies and entertainment as a result of, and with the exception of, internet games; (6) continued excessive use of internet games despite knowledge of psychosocial problems; (7) deception of family members, therapists, or others regarding the amount

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of internet gaming; (8) use of internet games to escape or relieve a negative mood; and (9) jeopardizing or losing a significant relationship, job, or educational or career opportunity because of participation in internet games (APA, 2013). Recently, numerous studies have demonstrated that the prevalence rates of IGD were 14.6%, 13%, and 14.8% in Chinese children, adolescents, and young adults, respectively (Yang et al., 2020, 2021; Zhang et al., 2019). Moreover, experiencing IGD will increase the risks of mental disorders, problematic behaviors, and brain function and structural damage (Pontes, 2017; Yan et al., 2021). Given the high prevalence and serious impacts of this phenomenon, it is necessary to explore some protective factors that could effectively prevent or intervene in IGD among adolescents. Fortunately, scholars have repeatedly confirmed that positive resources could protect adolescents from developmental problems such as externalizing behaviors and mental disorders symptoms amidst regular and specific periods (Chang et al., 2019; Shek et al., 2021). Accordingly, the present study aims to evaluate whether and how developmental resources protect adolescents from IGD during the COVID-19 pandemic.

Literature review

Internet games and IGD during the COVID-19 pandemic

The coronavirus disease-2019 (COVID-19) pandemic has profoundly disrupted normal human life around the world (Verschuur et al., 2021; Lauret & Bayram-Jacobs, 2021; Tunk & Kumar, 2022). Due to it, people cannot go to work, study, and travel as usual, and have to wear surgical masks, keep physical distance and even be lockdown. As of March 20th, 2022, over 468 million confirmed cases and over 6 million deaths have been reported globally (WHO, 2022). For humans, this virus pandemic is a devastating disaster, whereas it is a promoter for internet games, providing a rare opportunity of rapid popularization and development. It is reported that, in 2020, worldwide digital games spending has increased by 12% in content and 21% in paid downloads (Statista, 2021). There are at least three reasons to explain the above increase. First, during this pandemic, nearly all the work and education takes place over the internet (Lauret & Bayram-Jacobs, 2021; Tunk & Kumar, 2022), which makes it easier for people to access the internet and mobile devices. Second, the choices of entertainment are limited as the lockdowns force people to stay at home. For example, outdoor activities and parties are not permitted, so people have to spend free time through online entertainment such as social media and online games (Cauberghe et al., 2021; Teng et al.,

2021). Third, numerous online games, especially teamwork games, provide a virtual platform for individuals to satisfy their psychological needs during this unprecedented period.

In addition, the World Health Organization (WHO) has recommended playing online games as part of the #Healthy-AtHome campaign to mitigate the effects of the COVID-19 lockdown on individual mental health (WHO, 2021). Generally, European online game players have reported that playing internet games in this specific period made them feel less isolated and happier (Statista, 2021). However, it is worth noting that, as of June 2020, the time spent on internet games during the pandemic has increased by 39% globally (Statista, 2021). To a certain degree, the increasing time spent on internet games may lead to more possibilities of developing IGD (WHO, 2020). A school-based study of Chinese adolescents revealed that perceived COVID-19 stress was positively and indirectly associated with both depression and IGD (She et al., 2021). Similarly, a large Japanese survey indicated that people infected with COVID-19 were at higher risk for IGD (Oka et al., 2021). Overall, IGD was significantly aggravated by the occurrence of COVID-19. Therefore, it is an urgent and necessary task for scholars to figure out the protective factors that could assist adolescents avoid the engagement in IGD and navigate this special period smoothly.

Internal and external developmental assets and IGD

Based on the positive youth development theory, Benson and his colleagues (2011) devoted to developing a widely adopted framework of positive resources in the individual growth process, which they named the developmental assets framework. Developmental assets are conceptualized as a series of positive developmental nutrients that not only assist young people to avoid problematic behaviors, but promote young generations to grow up in a healthy and successful way (Leffert et al., 1998). According to the developmental assets framework, developmental resources are grouped into 20 external resources and 20 internal resources (Benson et al., 2011). The external assets compose of four categories, including support, empowerment, boundaries and expectations, and constructive use of time. The internal assets also comprise four categories including commitment to learning, positive values, social competence, and positive identity. A vast number of empirical studies have confirmed that those positive assets function as a protective umbrella in preventing developmental problems, and serve as a booster for individual thriving among worldwide youth (Kaur et al., 2019; Manrique-Millones et al., 2021; Wium et al., 2021; Xiang et al., 2022; Yourell & Doty, 2022; Gomez-Baya et al., 2022).

In the bioecological theory of human development, Bronfenbrenner and Morris (2006) highlight that individual growth is jointly influenced by considerable factors from microsystem (e.g., community), mesosystem (e.g., interaction between family and school), exosystem (e.g., parents' work environment), and macrosystem (e.g., social culture). These influential factors can be divided into two groups: personal and environmental factors. And internal and external developmental resources represent most of the positive factors from oneself and environment respectively, and they operate as a whole to affect the individual's development process, such as experiencing IGD. For instance, Chang et al. (2019) revealed a negative association between overall developmental resources and adolescents' externalizing behaviors. Moreover, Xiang and his colleagues (2022) confirmed the overall effects of both internal and external assets in reducing IGD among Chinese adolescents. In general, adolescents experiencing more kinds of developmental assets are less likely to develop negative outcomes. However, it is not difficult to realize that previous studies only focus on the total influence of developmental nutrients. Actually, internal resources and external resources are two kinds of positive factors that differ in conception, content, and origin (Benson et al., 2011). Evaluating the overall effects of them limits the understanding of their mechanisms in affecting individual growth. Therefore, the present study, based on the above theories and literature, hypothesizes that the overall, internal, and external developmental assets will be negatively associated with IGD, concurrently and longitudinally (H1).

Cumulative effect and relationship patterns

The application of cumulative effects in developmental psychology can be traced back to risk assessments in individual growth. Inspired by the bioecological theory of human development, scholars agree that multiple risk factor exposure exceeds the adverse developmental impacts of singular exposures (Whipple et al., 2010; Evans et al., 2013). Gradually, a cumulative risk model is developed and applied to evaluate the cumulative risks of developmental problems (Lian et al., 2022; Gan et al., 2022). In the cumulative risk model, the risk indicator is constructed by dichotomizing each risk factor exposure (0=no risk; 1=risk) and then summing the dichotomous scores (Evans et al., 2013). Furthermore, scholars also devote to figuring out the relationship pattern of cumulative effect, which has two kinds: the superposition model and the threshold model (Lamela & Figueiredo, 2018). The superposition model indicates that the more risks people face, the more likely they will suffer from developmental problems. Conversely, the threshold model suggests that people may dramatically suffer from

negative outcomes only when the risk accumulates to a certain level. Encouraged by this method, numerous empirical studies attempt to develop cumulative protective factors models and examine the model patterns (Hsieh et al., 2016; Buckley & Chapman, 2020). Despite cumulative risk/protection evaluation being a widespread procedure to examine the effect of multiple risk/protective factors on specific developmental outcomes, few studies have tested the cumulative protection assumption on the current issue, adolescent IGD.

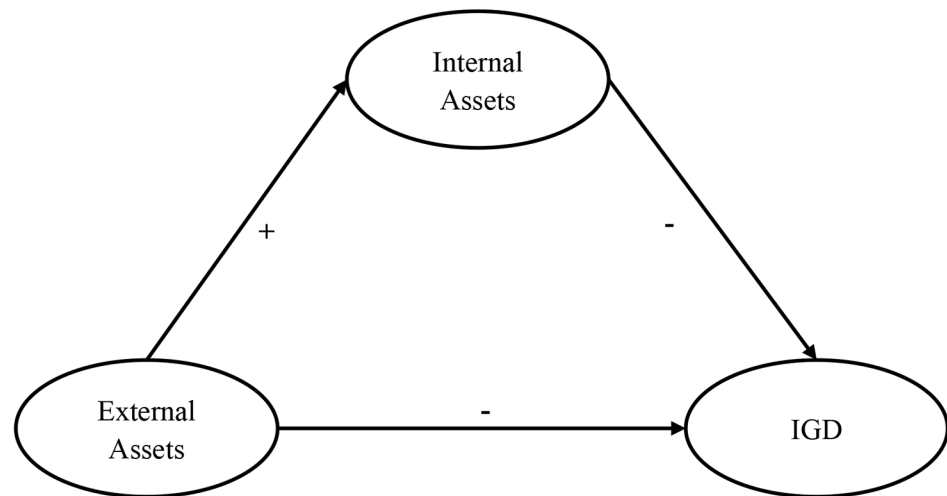
According to the developmental assets framework, there are two core perceptions about the breadth and depth of developmental resources that also reflect the cumulative protection model (Benson et al., 2011). The breadth hypothesis suggests that the more types of resources one has, the stronger the protection effect of those resources will be. Similarly, the depth hypothesis emphasizes that, for each kind of developmental asset, the higher the quality of the resource, the stronger the protective effect. To examine the above notions, researchers construct a cumulative protection model of developmental assets. For instance, Soares et al. (2019) indicated that Portuguese adolescents who had greater experience of developmental assets would perceive greater satisfaction with their lives. Moreover, Chang et al. (2019) and Xiang et al. (2022) revealed that, using longitudinal designs, developmental resources had profound cumulative effects on externalizing behaviors and IGD in Chinese adolescents. All of these studies constructed cumulative protection models by dichotomizing each resource (0=not have; 1=have) and then adding them. Actually, this procedure only investigates the breadth hypothesis of developmental assets and neglects the depth hypothesis. In order to confirm both of the core perceptions, the present study will establish a cumulative protection model of overall developmental assets including their variety and quality and hypothesize that the overall developmental assets will have stable cumulative effects on IGD in Chinese adolescents (H2).

Mediating effect of internal developmental assets

The 40 developmental resources were confirmed to have a cumulative and protective effect on adolescent IGD and other developmental problems (Toomey et al., 2019; Dimitrova & Wiium, 2021; Xiang et al., 2022). But since internal resources and external resources differ in conception, content, and origin (Benson et al., 2011), they may play various roles as two groups (internal assets and external assets) in these issues. Good external resources will activate the formation and development of adolescents' internal resources to foster positive development (Chang et al., 2017). A multinational study suggested that external resources could

Fig. 1 The hypothesized model.

(Note. IGD = internet gaming disorder)



positively affect internal assets (Dost-Gözkan et al., 2021). Similarly, Wei (2016) found that Chinese adolescents who had more external resources would develop more internal assets. Additionally, Lewin's behavior theory points out that individuals' behavior is the results of joint effect of environmental factors (e.g., physical and social surroundings) and personal factors (e.g., personality and motivation) (Lewin, 1946). Thus, external and internal developmental assets may also jointly affect adolescents' behaviors. For instance, Wei (2016) revealed the mediating effect of internal assets on the relationship between external resources and emotional adaptation. Perceived external resources could assist adolescents to develop more internal assets, which in turn improved their emotional adaptation ability. Considering the aforesaid evidence and the comprehensive associations between external assets, internal resources, and IGD, the present study hypothesizes that internal resources will play a longitudinally mediating role in the relationship between external assets and adolescents' IGD (H3).

The present study

The COVID-19 pandemic has triggered the dramatical development and prosperity of online games, while worldwide people are suffering from it. Given the high prevalence, serious impacts, and huge development potential of IGD, it is extremely necessary to develop a protective model to prevent and intervene with it among young generations. To the best of our knowledge, most of the existing studies about IGD focus more on the risk factors (She et al., 2021; Oka et al., 2021), which underlines that avoiding or reducing these risks is effective in prevention and intervention of IGD. However, the developmental assets theory provides a new perspective shifting our concentration from risky factors to positive factors that could prevent negative outcomes (Benson et al., 2011). To date, the literature about

the positive factors preventing IGD and other developmental problems in adolescents is still limited. Additionally, little research has employed longitudinal design to assess the effects of positive factors in youth development, neither evaluated the protective effects of this kind of factors in specific period such as the COVID-19 pandemic. Given these research gaps, the present study will adopt a two-wave longitudinal design to investigate whether and how developmental assets prevent IGD among Chinese adolescents during this specific period (see Fig. 1).

Method

Participants

In this study, participants were recruited using convenient sampling from two public middle schools in Hubei province, Central China, in October 2020 (Time 1, T1). A sample of 1023 adolescents from Grade 7 to Grade 9 participated in the first data collection and completed a self-reported questionnaire. Of those, 505 were boys, and their average age was 13.16 years ($SD=0.86$). For various reasons, 30 adolescents dropped out of the follow-up survey half a year later (attrition rate = 2.93%, 12 boys). In the remaining sample, the number of adolescents was about the same in three grades (35.75% were in Grade 7, 35.15% were in Grade 8, and 29.10% were in Grade 9). Moreover, Chi-square tests and independent sample t-tests were performed to examine the potential bias between the remaining sample and the dropped sample. The results suggested that these two groups did not differ in T1 developmental assets ($t_{(28)}=0.96$, $p=0.346$), T1 IGD ($t_{(1,017)} = -0.83$, $p=0.409$), and gender ($\chi^2_{(1)}=1.08$, $p=0.298$), indicating that the current results would not be biased due to attrition.

Measures

Developmental assets

The Developmental Assets Profile (DAP) was adopted to measure adolescents' developmental assets (Scales, 2011). The DAP consisted of 2 subscales, 58 items in total. The Internal Assets Subscale composed of 32 items from 4 dimensions, including commitment to learning, positive values, social competence, and positive identity. One example item is that "I am encouraged to try things that might be good for me". The External Assets Subscale also comprised 26 items from 4 dimensions, including support, empowerment, boundaries and expectations, and constructive use of time. And one example item is that "I have teachers who urge me to develop and achieve". All items were rated on a 4-point scale, ranging from 1 (not at all or rarely) to 4 (extremely or almost always). The average score of all items on the scale represents the index of this scale, with higher average scores indicating more developmental assets. In the current study, the Cronbach's alpha of DAP at Time 1 and Time 2 were 0.95 and 0.96, respectively. The Cronbach's alpha of the Internal Assets Subscale at Time 1 and Time 2 were 0.90 and 0.93, respectively. The Cronbach's alpha of the External Assets Subscale at Time 1 and Time 2 were 0.92 and 0.93, respectively.

Internet gaming disorder

The Internet Gaming Disorder Questionnaire (IGDQ) was used to measure adolescents' IGD (Yu et al., 2017). The IGDQ composed of 11 items and one example item is that "Do you sometimes skip doing homework in order to spend more time playing online games". All items were responded on a 3-point Likert scale ranging from 1 (never) to 3 (frequently). The average score of all items represents the index of IGDQ, with higher scores reflecting higher levels of IGD. In the current study, the Cronbach's alpha at T1 and T2 were 0.81 and 0.77, respectively.

Procedure

All procedures performed in this study involving human participants conform to the 1964 Helsinki declaration and its later amendments or comparable ethical standards, and they were approved by the Ethics Committee for Scientific Research at the first authors' institution. Before formal data collection, written consent was obtained from the school leaders, students, as well as their legal guardians. Participants were informed that the survey was voluntary and they had the right to quit at any time. Paper-and-pencil based questionnaires were administered by well-trained research

assistants during class time, and the duration lasted for thirty minutes. Honest self-report was encouraged by emphasizing the anonymity and confidentiality of the survey. The procedures for the data collection in the two waves were absolutely the same.

Statistical analyses

In the present study, SPSS 26 and the PROCESS macro were adopted to analyze the data. First of all, Harman's single factor test was performed to examine the data for potential common method bias in all research items (Rodríguez-Ardura & Meseguer-Artola, 2020). Second, the descriptive statistic was used to assess the means, standard deviations, skewness, and kurtosis for developmental assets and IGD. Third, Pearson correlation analysis was employed to test the associations between key variables. Fourth, hierarchical regression analysis was conducted to evaluate the cumulative effect of developmental assets on adolescents' IGD, concurrently and longitudinally. Moreover, the specific relationship patterns were further analyzed as well. Fifth, PROCESS macro (model 4) was performed to test the longitudinal mediating model between developmental assets and IGD.

Results

Common method biases analyses

Harman's one factor test was used to test common method variance (Rodríguez-Ardura & Meseguer-Artola, 2020). The results suggested that there were 14 factors with eigenvalues greater than 1 at T1. And the first factor accounted for only 22.08% of the total variance. At T2, there were 13 factors with eigenvalues greater than 1. And the first factor accounted for only 27.39% of the total variance. The variation values of first factors were all less than the critical criterion of 40% at both waves. Therefore, common method variance was restricted in the present study.

Distribution of developmental assets

The distribution of developmental assets is displayed in Table 1. In total, there were eight kinds of developmental assets from self, family, school, community, and society in the process of Chinese adolescents' growth, such as support, empowerment, constructive use of time, and positive values. Overall, adolescents experienced more internal resources than external resources. And it is necessary to assist them to develop more resources, including empowerment, constructive use of time, and positive identity. Moreover, the

Table 1 Distribution of developmental assets (T1)

Categories	Boys		Girls		Total		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>Range</i>
<i>External Assets</i>	42.78	13.88	42.56	13.93	42.67	13.90	0–78
Support	12.32	4.49	12.20	4.84	12.26	4.66	0–21
Empowerment	9.82	3.54	9.57	3.21	9.70	3.38	0–18
Boundaries & Expectations	16.53	5.42	16.59	5.64	16.56	5.53	0–27
Constructive Use of Time	4.00	2.52	4.22	2.39	4.11	2.45	0–12
<i>Internal Assets</i>	54.60	14.73	53.61	12.63	54.10	13.71	0–96
Commitment to Learning	12.94	3.86	12.95	3.50	12.94	3.68	0–21
Positive Values	17.29	5.35	17.20	4.89	17.24	5.12	0–33
Social Competencies	15.61	4.23	15.71	3.39	15.66	3.83	0–24
Positive Identity	8.62	3.52	7.71	3.22	8.16	3.40	0–18
<i>Total Assets</i>	97.60	26.92	96.22	25.00	96.90	25.96	0–174

Table 2 Skewness, kurtosis, and intercorrelations of key variables

Variables	Skewness	Kurtosis	1	2	3	4	5	6	7
1. T1 IGD	1.54	3.13							
2. T2 IGD	1.71	3.68	0.24**						
3. T1 Total Assets	0.06	0.09	−0.10**	−0.14**					
4. T1 Internal Assets	0.07	0.36	−0.11**	−0.14**	0.94**				
5. T1 External Assets	−0.01	−0.38	−0.10**	−0.13**	0.94**	0.77**			
6. T2 Total Assets	−0.06	−0.21	−0.06	−0.24**	0.35**	0.33**	0.32**		
7. T2 Internal Assets	−0.07	−0.04	−0.07*	−0.22**	0.32**	0.33**	0.28**	0.96**	
8. T2 External Assets	−0.15	−0.40	−0.05	−0.23**	0.35**	0.31**	0.35**	0.96**	0.84**

Note. T1 = time 1, T2 = time 2, IGD = internet gaming disorder. * $p < 0.05$, ** $p < 0.01$.

Table 3 Cumulative effects of developmental assets on IGD

Variables	T1 IGD					T2 IGD				
	<i>R</i> ²	ΔR^2	<i>F</i> (<i>df</i>)	β	95%CI	<i>R</i> ²	ΔR^2	<i>F</i> (<i>df</i>)	β	95%CI
The First Step	0.019	0.019	9.302(2)			0.085	0.085	29.553(3)		
Gender				−0.13***	[−1.53, −0.55]				−0.03	[−0.65, 0.22]
Age				−0.06	[−0.56, 0.01]				0.14***	[0.34, 0.85]
T1 IGD									0.24***	[0.16, 0.27]
The Second Step	0.028	0.012	10.141(3)			0.098	0.013	26.023(4)		
T1 DA ^a				−0.11***	[−0.03, −0.01]				−0.12***	[−0.02, −0.01]

Note. T1 = time 1, T2 = time 2, IGD = internet gaming disorder, DA^a = the linear term of developmental assets. *** $p < 0.001$.

results of the independent sample t-test indicated that boys had better positive identity resources than girls ($t_{(987)} = 4.20$, $p < 0.001$).

Skewness, kurtosis and correlation coefficients of key variables

Skewness, kurtosis, and correlation coefficients of the main variables are shown in Table 2. In general, the three indicators of developmental assets in the two waves were positively correlated in pairs. T1 IGD was positively related to T2 IGD. T1 IGD was negatively associated with T1 total assets, T1 internal assets, T1 external assets and T2 internal assets. T2 IGD was negatively correlated to three indicators of developmental assets in both waves. Thus, the first hypothesis was supported.

Examination of the cumulative effects and relationship patterns

First, hierarchical regression analysis was conducted to assess whether total developmental assets had cumulative effects on reducing adolescents’ T1 and T2 IGD. In particular, two models have been established in this study. In model 1, gender and age were considered as control variables, T1 total developmental assets (linear term) was the independent variable, and T1 IGD was the dependent variable. In model 2, the only item that differed from model 1 was that T2 IGD was used as the dependent variable. The results suggested that in model 1, after controlling for the effects of adolescent gender and age, T1 total developmental assets (linear term) had a negative predictive effect on T1 IGD ($\beta = -0.11$, $p < 0.001$; see Table 3). In model 2, after controlling for

Table 4 Relationship patterns of developmental assets and IGD

Variables	T1 IGD					T2 IGD				
	R^2	ΔR^2	$F(df)$	β	95%CI	R^2	ΔR^2	$F(df)$	β	95%CI
The First Step	0.019	0.019	0.302(2)			0.082	0.085	29.553(3)		
Gender				-0.13***	[-1.52, -0.54]				-0.03	[-0.65, 0.22]
Age				-0.06	[-0.57, 0.00 ^c]				0.14***	[0.34, 0.85]
T1 IGD									0.24***	[0.16, 0.28]
The Second Step	0.031	0.012	10.141(3)			0.095	0.013	26.023(4)		
T1 DA ^a				-0.11***	[-0.03, -0.01]				-0.12***	[-0.02, -0.01]
The Third Step	0.031	0.001	7.742(4)			0.094	0.000 ^c	20.798(5)		
T1 DA ^b				0.02	[-0.00 ^d , 0.00 ^c]				-0.00 ^d	[-0.00 ^d , 0.00 ^c]

Note. T1=time 1, T2=time 2, IGD=internet gaming disorder, DA^a= the linear term of developmental assets, DA^b= the quadratic term of developmental assets. *** $p < 0.001$. ^c This number cannot be fully displayed and is greater than zero. ^d This number cannot be fully displayed and is smaller than zero.

Table 5 Summary of mediating model results

Outcome (Y)	Predictor (X)	R	R^2	F	β	SE	95%CI
T2 Internal assets		0.313	0.098	26.261***			
	Age				-1.88***	0.558	[-2.97, -0.79]
	Gender				-2.80**	0.967	[-4.69, -0.90]
	T1 IGD				-0.20	0.123	[-0.45, 0.04]
T2 IGD	T1 External assets				0.31***	0.035	[0.24, 0.37]
		0.353	0.125	27.511***			
	Age				0.52***	0.127	[0.27, 0.77]
	Gender				-0.39	0.220	[-0.82, 0.04]
	T1 IGD				0.21***	0.028	[0.15, 0.26]
	T1 External assets				-0.01	0.008	[-0.03, 0.00 ^c]
Effect	T2 Internal assets				-0.04***	0.007	[-0.06, -0.03]
	β		Boot SE			Boot 95%CI	
Direct	-0.01		0.008				[-0.03, 0.00 ^c]
Indirect	-0.01		0.003				[-0.02, -0.01]

Note. T1=time 1, T2=time 2, IGD=internet gaming disorder, ** $p < 0.01$, *** $p < 0.001$. ^c This number cannot be fully displayed and is greater than zero.

the effects of adolescent gender, age and T1 IGD, T1 total developmental assets (linear term) had a negative predictive effect on T2 IGD ($\beta = -0.12$, $p < 0.001$; see Table 3). These results confirmed the second hypothesis that developmental assets had stable cumulative effects on the reduction of IGD among adolescents, both concurrently and longitudinally.

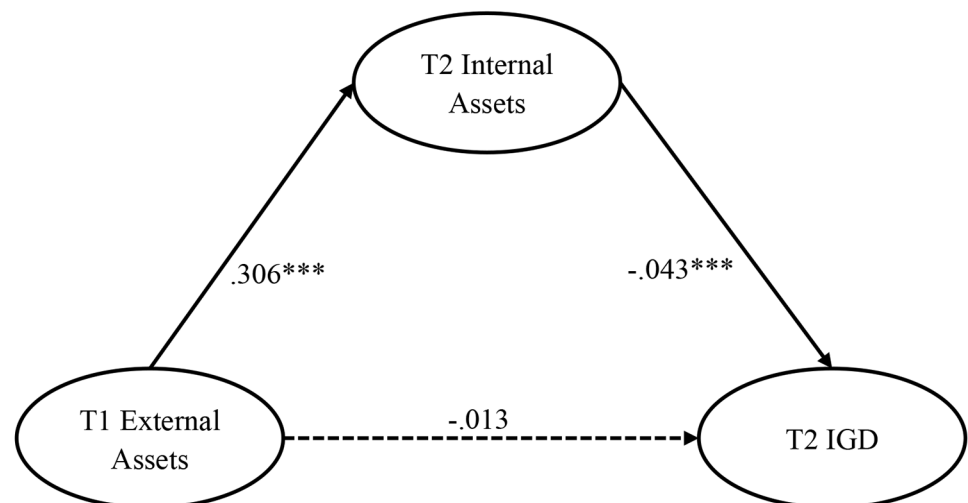
Second, in order to investigate the specific relationship patterns of developmental assets and IGD, T1 total developmental assets (quadratic term) was included in the hierarchical regression analysis according to Cohen et al.'s method (2003). Similar to Li et al.'s research (2012), if the regression coefficients of T1 total developmental assets (quadratic term) and IGD were significant, it meant that their relationship pattern was best fit by a quadratic function, otherwise it indicated a linear functional relationship between them. And the regression results are displayed in Table 4. After controlling for the effects of gender and age, T1 total

developmental assets (quadratic term) could not significantly predict T1 IGD ($\beta = 0.02$, $p > 0.05$). It suggested there was a linear functional relationship between T1 total developmental assets and T1 IGD ($\beta = -0.11$, $p < 0.001$). Similarly, T1 total developmental assets (quadratic term) could not significantly predict T2 IGD neither ($\beta = -0.002$, $p > 0.05$) with controlling for the impacts of gender, age and T1 IGD, indicating that T1 total developmental assets had a linear functional relationship with T2 IGD ($\beta = -0.12$, $p < 0.001$).

Testing of the longitudinal mediating model

In the mediating effect test, age, gender, and T1 IGD were controlled as covariables. The results of the mediation analysis are presented in Table 5. T1 external assets could positively predict T2 internal assets ($\beta = 0.31$, $p < 0.001$), while it could not significantly predict T2 IGD ($\beta = -0.01$, $p > 0.05$).

Fig. 2 The longitudinal mediating model. (Note. T1= time 1, T2 = time 2, IGD = internet gaming disorder. *** $p < 0.001$)



T2 internal assets had a negatively predictive effect on T2 IGD ($\beta = -0.04$, $p < 0.001$). Further results revealed that T1 external assets could not directly affect T2 IGD ($\beta = -0.01$, 95% CI: -0.03, 0.003), but they had an indirect effect via T2 internal assets ($\beta = -0.01$, 95% CI: -0.02, -0.01), which indicated that T2 internal assets fully mediated the relationship between T1 external assets and T2 IGD (see Fig. 2). Thus, the results supported the third hypothesis.

Discussion

The present study was conducted to investigate the relationship between developmental assets and adolescents' IGD, including examinations of the constant cumulative effect and longitudinal mediating mechanism during the COVID-19 pandemic. Adopting the pencil-and paper questionnaires through two consecutive follow-up surveys, this study indicated that adolescents who experienced more developmental assets in their past developmental process had a lower possibility of developing IGD. In specific, the relationship between overall developmental assets and IGD was in a linear pattern. Moreover, external resources could promote the development of internal resources, which in turn prevented adolescents from involvement in IGD. Details of the current findings will be discussed in the following paragraphs.

First, this study found that, at the baseline level, Chinese adolescents reported 8 categories of developmental assets in various magnitude, and gender differences were not significant in most of the categories of developmental resources except positive identity resources. This finding is inconsistent with previous surveys on Portuguese and Spanish adolescent samples, which reported significant gender differences in internal assets and external assets (Soares et al., 2019; Gomez-Baya et al., 2021), but in line with Chang et

al.'s research (2019) on Chinese adolescents. These various findings on gender differences may be due to cultural differences. In a sense, there seems to be a different availability of developmental assets for different genders in these countries (Gomez-Baya et al., 2021), whereas Chinese boys and girls share a more equal availability to positive resources under collectivism values. More interestingly, the current finding is in agreement with Gomez-Baya et al.'s finding that male adolescents reported higher positive identity than females (Gomez-Baya et al., 2021), which implies the need for girls in building positive self-identity. Overall, Chinese adolescents experienced more internal resources than external resources, which is conversely different from Chang et al.'s research (2019) on Chinese adolescent sample conducted in the ordinary period. Because during the outbreak of public health incidents, the environment is changing dramatically and the connection between it and individuals is also altering. In the early duration of COVID-19, most of the young people were in panic and lockdown, and they could not connect with the outside world as normal and felt isolated (Loades et al., 2020; Zhen et al., 2021). Thus, in the first survey, adolescents reported fewer perceived external resources.

Second, the three indicators of developmental assets were confirmed to be negatively associated with adolescents' IGD concurrently and longitudinally, and all of the 40 resources further converged to have a table cumulative effect in a linear pattern on it. The more types and higher quality of positive resources adolescents experience, the less likely they will be at risk of IGD later. These findings expand Xiang et al.'s related study (2022) by examining the steady cumulative effect in the relationship between positive resources and IGD. Moreover, this finding also further expands previous evidence on the cumulative effect of developmental assets (Chang et al., 2019) through simultaneous

considerations of the quantity and quality. Theoretically, these current findings about the cumulative effect provide empirical evidence for the developmental assets theory that young people who experience more kinds or higher quality of developmental assets will develop fewer negative outcomes and more thriving (Benson et al., 2011). In addition, as the developmental assets are from various microsystems such as oneself, family, school, and community (Leffert et al., 1998), the joint cumulative effect, to a certain degree, also provides support for the bioecological theory of human development, underlining the complex impacts of different microsystems on individual growth (Bronfenbrenner & Morris, 2006). Besides, since this evidence is from one of the biggest developing countries in the world, it encourages scholars to concentrate more on the positive development of youth in disadvantage to facilitate equality and harmony (Miconi et al., 2021). This contribution suggests developmental psychologists and practitioners paying more attention to the comprehensive influence of the environment on the individual growth process.

Third, the current study demonstrated that internal developmental assets fully mediated the relationship between external developmental assets and adolescents' IGD longitudinally. Adolescents who experienced more types and higher quality of social resources would develop more positive attributes, which in turn assisted them to avoid suffering from IGD. This finding is in favor of numerous prior literatures, which hold the opinion that good environmental resources will activate the formation and development of individual internal attributes to foster positive development (Wei, 2016; Chang et al., 2017; Dost-Gözkan et al., 2021). Moreover, this finding supports Lewin's behavior theory that environmental factors (e.g., external assets) and personal factors (e.g., internal assets) will jointly affect individuals' behaviors (Lewin, 1946). Particularly, adolescents who grow up in a healthy environment will be instilled with positive attributes because people will learn ideas and behaviors through observation and imitation of good examples in social situations (Bandura, 1962). Thus, a good environment needs to be constructed by family, school, and community to guide young people to grow up in a positive approach. Furthermore, external resources could only prevent adolescents from IGD via improving personal resources, which emphasizes the decisive role of the individual in his or her own development. This full mediation effect is in conformity with the self-determination theory, which highlights the function of internal factors in behavioral development (Deci & Ryan, 2012; Mills & Allen, 2020). Additionally, it also echoes the bioecological theory of human development at a mesosystem level (Bronfenbrenner & Morris, 2006), since the full mediating effect represents the positive connections and interactions between environmental elements

(e.g., family and school) and intrapersonal resources. Overall, apart from a healthy environment, parents, teachers, and other practitioners should intentionally take comprehensive measures to improve and strengthen adolescents' internal positive attributes.

Implications and limitations

In summary, the current study has several critical implications. As for its theoretical contribution, this study combined the bioecological theory of human development and the developmental assets framework (Bronfenbrenner & Morris, 2006; Benson et al., 2011) to explain the IGD phenomenon in adolescents. It demonstrated that developmental assets had constant cumulative effects on IGD and the mediating role of internal assets between external assets and IGD. These findings expanded the literature related to the protective factors of IGD and provided a more comprehensive perspective for future research. Moreover, the current findings also provide empirical support for the above theories (Bronfenbrenner & Morris, 2006; Benson et al., 2011; Bandura, 1962; Deci & Ryan, 2012). In terms of clinical practice, this study brought public awareness to the protective role of positive resources on individual development, especially in emergent periods such as COVID-19. Furthermore, this study encouraged individuals, families, schools, and communities to work together to construct an encouraging environment for youth and guide them to develop and enhance more positive internal attributes. Various programs based on school, outdoor activity, music, and sports can be adopted to assist young people to develop social and personal resources (Waid & Urich, 2020). For instance, Zhu and Shek (2020) have performed a school-based program and successfully improve adolescents' positive resources in mainland China.

Notwithstanding these implications, this current study has some important limitations. First, all the data were collected by self-report questionnaires, which may have increased shared method variance and cannot avoid non-real responses (Rodríguez-Ardura & Meseguer-Artola, 2020). More objective data collection methods such as others' evaluations and mixed-methods design should be used to assess IGD and developmental assets in future studies (Geukens et al., 2021; Miconi et al., 2021). Second, the present study was based on a short-term longitudinal design, lasting only half a year, and the stability of research conclusions needs more time to re-examine. It suggests that future research can use longer longitudinal studies to explore the relationship. Third, since the participants were middle school students in China, it is unclear whether these findings can be generalized to young people with other cultural backgrounds. Thus, future research can conduct cross-cultural surveys or include more

adolescents with diverse characteristics (Brislin, 1983). Fourth, the present study did not include any moderators to test the boundary conditions of the current findings. Future research may attempt to explore the possible moderators of the aforesaid relationship, such as gender (Chang et al., 2019). Fifth, the bioecological theory of human development demonstrates that individual growth is shaped by four hierarchical subsystems (Bronfenbrenner & Morris, 2006). But this study only focused on the developmental assets from oneself, family, school and community in microsystem and mesosystem. Hence, scholars are encouraged to explore more positive factors from other hierarchical subsystems (e.g., macrosystem) to prevent developmental problems and promote flourishing in young people.

Conclusion

The present study investigated the relationship between developmental assets and adolescents' IGD in a follow-up design lasting half a year and revealed that during the COVID-19 pandemic, developmental assets were negatively associated with adolescents' IGD concurrently and longitudinally, and the overall developmental assets had cumulative effects in linear patterns on adolescents' IGD concurrently and longitudinally. Additionally, internal developmental assets mediated the relationship between external developmental assets and adolescents' IGD longitudinally. In light of these findings, the present study supports the developmental assets theory and expands the literature by explaining how developmental assets affect IGD in younger generations. Practically, the present study provides theoretical guidance for IGD prevention and intervention among adolescents during and after the COVID-19 pandemic. In specific, comprehensive measures should be taken to assist in developing positive personal and social resources to promote youth thriving.

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Author contribution G-X. Xiang contributed to the data collection and analysis, drafting and critical revision of the manuscript. X. Gan provided conception and design for this study. Y-H. Zhang and X. Jin participated in the data collection. All authors approved the final version to be published.

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Data Availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

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