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ORIGINAL ARTICLE

Internet Use and Adolescents' Physical and Mental Health: the Mediating Role of Self-consciousness and Peer Relationships

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Abstract
In recent years, online gaming and cyber pornography have become problematic activities among Internet users. When individuals immerse themselves in these activities, the experience of flow can negatively influence users' physical and mental health and interpersonal relationships. Thus, this study analyzed the mediating roles of self-consciousness and peer relationships in the relationships between online gaming, cyber pornography, and physical and mental health. We obtained data from fifteen senior high schools in Taiwan ($N = 1838$ students; first year, 996 students, and second year, 842 students) by conducting a 2-year longitudinal survey. Statistical analyses were performed using structural equation modeling. The results indicated that adolescents' online gaming was positively associated with their physical and mental health; however, it was negatively associated with their self-consciousness. In addition, when they became absorbed in cyber pornography, they lost track of time and lost self-consciousness, and it influenced their peer relationships. Self-consciousness and peer relationships mediated the relationships between cyber pornography and participants' physical and mental health. We identified relationships between online gaming, cyber pornography, elements of flow, and physical and mental health. The findings of this research can offer guidelines for policy makers and educators who evaluate adolescents' Internet use and behavior to provide proper access to Internet use and promote by building a healthy Internet environment in educational activities.

Keywords Internet use · Self-consciousness · Peer relationships · Mediation effect · Physical and mental health

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The Internet has significantly influenced many aspects of human life and has become integral to individuals' daily activities (Symons et al., 2019; Chao & Yu, 2017; Öztürk & Özmen, 2016; Yu & Chao, 2016; Chao et al., 2013), including online gaming and other forms of entertainment (Chao & Yu, 2017; Öztürk, & Özmen, 2016; Wartberg et al., 2017). Appropriate Internet use may promote personal development, broadened knowledge, and improved physical and mental health. However, problematic Internet use may have negative consequences, especially among adolescents who have yet to reach psychological maturity. These consequences may include a change in daily routine, problematic Internet use (PIU), interpersonal relationship problems, dysfunctional social skills, and physical/mental health damage (Baumgartner et al., 2010; Chao & Yu, 2017; Öztürk & Özmen, 2016; Yu & Chao, 2016). Greenfield and Yan (2006) noted that, among all age groups, adolescents—who are the most frequent Internet users (Öztürk & Özmen, 2016)—are the most affected by PIU. Many researchers have also acknowledged that adolescents' PIU has become a major global public health issue, specifically in Asian countries such as South Korea and China (Dunbar et al., 2017; Lai & Kwan, 2017; Wartberg et al., 2017).

While PIU among adolescents is a known issue globally (Dunbar et al., 2017; Lai & Kwan, 2017; Spada, 2014; Thatcher et al., 2008; Wartberg et al., 2017), previous literature has yet to reach a consensus on the definition of PIU. Lai and Kwan (2017) define PIU as "the excessive use of the Internet which causes disturbances or harm to the individual." They also describe "Internet use" as using the Internet for informational, entertainment, or other purposes, with any connected device. Davis (2001) defines PIU as the problematic use of the Internet by an individual for a specific purpose (e.g., online gaming, online pornography, or online gambling). Some researchers argue that PIU is a lack of one's strength to limit Internet use despite severe negative outcomes in daily life (Spada, 2014; Tam & Walter, 2013). According to this literature (Davis, 2001; Spada, 2014; Tam & Walter, 2013), in this research, we defined PIU as PIU for a specific purpose that influences one's daily life; specifically, we focused on online gaming and cyber pornography.

Cyberspace is a borderless environment, and users can interact with each other anonymously. Therefore, online gaming has become a popular recreational activity for its distinctive features. In the past few decades, online gaming has become one of the most popular leisure activities (Hu et al., 2019; Kim & Kim, 2018). For adolescents, while low levels of gaming may be beneficial (e.g., increased connection with friends, decreased loneliness) (Kaye et al., 2017; Sundberg, 2018), excessive online gaming may also result in negative consequences (e.g., decreased physical and mental health, neglecting "real-life" friendships, and decreased self-esteem) (Kaye et al., 2017; Spada & Caselli, 2017; Sundberg, 2018; Trepte et al., 2012; Yu & Chao, 2016). Previous research on online gaming has gained much attention from scholars. Some previous studies examined the characteristics of individuals addicted to online gaming, its connection with various psychological problems, and how it triggers a series of negative outcomes (Kaye et al., 2017; Spada & Caselli, 2017; Sundberg, 2018; Trepte et al., 2012; Yu & Chao, 2016). Clearly, the impacts of adolescents' online gaming behavior are a valuable topic for further exploration.

In recent years, the fast-growing popularity of the Internet, along with the spread of information and communication technology, have not only made pornography more accessible, but may have made it more acceptable (D'Orlando, 2011), magnifying anxieties about the harmful influence of Internet pornography on minors. Most adults have accessed online pornography (Brown et al., 2017; Grubbs et al., 2018; Regnerus et al., 2016). Regnerus et al. (2016) indicated in a national representative study of adults in the USA that 46% of men and 16% of women had viewed some form of cyber pornography within the past week. Since pornography became available online, it has created

an impact that was previously unimaginable. Unlike other forms of pornography, cyber pornography is easily accessible, anonymous, and often free (Kor et al., 2014). Since adolescents are frequent Internet users, their exposure to online pornographic content is likely, and it may result in them experiencing various anxieties. Therefore, further exploration of the negative influences is critical.

In recent years, flow theory has been examined in various information–technology environments, such as online gaming, human–computer interactions, and social networking services (Chen et al., 2017; Thatcher et al., 2008). It is a comprehensive theory to explain individuals' use of computers and Internet activities. Most prior studies argued that flow often brings positive effects (Chen et al., 2017; Thatcher et al., 2008). Essentially, flow refers to the feeling of pleasure when one is fully immersed in what he or she is doing (Hu et al., 2019). The most obvious characteristic of flow is time distortion—someone who is in a state of flow is so dedicated to the work at hand that they do not notice the pass of time (Csikszentmihalyi, 1997). However, excessive use of the Internet might lead to an increased risk of social phobias, problems in interpersonal relationships, physical and mental health damage, or damage to other social and family commitments (Fisher et al., 2016; Öztürk & Özmen, 2016; Thatcher et al., 2008; Yu & Chao, 2016).

Previous research has focused on exploring the effects of flow experience on users' behavior and Internet gaming disorder (Chen et al., 2017; Hu et al., 2019; Thatcher et al., 2008); however, few studies have focused on exploring the effects of flow experience on users' physical and mental health. Therefore, we believe it is worth investigating the effects of flow experience on physical and mental health. Although several previous researchers have investigated the effects of the Internet on interpersonal relationships (Lai & Gwung, 2013), their focus was on peer relationships, teacher–student relationships, and parent–child relationships. In addition, when people are completely focused on Internet use and there is little focus on other events in their surrounding environment, their sense of time becomes distorted. Thus, there will be a feeling of losing self-consciousness, which will also affect peer relationships. However, for adolescents, peer relationships are often related to their inner self-consciousness.

In addition, prior literature suggests that men report pornography use at substantially higher rates than do women (Brown et al., 2017; Price et al., 2016). Price et al. (2016) reported that approximately 60% of men and 35% of women have viewed some form of pornography. According to a 2014 survey of the Entertainment Software Association (ESA), most gamers want to socialize with other gamers while gaming, and more than 50% of online games have social features. That survey also indicated that the ratio of female gamers has increased significantly (a 50% increase), implying that male gamers no longer dominate online gaming communities (ESA, 2014). Nevertheless, no prior research attempted to investigate the possible association between adolescents' sex on their physical and mental health. As such, this study will further investigate the effects of adolescents' sex on their physical and mental health.

Cyber pornography and online gaming not only affect self-consciousness and peer relationships, they also affect individuals' physical and mental health. However, most previous research was based on cross-sectional data to understand the association between Internet use on physical and mental health at a single point in time. Therefore, the long-term applicability of these results will differ. This could be because adolescents' predisposition to use the Internet and physical and mental health are more likely to change over time. However, to our knowledge, no longitudinal study has analyzed these effects. Therefore, we employed a longitudinal approach to elucidate adolescents' Internet usage over time.

We also developed and evaluated a physical and mental health model to examine the antecedents of adolescents' physical and mental health by PIU and interpersonal relationship concepts. Based on the valence framework, we considered the association between PIU, self-consciousness, and peer relationships on participants' physical and mental health. The former has two dimensions—online gaming and cyber pornography—while the latter has two dimensions, self-consciousness and peer relationships. We also investigated the mediating roles of the self-consciousness and peer relationships in PIU (online gaming/cyber pornography) and physical and mental health.

Our specific research questions were as follows: (1) what are the dimensions of PIU, self-consciousness, and peer relationships that are associated with physical and mental health, and how is PIU related to each dimension of the self-consciousness and peer relationships? (2) How does self-consciousness and peer relationships mediate the effects of PIU on physical and mental health? (3) Do adolescents' physical and mental health change over time and are there sex differences?

Literature Review and Hypothesis Development

Self-consciousness and Peer Relationships

Flow refers to a mental state characterized by a narrowed focus of awareness and attention, such that all irrelevant thoughts are dismissed (Chen et al., 2017; Thatcher et al., 2008). In addition, flow also refers to a positive state of fundamental motivation. When one can process their tasks with full attention, they can forget the sense of self-consciousness and thus brings the state of enjoyment (Wu et al., 2020). Flow theory proposes that flow experience occurs when individuals engage in a specific activity with their full attention (Csikszentmihalyi, 1997). Thatcher et al. (2008) define flow as "a state of consciousness (usually characterized by a loss of a sense of time) that is sometimes experienced by individuals who are deeply involved in an activity they enjoy."

Csikszentmihalyi (1990) conceptualizes the state of flow as an optimal experience. In flow theory, time distortion is the most obvious characteristic—when one is immersed in an ongoing task, and their focus is narrowed to only that activity (Csikszentmihalyi, 1990). At these moments of complete involvement—the merging of action and awareness—temporarily loss self-consciousness occurs (Csikszentmihalyi, 1990; Sun et al., 2015). The flow experience has eight components: (1) challenges that match an individual's skills, (2) loss of self-consciousness, (3) a clear goal, (4) control over the task, (5) concentration and focus, (6) immediate and efficient feedback, (7) loss of a sense of time, and (8) an activity that becomes purposeful (Csikszentmihalyi, 1997).

During game play, the loss of self-consciousness component of flow is often referred to as a state of immersion. When players are in this state, they have a sense of being part of the computer or game world, and they are less likely to pay attention. For example, too much involvement in flow by being over absorbed and engaged can harm children since they might lose themselves in the state of enjoyment but neglect self-care and interpersonal relationships (Chiang et al., 2011). When users make friends on the Internet, they could also become friends in real life; therefore, the distinction is often blurred. Consequently, friendships formed in virtual space become as meaningful as offline friendships. When individuals become absorbed in their online work, they lose track of time and temporarily lose self-consciousness, which influences their peer relationships. However, for

adolescents, the Internet has become an important tool for maintaining both online and offline friendships, and it is associated with both physical and mental health.

Flow theory is related to PIU, especially concerning time distortion; however, flow is most often characterized as a positive state, whereas PIU is characterized as a negative state. According to Thatcher et al. (2008), there is also negativity in the characteristics of flow, for example, focusing more on recreational activities instead of one's work, academic tasks, or social/family commitments. Consistently, PIU can lead to negative consequences such as poor physical and mental health and dysfunctional social skills (Li et al., 2016; Moreno et al., 2013; Öztürk & Özmen, 2016; Yu & Chao, 2016). Therefore, the following research hypotheses were established:

Hypothesis 1 (H1): Self-consciousness will have a significant effect on physical and mental health.
Hypothesis 2 (H2): Peer relationships will have a significant effect on physical and mental health.
Hypothesis 5 (H5): Self-consciousness will have a significant effect on peer relationships.

Online gaming, Cyber Pornography, and Physical and Mental health

As people have more time, and chance to use the Internet, problematic Internet use (PIU) has become a critical behavioral problem globally, specifically for adolescent, for the Internet has become inseparable from their daily lives (Chao & Yu, 2017; Chao et al., 2013; Öztürk & Özmen, 2016; Wartberg et al., 2017). A few previous literature has found that adolescents mostly use the Internet for music listening, online gaming, social networking sites (SNS) visits, cyber friendships, movies, and other recreational purposes (Öztürk & Özmen, 2016; Sundberg, 2018; Wartberg et al., 2017).

Research findings regarding the association between online gaming and physical and mental health remain inconclusive. Online gaming may have a positive impact on users' physical and mental health because they afford opportunities for engagement and interaction (Carras et al., 2018). As a form of recreation, online gaming provides individuals with the opportunity to recover from stress, manage their mood, and restore energy (Carras et al., 2018; Rigby & Ryan, 2017; Primack et al., 2012). Online gaming also provides players an ideal place for social interactions: players become friends and provide stress-buffering social support to one another, thus strengthening users' physical and mental health (Carras et al., 2018; Primack et al., 2012; Steinkuehler & Williams, 2006). Primack et al. (2012) found that online gaming improves health conditions both mentally and physically. In addition, some studies argue that online gaming helps shy adolescents maintain existing friendships while making new friends and social connections (Hu et al., 2019; Sundberg, 2018). However, other studies considered online gaming to be one of the most addictive online activities (Hu et al., 2019), and excessive online gaming can bring negative effects to adolescents—damaging their physical and mental health and interpersonal relationships (Hu et al., 2019; Spada & Caselli, 2017).

Considering the contradictory empirical findings, the impact of online gaming on adolescents' physical and mental health merits further testing. We argue that online gaming is an important leisure activity for adolescents and appropriate online gaming activities may improve adolescents' physical and mental health. Therefore, we posit the following research hypothesis:

Hypothesis 3 (H3): Online gaming will have a significant effect on physical and mental health.

Concerning online pornography, 25% of daily search engine results are related to pornographic material (Allen et al., 2017; Grubbs et al., 2018). As with the effect of online gaming on physical and mental health, the findings remain inconclusive. Several studies have identified a positive impact of Internet pornography on viewers' physical and mental health, including helping individuals identify and understand their sexual orientation and increasing individuals' satisfaction with their body image (Hald et al., 2013; Watson & Smith, 2012). Yu and Chao (2016) studied Taiwanese high school students and found that cyber pornography positively significantly influenced their physical and mental health. However, individuals who excessively view cyber pornography may face negative outcomes including psychological problems, social isolation, and interpersonal relationships and mental health damage (Grubbs et al., 2018; Price et al., 2016). Like online gaming, contradictory findings suggest that the association between of cyber pornography and adolescents' physical and mental health merits further study. We posited the following hypothesis:

Hypothesis 4 (H4): Cyber pornography will have a significant effect on physical and mental health.

Online gaming, Cyber Pornography, Self-consciousness, and Peer relationships

Online gaming and cyber pornography have become the most problematic online activities, because these activities can influence users' physical and mental health and interpersonal relationship. During the last few years, with the continuous growth of Internet technology, especially the development of Web 2.0, the cyberspace has provided a more diverse and convenient way for social interactions. For example, Internet users nowadays can interact and cultivate interpersonal relationships via social networking sites (SNS) (Chao & Yu, 2017; Chao et al., 2013; Lai & Gwung, 2013; Yu & Chao, 2016; Yu et al., 2010).

A few previous studies have indicated that flow theory is useful for exploring individuals' behavior and their experience with online gaming (e.g., Hu et al., 2019). Sundberg (2018) found a significant relationship between online gaming and friendships among the general population. Lenhart et al. (2015) investigated online gaming habits among adolescents aged 13 to 17 years and found that playing games online with old friends can cultivate closer friendships. Cole and Griffiths (2007) found that social interactions during online gaming are at the center of players' enjoyment, which helps them maintain long-lasting friendships and emotional attachments. While appropriate Internet use may bring many positive results for game players, excessive gaming could make players lose themselves in the virtual world and temporarily lose self-consciousness and track of time. Therefore, we proposed the following:

Hypothesis 6 (H6): Online gaming will have a significant effect on self-consciousness.
Hypothesis 7 (H7): Online gaming will have a significant effect on peer relationships.

Allen et al. (2017) argued that cyber pornography—sexually explicit materials that evoke erotic thoughts, feelings, and behaviors—is a prevalent form of media that may cause problematic use. Some scholars argue that excessive pornography use is usually

accompanied by increased usage times and negative consequences in several aspects of daily life, such as academic/work performance (Allen et al., 2017; Grubbs et al., 2018; Kor et al., 2014). Moreover, frequent use of cyber pornography can also affect users' self-consciousness. To conclude, cyber pornography is likely to be associated with self-consciousness and peer relationships; therefore, we hypothesized the following:

Hypothesis 8 (H8): Cyber pornography will have a significant effect on self-consciousness.
Hypothesis 9 (H9): Cyber pornography will have a significant effect on peer relationships.

Gender and Adolescents' Physical and Mental Health

In recent years, exploring the influence of gender on cyber pornography and online gaming has received considerable attention and interest in the literature (Sallie et al., 2021; Brown et al., 2017; Price et al., 2016; Chou et al., 2011; Lin & Yu, 2008). Chou et al. (2011) analyzed gender differences in Internet-related attitudes of college students. The empirical results showed that male students assigned more importance to the attitude toward Internet-related enjoyment dimension than female students. Sallie et al. (2021) investigate how the COVID-19 isolation affects people's online gaming (OG) and pornography viewing (PV). They found that males have increased online gaming (OG) and pornography viewing (PV) compared to girls. One study on Internet usage among adolescent in Taiwan found that gender differences among adolescent persist in online activities. Male adolescents tend to play online games, and female adolescents view social interactions (emailing friends) and searching for information as more important (Lin & Yu, 2008). According to the above-mentioned literature, we found that gender differences in cyber pornography and online gaming seem to persist. In addition, previous studies have pointed out that online gaming and cyber pornography will affect users' physical and mental health and interpersonal relationship. However, excessive use of online games and cyber pornography could make users lose themselves in the virtual world and affect their self-consciousness. Accordingly, this study attempts to explore gender differences in the effects of adolescents' cyber pornography and online gaming on peer relationships, self-consciousness, and physical and mental health.

Research Methodology

Measure Development and Validation

The present study examined whether online gaming and cyber pornography significantly predict the self-consciousness, peer relationships, and users' physical and mental health. The hypothesized model was constructed using (1) exogenous variables (online gaming, cyber pornography), (2) endogenous variable (physical and mental health), and (3) the mediator variable (self-consciousness and peer relationships). See Fig. 1 for a summary of the hypotheses and the proposed path model.

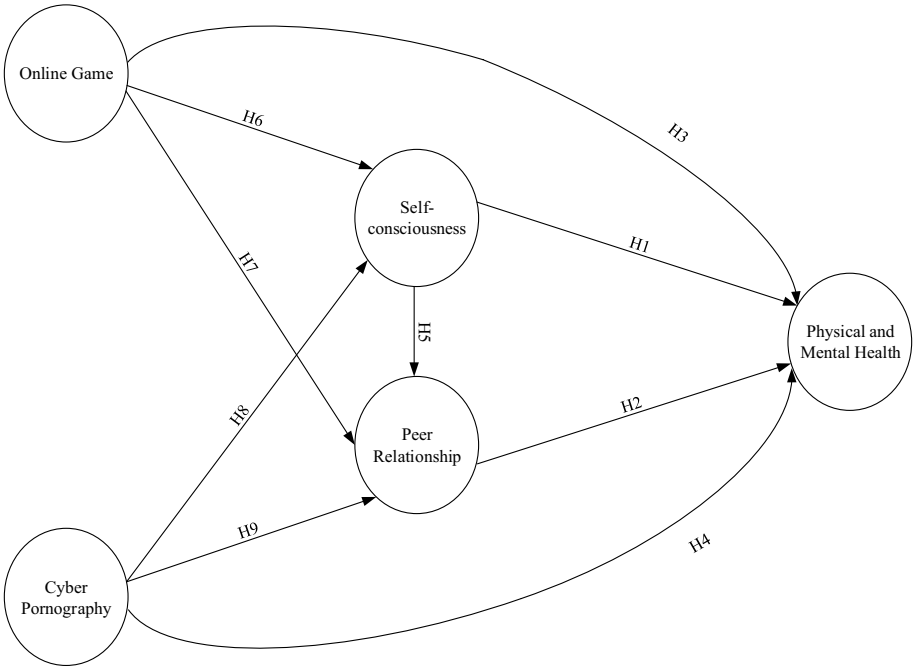

Fig. 1 Research framework

Sample and Descriptive Statistics

Instrumentation and Data Collection Tools

Data were collected by conducting a survey. The instrument consisted of a two-part questionnaire. The first part concerned participants' basic demographics. The second part concerned respondents' perceptions of online gaming, cyber pornography, peer relationships, self-consciousness, and physical and mental health.

Scale development followed MacKenzie et al. (2011) and the development procedures suggested by Devellis (2003) for standard psychometric scales. The main constructs of PIU (i.e., online gaming and cyber pornography) were adapted from a previously developed measure (Carras et al., 2018; Hald et al., 2013; Kaye et al., 2017; Rigby & Ryan, 2017; Sundberg, 2018; Watson & Smith, 2012; Yu & Chao, 2016). Two constructs of self-consciousness and peer relationships were measured by 3 and 4 items, respectively, that were adapted from previous studies (Cole & Griffiths, 2007; Csikszentmihalyi, 1997; Hu et al., 2019; Sun et al., 2015). Finally, the constructs of physical and mental health were measured by 4 items that were adapted from previous studies (Carras et al., 2018; Rigby & Ryan, 2017; Yu & Chao, 2016). Items measuring respondents' perceptions utilized a 5-point Likert-type scale anchored at 1 (*strongly disagree*) and 5 (*strongly agree*).

Prior to data collection, a pilot study was conducted to confirm the reliability of the developed instrument. The questionnaire was administered to 425 senior high school students in central Taiwan. The results revealed that the Cronbach's alpha coefficients of all components exceeded the minimum value of 0.6 that is widely used as an indicator of

reliability (Hair et al., 2010), which indicated that the questionnaire was reliable (see the Results section below).

Participants and Data Collection

Participants were recruited from 25 senior high schools (including a vocational high school) in Taiwan. This was a 2-year longitudinal study; thus, students who participated in the first year also participated in the second year. We utilized stratified sampling to enhance representativeness by region. As a preliminary step, a teacher working in academic affairs at each high school was contacted to ensure their cooperation. This study adopted a quantitative survey and utilized mail and face-to-face interviews with high schools that were willing to distribute the survey. The teachers explained the questionnaire to the students. Fifteen schools were willing to participate.

Two classes were randomly selected from each school, and 100 students from each school were enrolled as participants. A total of 1,500 questionnaires were disseminated simultaneously each year. During the 2-year investigation, 1,838 students responded to the questionnaire ($n=996$ in year 1, $n=842$ in year 2; overall response rate = 61.27%). The eventual response rates were 66.4% for the first year and 56.1% for the second year. All participants were students enrolled in the sample schools, and participation was voluntary.

Participants' demographic characteristics are shown in Table 1. Participants' mean age in years 1 and 2 were 16.99 years (standard deviation (SD) = 2.90) and 18.49 years ($SD=5.38$), respectively. The mean number of good friends they had made on the Internet in the last 6 months was 7. Concerning sex distribution, in year 1, 66.5% were boys; in year 2, 62.2% were boys. Concerning grade, in year 1, 42.4% were in their first year of senior high school, and 57.6% were in their second; in year 2, 31.9% were in the

Table 1 Profile of respondents

Demographics/level	First year		Second year	
	N	Percentage	*N*	Percentage
Gender				
Male	662	66.5	524	62.2
Female	334	33.5	318	37.8
Grade				
1st grade	422	42.4	0	0.0
2nd grade	574	57.6	269	31.9
3rd grade	0	0.0	573	68.1
Place of internet usage				
Home	888	89.2	735	87.3
School's computer room	9	0.9	6	0.7
Internet cafe	56	5.6	41	4.9
Other place	43	4.3	60	7.1
	Mean	SD	Mean	S.D
Age	16.99	2.90	18.49	5.38
The number of good friends you have made on the Internet in the last 6 months	7.31	52.29	6.64	54.71

second year, and 68.1% were in the third year of senior high school. Lastly, 89.2% and 87.3% reported using the Internet at home in years 1 and 2, respectively.

Results

Data Analysis

Structural equation modeling (SEM) was used in a comprehensive analysis of both the measurement models and structural models. The most commonly adopted SEM techniques include partial least squares (PLS), analysis of moment structure, and linear structural relations (Chin, 1998; Jöreskog & Sörbom, 2005). PLS regression is component-based and employs a least squares estimation procedure. This research used PLS with bootstrapping for our research model and to test and validate the proposed model and the relationships among the hypothesized constructs.

Measurement Model Evaluation

In PLS analyses, the composite reliability (CR) and average variance extracted volume (AVE) can be utilized to assess the reliability and validity of the structural model, respectively. Accordingly, we selected the three most commonly used evaluation indicators, which reflected the measurement mode: (1) individual item reliability, (2) CR, and (3) AVE (Bagozzi & Yi, 2012; Chin, 1998; Fornell & Larcker, 1981; Hair et al., 2010; Jöreskog & Sörbom, 2005). Table 2 shows the indices of reliability and convergent validities for the scale.

As demonstrated in Table 2, all item factor loading ranged from 0.606 to 0.906, which indicated reliability because all values exceeded 0.60 (Hair et al., 2010). In addition, all values displayed a higher composite reliability than the 0.6 benchmark recommended by Fornell and Larcker (1981). Concerning AVE, all exceeded the criteria except for peer relationships and physical and mental health.

Table 2 Reliability and validity indicators of the proposed model

Items	All Sample		Year				Gender			
			First year		Second year		Male		Female	
	CR	AVE	CR	AVE	CR	AVE	CR	AVE	CR	AVE
OG	0.824	0.541	0.825	0.544	0.816	0.528	0.831	0.553	0.792	0.491
CP	0.920	0.743	0.921	0.746	0.919	0.739	0.909	0.714	0.907	0.711
SC	0.768	0.525	0.780	0.542	0.749	0.501	0.764	0.520	0.755	0.509
PR	0.761	0.446	0.774	0.463	0.744	0.424	0.751	0.432	0.747	0.433
PMH	0.787	0.481	0.796	0.495	0.772	0.461	0.795	0.494	0.761	0.450

SC, self-consciousness; *PR*, peer relationship; *CP*, cyber pornography; *OG*, online game; *PMH*, physical and mental health

Testing the Structural Model

The structural model path analysis results for the effect of PIU (online gaming and cyber pornography), self-consciousness, and peer relationships on physical and mental health were as follows: online gaming and peer relationships had a significant positive effect on physical and mental health ($\beta = 0.152$ and 0.395, $p < 0.05$, respectively). Self-consciousness had a significant negative effect on physical and mental health ($\beta = -0.151$, $p < 0.05$). Cyber pornography had a non-significant effect on physical and mental health ($\beta = -0.037$, $p > 0.05$). Therefore, hypotheses 1–3 were supported; however, hypothesis 4 was not supported. Self-consciousness had a significant negative effect on peer relationships ($\beta = -0.493$, $p < 0.05$), thereby supporting hypothesis 5. Online gaming and cyber pornography had significant negative effects on self-consciousness ($\beta = -0.156$ and -0.190, $p < 0.05$, respectively), thereby supporting hypotheses 6 and 8. Cyber pornography had a significant positive effect on peer relationships ($\beta = 0.182$, $p < 0.05$). Therefore, hypothesis 9 was supported. Finally, online gaming had a non-significant effect on peer relationships ($\beta = -0.005$, $p > 0.05$); thus, hypothesis 7 was not supported. The PLS results for the structural model are presented in Table 3. Figure 2 presents the explanatory power.

Testing the Mediator Effect

To further investigate the mediating effect of self-consciousness and peer relationships in the model, we followed the key mediator variable analysis suggested by Morgan and Hunt (1994). Since we were investigating the mediating effect of self-consciousness and

Table 3 Estimation results for hypotheses

Construct	All sample	Year		Year differences	Gender		Gender differences
		First year	Second year	*t* value (*p* value)	Male	Female	*t* value (*p* value)
SC → PMH	−0.151**	−0.161**	−0.137**	−0.024 (0.655)	−0.163**	−0.114*	−0.049 (0.421)
PR → PMH	0.395**	0.396**	0.392**	0.003 (0.955)	0.419**	0.344**	0.075 (0.188)
OG → PMH	0.152**	0.136**	0.168**	−0.032 (0.512)	0.185**	0.066	0.119* (0.024)
CP → PMH	−0.037	−0.036	−0.038	0.003 (0.958)	−0.019	−0.062	0.042 (0.442)
SC → PR	−0.493**	−0.476**	−0.513**	0.037 (0.354)	−0.516**	−0.425**	−0.091* (0.031)
OG → SC	−0.156**	−0.193**	−0.111**	−0.081 (0.102)	−0.178**	−0.121**	−0.057 (0.297)
OG → PR	−0.005	−0.007	−0.017	0.010 (0.841)	0.000	0.022	−0.022 (0.657)
CP → SC	−0.190**	−0.204**	−0.166**	−0.038 (0.440)	−0.110**	−0.218**	0.108* (0.026)
CP → PR	0.182**	0.196**	0.174**	0.022(0.620)	0.098**	0.264**	−0.166** (< 0.001)

*$p < 0.05$, **$p < 0.01$

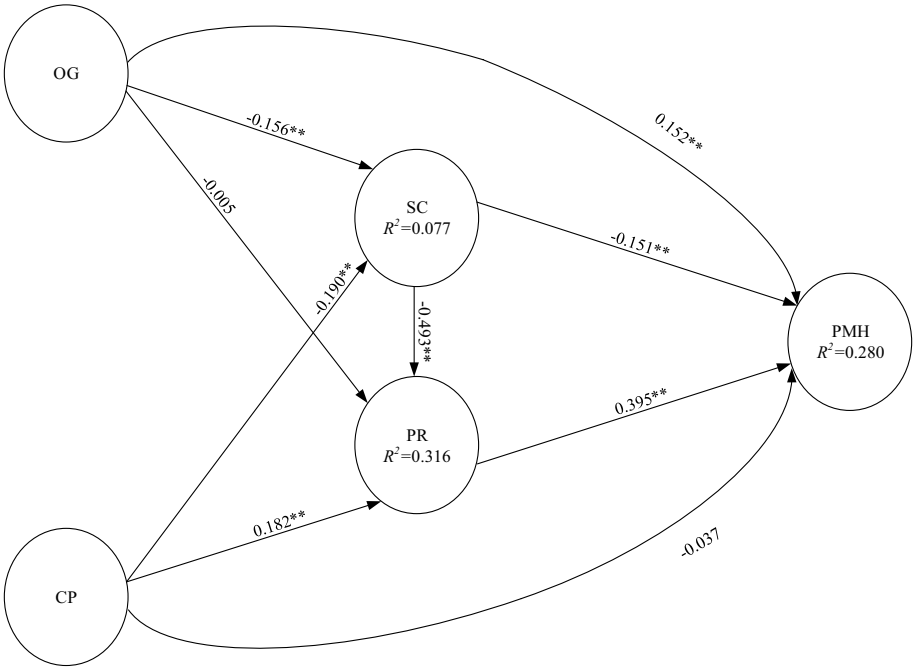

Fig. 2 Results of the structural model testing (all sample). Value on path, standardized coefficients (β); R^2, coefficient of determination; and * $p < 0.05$, ** $p < 0.01$

peer relationships in a model that includes the relationships between two independent variables (online gaming and cyber pornography) and one dependent variable (physical and mental health), eight paths were examined: (1) online gaming → self-consciousness, (2) online gaming → peer relationships, (3) online gaming → physical and mental health, (4) cyber pornography → self-consciousness, (5) cyber pornography → peer relationships, (6) cyber pornography → physical and mental health, (7) self-consciousness → physical and mental health, and (8) peer relationships → physical and mental health.

First, with online gaming as an independent variable, the self-consciousness and peer relationships exhibited a significant mediating effect between online gaming and physical and mental health (see Table 4). Thus, the mediating effect of self-consciousness and peer relationships was supported. Table 4 also presents the results of further investigation into the effects on physical and mental health of online gaming, cyber pornography, self-consciousness, peer relationships, and the mediating roles of the self-consciousness and peer relationships as mediated by 2-year data and sex. The adolescents whose first-year survey had the highest mediator coefficient in all critical paths of physical and mental health, especially for online gaming → self-consciousness → peer relationships → physical and mental health. Compared to girls, boys had higher coefficients, especially for online gaming → peer relationships → physical and mental health.

Second, with cyber pornography as an independent variable, the results showed that self-consciousness and peer relationships exhibited a significant mediating effect between cyber pornography and physical and mental health (see Table 5); thus, the

Table 4 Analysis of flow relationship chain mediator test results (IV = OG)

DV: PMH		Product of coefficients			Percentile 95% CI		BC 95% CI	
IV: OG		Point estimate	SE	*p*	Lower	Upper	Lower	Upper
Complete data	Total:	0.088**	0.011	< 0.001	0.067	0.110	0.068	0.110
	Ind1:	0.031**	0.006	< 0.001	0.019	0.044	0.020	0.046
	Ind2:	0.036**	0.005	< 0.001	0.027	0.045	0.028	0.046
	Ind3:	0.021**	0.006	0.001	0.009	0.034	0.010	0.035
First year	Total:	0.100**	0.015	< 0.001	0.072	0.131	0.072	0.131
	Ind1:	0.038**	0.010	< 0.001	0.020	0.058	0.020	0.060
	Ind2:	0.040**	0.006	< 0.001	0.028	0.054	0.029	0.055
	Ind3:	0.021*	0.009	0.020	0.005	0.041	0.006	0.043
Second year	Total:	0.067**	0.015	< 0.001	0.039	0.097	0.041	0.099
	Ind1:	0.021**	0.007	0.003	0.008	0.035	0.009	0.036
	Ind2:	0.027**	0.006	< 0.001	0.015	0.041	0.014	0.041
	Ind3:	0.020*	0.009	0.029	0.003	0.039	0.003	0.040
Male	Total:	0.074**	0.014	< 0.001	0.049	0.101	0.049	0.101
	Ind1:	0.031**	0.007	< 0.001	0.018	0.047	0.019	0.047
	Ind2:	0.035**	0.006	< 0.001	0.025	0.047	0.025	0.048
	Ind3:	0.001	0.008	0.329	− 0.007	0.025	− 0.007	0.026
Female	Total:	0.064**	0.017	< 0.001	0.031	0.101	0.033	0.102
	Ind1:	0.020*	0.009	0.030	0.004	0.041	0.005	0.044
	Ind2:	0.022**	0.007	0.001	0.011	0.038	0.011	0.039
	Ind3:	0.021	0.011	0.054	0.001	0.043	0.001	0.044

*$p < 0.05$; **$p < 0.01$

Ind1: OG → SC → PMH; Ind2: OG → SC → PR → PMH; Ind3: OG → PR → PMH

mediating effect of self-consciousness and peer relationships was supported. Further, the first-year survey model supported the full mediating effect of peer relationships and self-consciousness. In addition, the female model also supported the full mediating effect of peer relationships but not self-consciousness. The male structural model supported the full mediating effect of both peer relationships and self-consciousness.

Discussion

The Internet is an integral part of adolescents' daily lives. They use the Internet predominately for information searching, entertainment, and connecting with others (Chao & Yu, 2017; Öztürk & Özmen, 2016; Wartberg et al., 2017). Our results showed that online gaming had a significant and positive influence on adolescents' physical and mental health; however, it had a negative influence on their self-consciousness, thus supporting our hypotheses. Our findings are consistent with the results of previous studies (Carras et al., 2018; Rigby & Ryan, 2017; Primack et al., 2012) concerning the association between online gaming and physical and mental health.

We did not find any significant relationship between online gaming and peer relationships, which contradicts prior findings (Hu et al., 2019; Lenhart et al., 2015; Sundberg,

Table 5 Analysis of flow relationship chain mediator test results (IV = CP)

DV: PMH		Product of coefficients			Percentile 95% CI		BC 95% CI	
IV: CP		Point estimate	SE	*t* value	Lower	Upper	Lower	Upper
Complete data	Total:	0.089**	0.009	10.184	0.000	0.072	0.105	0.072
	Ind1:	0.025**	0.005	5.319	0.000	0.016	0.034	0.017
	Ind2:	0.024**	0.004	6.971	0.000	0.018	0.032	0.018
	Ind3:	0.039**	0.006	7.145	0.000	0.029	0.051	0.029
First year	Total:	0.096**	0.012	8.017	0.000	0.074	0.120	0.074
	Ind1:	0.029**	0.007	4.042	0.000	0.016	0.045	0.016
	Ind2:	0.026**	0.005	5.543	0.000	0.018	0.035	0.018
	Ind3:	0.042**	0.008	5.200	0.000	0.028	0.058	0.029
Second year	Total:	0.076**	0.012	6.367	0.000	0.055	0.101	0.056
	Ind1:	0.019**	0.006	3.207	0.001	0.008	0.032	0.009
	Ind2:	0.022**	0.005	4.320	0.000	0.012	0.032	0.013
	Ind3:	0.036**	0.008	4.582	0.000	0.021	0.052	0.023
Male	Total:	0.061**	0.010	6.040	0.000	0.043	0.082	0.042
	Ind1:	0.020**	0.005	4.146	0.000	0.011	0.030	0.012
	Ind2:	0.019**	0.004	4.750	0.000	0.012	0.028	0.012
	Ind3:	0.022**	0.007	3.348	0.001	0.010	0.035	0.010
Female	Total:	0.117**	0.018	6.506	0.000	0.085	0.153	0.083
	Ind1:	0.025*	0.010	2.426	0.015	0.006	0.047	0.008
	Ind2:	0.024**	0.006	3.967	0.000	0.013	0.038	0.014
	Ind3:	0.068**	0.013	5.344	0.000	0.046	0.097	0.047

*$p < 0.05$; **$p < 0.01$

Ind1: CP → SC → PMH; Ind2: CP → SC → PR → PMH; Ind3: CP → PR → PMH

2018). For example, Sundberg (2018) found a significant relationship between online gaming and friendships among the general population. Lenhart et al. (2015) also found that playing games online with friends can cultivate closer friendships. Our finding may reflect the fact that online gaming has become one of the most frequent activities among adolescents. Adolescents play online games so frequently that the activity becomes a part of their lives, and they discuss online gaming both online and offline. Therefore, we did not observe a significant relationship between online gaming and peer relationships. When adolescents become immersed in an online game, they become aware of their skills compared to other players, even more so with professionals. Subsequently, their gaming frequency and interaction with other players are reduced, and they become less immersed in the game.

We also identified that cyber pornography had a significant and positive influence on peer relationships and a negative influence on self-consciousness. However, cyber pornography had a non-significant effect on physical and mental health. This finding differs from findings in previous studies (Hald et al., 2013; Yu & Chao, 2016). This indicates that, when adolescents become addicted to online pornography, they are also exploring their sexual orientation (Kor et al., 2014). Exploring online pornography can give adolescents something to talk about, thus making their friendships stronger. However, they may begin to feel inferior to the actors they see in graphics or videos, thereby negatively affecting their perception of said pornography. The ease of access to pornographic websites has enabled

adolescents to explore their sexual orientation; thus, online pornography did not negatively affect adolescents' physical and mental health.

Because self-consciousness was significantly correlated with peer relationships, self-consciousness should be used to predict adolescents' peer relationships. This result is consistent with those of Branden (2001) and Doherty and Schlenker (1991). The Internet has influenced adolescents' self-consciousness when accessing traditional and online media because adolescents can experience flow while participating in online activities. When immersing themselves in a virtual environment, adolescents focus on their performance and attitude, which, in turn, affects both their physical and mental health and peer relationships. Moreover, self-consciousness served as a mediating variable of online gaming. When adolescents play an online game, they encounter professional gamers—an experience that might reduce their interest in the game and thereby improve their physical and mental health by lowering their gaming frequency to a normal level.

Instead of exerting a direct effect, Internet pornography indirectly affected physical and mental health through two mediating variables: self-consciousness and peer relationships. Online gaming not only directly affected physical and mental health, it also indirectly affected them through these two mediating variables. Thus, self-consciousness and peer relationships could be key mediating variables between online pornography and physical and mental health. When adolescents immerse themselves in online pornography, they discuss related topics with their peers, helping adolescents form better peer relationships, understand sexual knowledge, and explore their sexual orientation, thus promoting their physical and mental health. However, the results also revealed that, because of the virtual characteristic of the Internet, adolescents pay little attention to their own status when immersing themselves in online pornography.

The results also showed that, while online gaming exerted a non-significant effect on physical and mental health among female participants, the effect was significant among male participants. Previous studies have indicated that the frequency of online gaming for female adolescents has progressively increased; nevertheless, online gaming and pornography are still more prevalent among boys, which coincide with our results.

Limitations

This study had several limitations that indicate the need for further research. The first limitation concerns our research design. Although we conducted a 2-year longitudinal study, definitive claims about causality cannot be made. Therefore, utilizing an experimental design is needed to fully understand adolescents' PIU (online gaming and cyber pornography) and its effects on their physical and mental health. Second, we did not focus on adolescents' addiction, which may be associated with their experience and their subsequent physical and mental health. These relationships should be explored in further studies. Third, data were collected through a self-administered questionnaire, and the responses were subjective. More objective measures could be used in the future. Finally, participants were senior high school students in Taiwan; therefore, caution is needed when generalizing our findings to other populations. Nonetheless, this study informs other researchers who wish to refine our model and determine its predictive power in other countries.

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Declarations

Ethics Approval The study research procedures were carried out in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The exemption of this study was because the data of this questionnaire were anonymous and there is no way for readers to be able to identify the participants. There are no name lists that correspond to the respondents of questionnaire, and the names of the participant universities were not mentioned.

Consent to Participate All of the subjects were informed about the research, and all of the participants who were enrolled in the study provided informed consent.

Conflict of Interest The authors declare no competing interests.

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