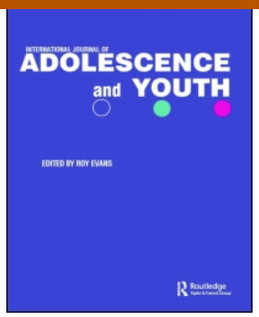

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Internet use and Problematic Internet Use: a systematic review of longitudinal research trends in adolescence and emergent adulthood

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ABSTRACT

The aim of this systematic literature review is to map the longitudinal research in the field of Internet Use (IU) and Problematic Internet Use (PIU) in adolescents and emergent adults. Further, this study endeavours to examine the terminology and instruments utilized in longitudinal IU and PIU research and investigate whether statistically significant results have arisen from the areas of research focus. In a total of 29 studies, trends in the research of adolescent/emergent adult IU and PIU were discovered. These trends were conceptualized into individual, contextual and activity-related factors. Findings suggested that individual factors are the most researched and have demonstrated significant relationships with adolescent/young adult PIU. However, more research on contextual and activity-related factors is needed in order to achieve a clearer understanding of young people's IU and PIU behaviours, and to incorporate into a comprehensive model that will guide future research in this growing field.

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Internet Use; Problematic Internet Use; systematic review; longitudinal; adolescence; emergent adulthood

Introduction

In the last decade, use of the Internet has grown exponentially and has become an integral part of daily life; providing global communication, access to information, and provision of entertainment. It has become especially central within the adolescent and emergent adult population for whom technological literacy is pivotal to both work and play (Aslanidou & Menexes, 2008; Thorsteinsson & Davey, 2014; Wallace, 2014). The significant role of the Internet in the lives of this population is clear, with 81% of adolescents who have access to computers reporting using the Internet daily for communication with their peers in 2012 (Pew Research Center, 2012), and only 15% of Americans reporting not using the Internet in 2014 (Pew Research Center, 2014).

However, the line between Internet Use (IU) and Problematic Internet Use (PIU) is noticeably being overstepped; with high use of the Internet to the extent of 'addiction' being the focus of much global research, and 'Internet Gaming Disorder' being proposed as a condition requiring further research by the American Psychiatric Association (2013). The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) describes this proposed condition as 'a clinically significant impairment on daily life as a result of continual gaming' (American Psychiatric Association, 2013, p. 795).

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PIU comprises an important area of research as its negative consequences have been found to impact on everyday functioning, interpersonal relationships and emotional well-being (Akin, 2012; Anderson, 2001; Young & Rogers, 1998). In fact, symptoms of PIU are similar to those suffering from substance-related addictions, including unpredictable behaviour and mood (Hsu, Wen, & Wu, 2009; Ko, Yen, Chen, Yeh, & Yen, 2009).

This area is particularly relevant to adolescents (12–17 years) and emerging adults (18–29 years) because they access the Internet more than any other age group (Pew Research Center, 2012) and therefore, are more at risk of the above-mentioned implications of PIU. Further, it is important that PIU does not go unnoticed during this developmental period since it has been found that addictive behaviours developed during this time are likely to continue into adulthood (Coffey, Carlin, Lynskey, Li, & Patton, 2003).

The potential positive implications of IU, and the negative repercussions of PIU, along with the developmental significance of this period for adolescents and emerging adults demonstrate the importance of research on the entire range of this population's IU and PIU behaviours (Ko, Liu, et al., 2009; Wallace, 2014). Despite the important theoretical contributions to conceptualizing PIU predictors and consequences, the current literature lacks a conceptual framework that would embrace the developmental influence that is pivotal to the study of behaviour, particularly during this transitional developmental time. This review endeavours to contribute to the extant literature by emphasizing the developmental perspective and the possible changes of IU and PIU behaviours, by approaching them as a continuum, ranging from healthy to problematic or excessive use, and focusing on age related and ecological effects during adolescence and emergent adulthood. Specifically, this review aims to summarize the current longitudinal research regarding IU and PIU during adolescence and emergent adulthood, which has not been addressed in the past. Further, the empirical evidence of individual, contextual and activity-related antecedents of PIU will be explored in order to identify research trends to determine factors that have been over researched, and those that have been overlooked. Finally, this review will provide a framework for new hypotheses to be generated regarding the IU continuum, incorporating the developmental perspective.

Conceptual framework

The aim of this literature review is to summarize the existing longitudinal evidence considering IU and PIU during adolescence and emergent adulthood. Taking into account the recommendations of Griffiths (2005) and McMurran (1994), the conceptual model developed in this paper is built on the basis that a framework should be integrative and flexible. In order to encompass all the critical elements of the field in this way, two commonly used conceptual models were combined to create the lens through which the current review approaches the empirical longitudinal research of the IU/PIU continuum. The first, the Bioecological Model of Human Development (BMHD) (Bronfenbrenner & Morris, 2006) was chosen because of its emphasis on behaviours constantly evolving along a continuum due to the interplay of individual and contextual factors over time. Therefore, the current review approaches the literature with a focus on longitudinal studies, with the interplay of individual and contextual factors over time being considered. However, this model does not acknowledge the influence of activity-related factors, such as the Internet itself, which is why Douglas' Internet Addiction Model (IAM) has also been integrated into the framework of this review (Douglas et al., 2008).

The IAM conceptualizes PIU as the result of the interplay between an individual's 'push' and 'pull' factors (Douglas et al., 2008). This model describes 'push' factors as the aspects of the Internet that are attractive to people in a way that fulfils their needs and motivations (such as the facelessness and escapism aspects of the Internet). 'Pull' factors are the attributes of the Internet that give it high potential to be addictive (such as low cost, opportunity to forget social isolation, ease of communication, user convenience and anonymity), and which moderate individual's level of IU and/or PIU. Together, these two models conceptualize a framework through which to review the current longitudinal research of

IU-PIU. This integrative framework focuses on individual factors, contextual factors, developmental factors, and the influence of the Internet itself on people's position on the IU-PIU continuum.

Method

A computer database search of ScienceDirect, PubMed and Academic Search Complete was conducted on 13 June 2016, and the following search terms and logic were used to search for relevant resources: In title: (Internet OR web OR online OR gaming OR 'video game') AND title/abstract: (longitudinal OR longitudinally). All searches were limited to full text, in English papers, which have been peer reviewed, were published between 1994 and 2016 (there are no relevant studies before this time), and where humans were the participants. These search boundaries generated a total of 670 results which included the following results in each database: ScienceDirect (181), PubMed (291) and Academic Search Premier, (over 28,000 initial results; then limited to the area of psychology which yielded 198 results).

The reference list of reviews of Internet/gaming addictions/problematic use were examined for longitudinal studies (Chou, Condron, & Belland, 2005; King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; Kuss & Griffiths, 2012; Lam, 2014; Widyanto & Griffiths, 2006) and eight studies were added to further complement the research findings.

After duplicates were removed, studies were selected in accordance with the following inclusion criteria. Studies had to be (i) longitudinal, with at least 2 months between time points (a longer period allows for developmental sequences and causation to become apparent (Taplin, 2005); (ii) have IU and/or PIU as the dependent variable, (iii) have participants who were adolescents or young adults (as the focus of this literature review is on changes during that developmental period), (iv) contain empirical data. Studies were also excluded if the Internet variables measured existing sexual or gambling addictions because in these instances the Internet was considered the medium through which underlying disordered behaviour is carried out, and therefore according to literature, is not considered purely PIU (Shaffer, Hall, & Vander Bilt, 2000). A total of 29 studies were deemed eligible for this review after meeting all the above criteria. The methodological quality of these studies was evaluated, with specific attention to the reliability of IU and/or PIU measures (see Table 1). Figure 1 provides a visual representation of the current review's methodological process, according to the PRIMSA framework (Moher, Liberati, Tetzlaff, & Altman, 2009).

Results

Table 2 provides a summary of the 29 studies reviewed in this paper, including demographic information and the major findings of each study.

Definitions/terminology used to describe the IU and PIU behaviours studied

While there is consensus amongst researchers that the phenomenon of 'PIU' exists, there is no standardized definition supported by all in the field. A summary of the terms used in longitudinal research can be found in Table 3. Some studies base their conceptualization of PIU on the notion of lack of control of IU without accepting its compulsive qualities. These authors use the conceptualization of PIU to describe a psychological dependence and lack of control over the time spent online, without considering the behaviour as presenting similarities to compulsive manifestations (Gámez-Guadix, 2014; Gámez-Guadix, Calvete, Orue, & Havas, 2015; Gámez-Guadix, Orue, Smith, & Calvete, 2013; Mittal, Dean, & Pelletier, 2013). A second group of studies adopt the notion that the problem is not the Internet as a medium, but rather the different applications and activities facilitated by it (Ciarrochi et al., 2016; Meerkerk, Van Den Eijnden, & Garretsen, 2006; Sun et al., 2012; van Rooij, Schoenmakers, van de Eijnden, & van de Mheen, 2010; Van Rooij, Schoenmakers, Vermulst, Van Den Eijnden, & Van De Mheen, 2011). Therefore, they identify PIU as Compulsive Internet Use. This involves loss of control in relation to certain Internet activities and compulsively using the Internet in order to access these applications (Thorsteinsson & Davey, 2014;

Table 1. Quality of methodologies of studies (reported reliability at each time point).

	Instrument	Reliability (α)
Study 1	Internet Addiction Test (IAT)	'Strong internal reliability'**
Study 2	IAT (Chinese adaption)	.79 (T1)
		.80 (T2)
		.81 (T3)
Study 3	IAT	.91
Study 4	Compulsive Internet Use Scale (CIUS)	.88 (T1)
		.88 (T2)
Study 5	Measure of Frequency of Computer Game Use	–
Study 6	Measure of Frequency of Computer Game Use	–
Study 7	Generalized Problematic Internet Use Scale 2 (GPIUS2)	.90
Study 8	CIUS (Shortened version)	.85 (T1)
		.90 (T2)
Study 9	Measure of pathological video game use	.71 (T1)
		.77 (T2)
		.79 (T3)
Study 10	CIUS	.89 (T1)
		.89 (T2)
Study 11	Problematic Video Game Playing Test (Adaption of IAT)	.92
Study 12	Measure of Frequency of Internet Use	– (Server logged)
Study 13	IAT	–
Study 14	CIUS	.84 (T1)
		.87 (T2)
Study 15	CIUS	.82 (T1)
		.94 (T2)
Study 16	Measure of Problematic Gaming	.84
	Measure of Frequency of Internet Use	–
Study 17	Chen Internet Addiction Scale (CIAS)	.79–.93**
Study 18	Davis Scale for Problematic Internet Use (adaption)	.84 (Chinese Sample)
		.80 (USA Sample)
Study 19	GPIUS2	.76–.90
Study 20	CIAS	.79–.93**
Study 21	IAT	.93
Study 22	Measure of Frequency of Computer Game Use	–
Study 23	Measure of Pathological Video Game Use	–
Study 24	Measure of Pathological Video Game Use	.91 (T1)
		.91 (T3)
Study 25	CIAS	.79–.93**
Study 26	GPIUS2	.78–.90
Study 27	Measure of Frequency of Computer Game Use	–
Study 28	CIAS	.79–.93**
Study 29	CIUS (Shortened version)	.88 (T1)
		.89 (T2)
		.89 (T3)
		.90 (T4)

* = Reliability not recorded in research article, instead provided by author of research article.
** = Reliability data recorded in study refers to known reliability of measure in other studies.
– = No reliability data recorded.

van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008; van den Eijnden, Spijkerman, Vermulst, van Rooij, & Engels, 2010). As argued by Stavropoulos, Gentile, and Motti-Stefanidi (2016), compulsive symptoms function mainly as harm-avoidant behaviours and are ego-dystonic, whereas PIU is primarily driven by seeking gratification and is ego-syntonic. A third group of researchers emphasize on the similarities between aspects of PIU and addictive behaviours regarding how PIU impacts concurrent and future general adaptation, thus suggesting the term Internet Addiction (Chen, Chen, & Gau, 2015; Cho, Sung, Shin, Lim, & Shin, 2013; Dong, Lu, Zhou, & Zhao, 2011; Ko, Liu, et al., 2009; Ko, Yen, Yen, Lin, & Yang, 2007; Mittal et al., 2013; Stavropoulos, Kuss, Griffiths, Wilson, & Motti-Stefanidi, 2015; Sun et al., 2012; Yen et al., 2012; Yu & Shek, 2013). Finally, a fourth group of studies conceptualize PIU based primarily on the Internet application abused, especially when the latter includes Internet gaming. In this line, Online Game Addiction has been studied longitudinally (Hong, You, Kim, & No, 2014; Van Rooij

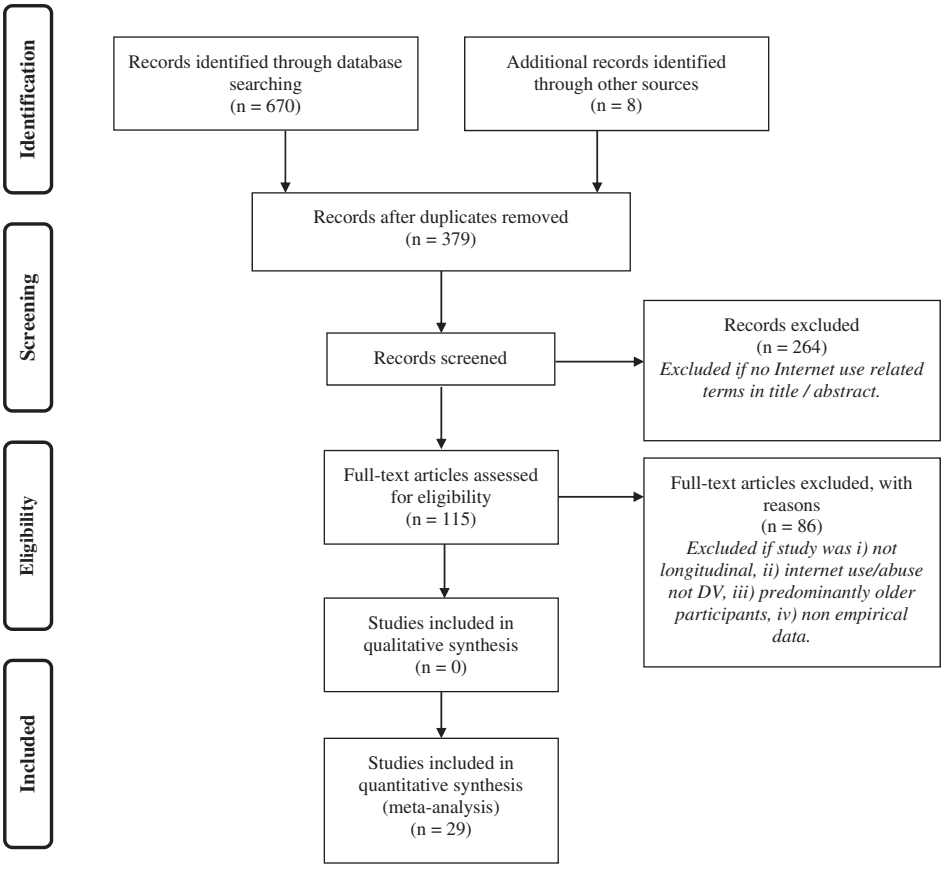

Figure 1. PRISMA flowchart of primary study selection.

et al., 2011), occasionally described as Problem Gaming (Haagsma, King, Pieterse, & Peters, 2013; King, Delfabbro, & Griffiths, 2013), Problem Online Game Use (Yu, Li, & Zhang, 2015) and/or Pathological Online Game Use (Choo, Sim, Liau, Gentile, & Khoo, 2015; Coyne et al., 2015; Gentile et al., 2011). These studies highlight the problematic engagement with Internet gaming, as a specific component of PIU, aligning with the perspective that the issue is not just excessive or disproportionate use, but a loss of control associated with Internet gaming in particular. Despite different terminology being used, the communalities regarding the negative repercussions of PIU are clear. This conceptual convergence is probably illustrated by some studies concurrently using the terms PIU and Internet Addiction and/or Compulsive Internet Use and Internet Addiction to describe the same construct (Mittal et al., 2013; Sun et al., 2012).

The inconsistencies considering the terms and the definitions suggested to describe PIU appear to reflect variations regarding the way literature has emphasized its communalities with compulsive, addictive, and more generally problematic behaviours. Furthermore, the significance of the particular Internet application abused (especially when this refers to Internet gaming) has attracted greater attention compared to the abuse of other Internet applications. The majority of the existing longitudinal studies during adolescence and emergent adulthood have not conceptualized PIU behaviours on a continuum with adaptive IU, and have only marginally highlighted its potential temporal or developmental aspects. In this context, the research area regarding IU-PIU would benefit from the ambiguity being removed through an agreement on criteria and terminology being made. To address these needs, the present study suggests a continuum (dimensional) conceptualization of IU-PIU.

Table 2. Basic information of studies and summary of findings related to *IU and/or PIU*.

	Title	Author/ year	Country	*N*	Age group	Time	Findings
1	Internet addiction, reality substitution and longitudinal changes in psychotic-like experiences in young adults	Mittal et al., (2013)	US	170	Adult	2m	Both groups reported similar level of IA and Reality Substitute at baseline Psychotic-like experience (PLE)-Improved/Constant group showed declines in PIU, and reported higher quality interactions PLE-Increase group reported PIU remained constant Moderate correlations between PLE and domains of PIU Association with Reality Substitute for the PLE-Increase group increased over time Aspects associated with PSE may also increase risk for PIU
2	Internet addiction in Hong Kong adolescents: A three-year longitudinal study	Yu & Shek, (2013)	HK	2,667	Adol	3yr	Age did not predict IA Males showed more PIU than females Immigration status and parent's marital status did not longitudinally influence IA behaviour Low socioeconomic status predicted low IA score High family function at Time 1 predicted low IA at Time 3 Positive youth development scores at Time 1 negatively predicted IA at Time 3
3	Does psychopathology in childhood predict Internet addiction in male adolescents?	Cho et al., (2013)	KR	524	Adol boys	7yr	High percentage (3.6) of participants had IA Significant relationship between those who experiencing withdrawal, anxiety/depression, and future IA
4	Compulsive Internet use: the role of online gaming and other Internet applications	van Rooij et al., (2010)	NL	4,753	Adol	1yr	Online gaming has strongest association with CIU at Time 1 and Time 2 Online gaming, MSN, social networking, Habbo Hotel and chatting are all associated with CIU No relationship was found between CIU and surfing or emailing
5	A short-term longitudinal study of Internet and computer game use by adolescent boys and girls: prevalence, frequency of use, and psychosocial predictors	Willoughby, (2008)	CA	1,591	Adol	21m	Being male, lower parental education, and greater frequency of IU in early high school were significant predictors of computer game and IU in late high school Higher friendship quality and less positive parental relationships found to be predictive of higher frequency IU Moderate IU associated with a more positive academic orientation than non-use or high levels of IU
6	A group-based modelling approach to estimating longitudinal trajectories of Korean adolescents' on-line game time	Hong et al., (2014)	KR	3,449	Adol	4yr	Males spend more time gaming than females Low self-control associated with 'chronic' IU Higher self-esteem associated with less IU No association between aggression and IU Poorer emotional regulation associated with gradual increase in time spent playing online Stress about school work can help decrease online play time Devoted students likely to spend less time gaming No association between social skills and time spent gaming
7	Longitudinal and reciprocal relations of cyber bullying with depression, substance use and problematic Internet use among adolescents	Gámez-Guadix et al., (2013)	ES	845	Adol	6m	CB victimization at Time 1 predicted depressive symptoms and problematic Internet use at Time 2 CB and higher depressive symptoms and more substance use at Time 1 predicted more CB victimization at Time 2 CB predicting substance use and PIU were not significant, but substance use predicted increase in CB victimization PIU did not predict CB Being a bully-victim increased probability of depression, substance use and PIU compared to those who were just victims at Time 1 and Time 2

(*Continued*)

Table 2. (*Continued*).

	Title	Author/ year	Country	*N*	Age group	Time	Findings
8	Online communication, compulsive Internet use, and psychosocial well-being among adolescents: A longitudinal study	van den Eijnden et al., (2008)	NL	663	Adol	6m	Instant messenger use and chatting in chat rooms found to be positively related to CIU at Time 2 Instant messenger use found to be positively associated with depression at Time 2 Loneliness negatively related to instant messenger use at Time 2
9	Pathological video game use among youths: A two-year longitudinal study	Gentile et al., (2011)	SG	3,034	Child/ Adol	2yr	Males had higher levels of OVG play at each time point Impulsivity, low social skills and poor emotional regulation are risk factors for becoming a pathological gamer and impulsivity worsens after a youth becomes a pathological gamer Amount of gaming and impulsivity significantly predict the number of pathological symptoms at T1 Those with lower social skills and greater impulsivity exhibit increases in their pathological gamer symptoms More pathological symptoms at Time 1 related to higher levels of depression, anxiety, poorer academic grades and social phobia at Time 2. This reduces if cease playing
10	Predicting compulsive Internet use: It's all about sex	Meerkerk et al., (2006)	NL	229	Adult	1yr	Large differences in the time spent on various Internet applications Large differences in the correlation between time spent on the applications and CIU Positive associations at Time 1 for gaming, chatting, and erotica Negative association between age and CIU Significant correlations between chatting, gaming, dating, buying, and erotica at Time 1, and CIU at Time 2 Spending a lot of time searching for erotic stimulation predicts an increase in CIU 1 year later No other application factors reached significance
11	Trajectories of problem video gaming among adult regular gamers: An 18-month longitudinal study	King, Delfabbro, et al.,(2013)	AU	117	Adult	18m	Gamers who self-identified as having problem OVG use at baseline reported more severe problem gaming symptoms than regular gamers at all time points Both groups experienced a significant decline in problem gaming symptoms over an 18-month period, controlling for ages, gaming activity, and psychopathological symptoms
12	Personality, cognitive style, demographic characteristics and Internet use – Findings from the HomeNet-Too project	Jackson et al., (2003)	US	117	Adult	6m	Extraversion was related to IU at Time 1 Neuroticism was negatively related to IU at Time 1 At Time 2 there were no relationships between IU and personality traits Weak predictive relationships between cognitive style and IU. At Time 1 high preference for perceiving abstractly, more time spent online, and number of online sessions. At Time 2, stronger visual preference related to less time spent on-line, and stronger preference for global/relational processing related to more emails sent at Time 2
13	Precursor or sequela: Pathological disorders in people with Internet addiction disorder	Dong et al., (2011)	CN	59	Adult	1yr	Higher than normal obsessive-compulsive (OC) behaviour prior to IA. OC considered a predictor of IA OC scores did not change significantly People with IAD scored significantly higher on OC, depression (DEP), anxiety (ANX) and hostility (HOS) EP, ANX, and HOS increased after IA; are more likely to be outcomes than precursors for IAD No relation between IAD and somatization, interpersonal sensitivity (INT), phobic anxiety, paranoid ideation, psychotic experiences (PSY) and additional items INT and PSY outcomes of IAD: changed significantly at Time 2 from Time 1
14	Compulsive Internet use among adolescents: Bi-directional parent–child relationships	van den Eijnden et al., (2010)	NL	510	Adol	6m	Prevalence of CIU decreased from 8% at Time 1 to 6.5% at Time 2 Higher quality parental communication regarding IU at Time 1 decreased development of CIU at Time 2

15	Adolescents' compulsive Internet use and depression: A longitudinal study	Thorsteinsson & Davey, (2014)	AU	41	Adol	1yr	*Social Internet use at Time 1 associated with decreased levels of depression* at Time 2 High support satisfaction, and social Internet use at Time 1 associated with lower increase in depression at Time 2, and lower CIU. CIU at Time 1 had a small association with depression at Time 2 and change in depression from Time 1 to Time 2
16	Assessing problematic video gaming using the Theory of Planned Behaviour: A longitudinal study of Dutch young people	Haagsma et al., (2013)	NL	810	Adol/ Adult	6m	Theory of Planned Behaviour variables accounted for significant amount of variance in PVGU at Time 1 but not Time 2 Perceived behavioural control important in predicting PVGU Males spent more time playing video games than females, and had higher levels of PVGU
17	ADHD and autistic traits, family function, parenting style, and social adjustment for Internet addiction among children and adolescents in Taiwan: A longitudinal study	Chen et al., (2015)	TW	1,153	Child/ Adol	4m	Prevalence of IA decreased from 11.4% at Time 1 to 10.6% at Time 2 High ADHD-related symptoms and low Autistic traits associated with increased risk and severity of IA ADHD-related symptoms predictive of IA Poor academic performance, male gender, poor social support, and less protective parenting were independent predictors for IA Participants with high grades reported high frequency and duration of IU, but not IA Participants with high hyperactivity/impulsivity higher gaming IU
18	Concurrent and predictive relationships between compulsive Internet use and substance use: Findings from vocational high school students in China and the USA	Sun et al., (2012)	CHN USA	1,761 1,182	Adol	1yr	CIU was not positively related with substance use at baseline Substance use did not predict an increase in CIU Relationships between concurrent changes in CIU and substance use were found among female, but not male students. No reciprocally predictive relationship found between CIU and substance use Positive predictive relationship between baseline CIU and change in substance use among females, but not males Substance use reduced CIU among USA sample. No significant relationship between substance use and change in CIU among Chinese sample
19	Depressive symptoms and problematic Internet use among adolescents: Analysis of the longitudinal relationships from the Cognitive–Behavioural Model	Gámez-Guadix, (2014)	ESP	699	Adol	1yr	Prior psychological distress is a risk factor for development of PIU Depressive symptoms at Time 1 predicted increase in preference for online relationships, IU for mood regulation, and negative outcomes of IU at Time 2 Negative outcomes of IU at Time 1 predicted increase in depressive symptoms at Time 2 No significant gender differences in the relationship between depression and PIU
20	Factors predictive for incidence and remission of Internet addiction in young adolescents: A prospective study	Ko et al., (2007)	TW	517	Adol	1yr	High exploratory excitability, low reward dependence, low self-esteem, low family function, and online gaming were found to predispose IA Low hostility and reduced levels of interpersonal anxiety were found to predict IA remission
21	MMORPG gaming and hostility predict Internet addiction symptoms in adolescents: An empirical multilevel longitudinal study	Stavropoulos et al., (2015)	GRK	648	Adol	2yr	More hostile adolescents were found to present higher IA symptom severity MMORPG playing increases IA symptoms Higher classroom percentage of MMORPG players was found to decrease individuals' IA symptoms

(*Continued*)

Table 2. (*Continued*).

	Title	Author/ year	Country	*N*	Age group	Time	Findings
22	Parental influences on pathological symptoms of video-gaming among children and adolescents: A prospective study	Choo et al., (2015)	SGP	2,974	Child/ Adol	1yr	High parent–child closeness at Wave 1 related to decreased number of PVGU symptoms at Wave 2. Effect stronger for males Parental restriction of video-gaming at Wave 1 had no main effect
23	Physiological indicators of pathologic video game use in adolescence	Coyne et al., (2015)	USA	374	Adol	1yr	Adolescents who don't find cognitive tasks stimulating (less RSA) or who show physiological signs of stress (less RSA) during family problem solving have a greater severity of PVGU GSC activation during family problem solving was related to higher PVGU symptoms for females only
24	Predicting adolescent problematic online game use from teacher autonomy support, basic psychological needs satisfaction, and school engagement: A 2-year longitudinal study	Yu et al., (2015)	CHN	356	Adol	2yr	Higher perceived teacher autonomy support found to be a protective predictor of adolescent POGU with mediating factors of basic psychological needs satisfaction and school engagement
25	Predictive values of psychiatric symptoms for Internet addiction in adolescents: A 2-year prospective study	Ko, Yen, et al., (2009)	TW	2,293	Adol	2yr	Depression, ADHD, social phobia, and hostility were found to predict IA Most significant predictor of IA in males was hostility, and in females was ADHD
26	Problematic Internet use and problematic alcohol use from the cognitive–behavioural model: A longitudinal study among adolescents	Gámez-Guadix et al., (2015)	ESP	801	Adol	6m	Low self-regulation at Time 1 predicted higher preference for online interactions, mood regulation, and negative consequences of the Internet at Time 2 No gender differences between longitudinal relationships of PIU and PIU and problematic alcohol use Negative consequences of PIU at Time 1 predicted increase in problematic alcohol use at Time 2 Low self-regulation related to IU found to maintain PIU
27	Psychosocial causes and consequences of online video game play	Kowert, Vogelgesang, Festl, and Quandt (2015)	GER	110	Adol	2yr	Being a member of the online game playing community was found to increase reported life-satisfaction Adolescent OVG players reported to have higher life satisfaction at Time 2 than non-online players No inverse relationships found between OVG play and psychosocial outcomes among adolescents No significant cross-lagged relationships found between OVG play and self-esteem, loneliness or psychosocial variables and OVG play frequency
28	The bi-directional interactions between addiction, behaviour approach and behaviour inhibition systems among adolescents in a prospective study	Yen et al., (2012)	TW	2,293	Adol	1yr	Higher BAS and fun-seeking predicted IA IA adolescents decreased more on BAS and BIS than the non-addiction group
29	The development of compulsive Internet use and mental health: A four-year study of adolescence	Ciarrochi et al., (2016)	AU	2,068	Adol	4yr	CIU predicted development of poor mental health; poor mental health did not predict CIU development Females and males increased CIU and mental health problems across the high school Females had higher CIU and worse mental health than males

Notes: IA = Internet Addiction, PIU = Problematic Internet Use, IU = Internet Use, CB = Cyber-bullying, CIU = Compulsive Internet Use, PVGU = Pathological Video. Game Use, IAD = Internet Addiction Disorder, MMORPG = Massive Multiplayer Online Role Playing Games, OVG = Online Video Game POGU = Problematic. Online Game Use, RSA = Respiratory Sinus Arrhythmia, GSC = Galvanic Skin Conductance, BIS = Behaviour Inhibition System, BAS = Behaviour Approach. System, ADHD = Attention Deficit Hyperactivity Disorder.

Table 3. Definitions and terminology used in studies regarding Internet use

		Compulsive Internet Use	Internet addiction	Problematic Internet Use	Online game addiction	Internet Use (high/low)	Pathological video game use	Problem gaming	Online video game play	Problematic online game use
1	Internet addiction, reality substitution and longitudinal changes in psychotic-like experiences in young adults	○	●	●	○	○	○	○	○	○
2	Internet addiction in Hong Kong adolescents: A three-year longitudinal study	○	●	○	○	○	○	○	○	○
3	Does psychopathology in childhood predict Internet addiction in male adolescents?	○	●	○	○	○	○	○	○	○
4	Compulsive Internet use: The role of online gaming and other Internet applications	●	○	○	○	○	○	○	○	○
5	A short-term longitudinal study of Internet and computer game use by adolescent boys and girls: Prevalence, frequency of use, and psychosocial predictors	○	○	○	○	●	○	○	○	○
6	A group-based modelling approach to estimating longitudinal trajectories of Korean adolescents' on-line game time	○	○	○	●	○	○	○	○	○
7	Longitudinal and reciprocal relations of cyber bullying with depression, substance use, and problematic Internet use among adolescents	○	○	●	○	○	○	○	○	○
8	Online communication, compulsive Internet use, and psychosocial well-being among adolescents: A longitudinal study	●	○	○	○	○	○	○	○	○
9	Pathological video game use among youths: A two-year longitudinal study	○	○	○	○	○	●	○	○	○
10	Predicting compulsive Internet use: It's all about sex!	●	○	○	○	○	○	○	○	○
11	Trajectories of problem video gaming among adult regular gamers: An 18-month longitudinal study	○	○	○	○	○	○	●	○	○
12	Personality, cognitive style, demographic characteristics and Internet use – Findings from the HomeNetToo project	○	○	○	○	●	○	○	○	○
13	Precursor or sequela: Pathological disorders in people with Internet addiction disorder	○	●	○	○	○	○	○	○	○
14	Compulsive Internet use among adolescents: Bi-directional parent–child relationships	●	○	○	○	○	○	○	○	○
15	Adolescents' compulsive Internet use and depression: A longitudinal study	●	○	○	○	○	○	○	○	○
16	Assessing problematic video gaming using the Theory of Planned Behaviour: A longitudinal study of Dutch young people	○	○	○	○	○	○	●	○	○
17	ADHD and autistic traits, family function, parenting style, and social adjustment for Internet addiction among children and adolescents in Taiwan: A longitudinal study	○	●	○	○	●	○	○	○	○
18	Concurrent and predictive relationships between compulsive Internet use and substance use: Findings from vocational high school students in China and the USA	●	●	○	○	○	○	○	○	○
19	Depressive symptoms and problematic Internet use among adolescents: Analysis of the longitudinal relationships from the cognitive–behavioural model	○	○	●	○	○	○	○	○	○
20	Factors predictive for incidence and remission of Internet addiction in young adolescents: A prospective study	○	●	○	○	○	○	○	○	○
21	MMORPG gaming and hostility predict Internet addiction symptoms in adolescents: An empirical multilevel longitudinal study	○	●	○	○	○	○	○	○	○
22	Parental influences on pathological symptoms of video-gaming among children and adolescents: A prospective study	○	○	○	○	○	●	○	○	○

(*Continued*)

Table 3. (*Continued*).

		Compulsive Internet Use	Internet addiction	Problematic Internet Use	Online game addiction	Internet Use (high/low)	Pathological video game use	Problem gaming	Online video game play	Problematic online game use
23	Physiological indicators of pathologic video game use in adolescence	○	○	○	○	○	●	○	○	○
24	Predicting adolescent problematic online game use from teacher autonomy support, basic psychological needs satisfaction, and school engagement: A 2-year longitudinal study	○	○	○	○	○	○	○	○	●
25	Predictive values of psychiatric symptoms for Internet addiction in adolescents: A 2-year prospective study	○	●	○	○	○	○	○	○	○
26	Problematic Internet use and problematic alcohol use from the cognitive–behavioural model: A longitudinal study among adolescents	○	○	●	○	○	○	○	○	○
27	Psychosocial causes and consequences of online video game play	○	○	○	○	○	○	○	●	○
28	The bi-directional interactions between addiction, behaviour approach and behaviour inhibition systems among adolescents in a prospective study	○	●	○	○	○	○	○	○	○
29	The development of compulsive Internet use and mental health: A four-year study of adolescence	●	○	○	○	○	○	○	○	○
	Total	7	10	4	1	3	3	2	1	1

○ = Definition not used, ● = Definition used.

This avoids negative connotations that terms such as Internet Addiction or Problematic Use may convey, or limitations by being too specific, as terminology referring explicitly to gaming applications may do. Finally, this conceptualization is in line with the theoretical framework of this literature review that identifies all behaviour as constantly varying along a continuum, in this instance from low to high IU (Bronfenbrenner & Morris, 2006).

Measurement of IU

As there is variation in the definitions, there are also several different instruments being used to measure IU-PIU longitudinally. The common denominator between these measures is their self-report nature, aside from one study that also utilized parental reports (Cho et al., 2013). This raises inevitably the issue of reliability, as items can be inaccurately answered (Meerkerk et al., 2006) either on purpose or due to impaired judgement, self-insight or unconscious subjectivity (Ko et al., 2007; Stavropoulos et al., 2015). Specifically, participant self-report measures are susceptible to deceptive behaviours associated with addictions, with PIU included (Hall & Parsons, 2001). However, privacy and anonymity of IU (Greenfield, 2004) could restrict the option of using actuarial-monitoring measurements. As suggested, seeking additional informant reporting, particularly parental or teacher reflections for children and adolescents, may result in more accurate data (Yen et al., 2012; Yu et al., 2015).

The most widely used instruments in longitudinal IU and PIU research were the Internet Addiction Test (IAT), the Compulsive Internet Use Scale (CIUS) and the Chen Internet Addiction (CIAS). The IAT was developed by Young (1998). It is a 20-item test which participants answer on a 6-point Likert scale (0 = 'it does not concern me' to 5 = 'always') of items related to the way their IU impacts on themselves (i.e. 'how often does your job performance or productivity suffer because of the Internet?'), as well as their relationship to their context (i.e. 'how often do you choose to spend more time on-line over going out with others?'). Item points are added to comprise a continuous total score from 0 to 100, with higher scores indicating higher symptoms of PIU (Internet Addiction). Four of the reviewed studies used all 20 items on Young's scale (Cho et al., 2013; Dong et al., 2011; Mittal et al., 2013; Stavropoulos et al., 2015), one study used a version shortened to 10 items adapted for a Chinese population (Yu & Shek, 2013), and one study used an adapted version of the IAT that contained the same number of items and response options as the original version (King, Delfabbro, et al., 2013).

The CIUS is a 14-item test on a 5-point Likert scale (Meerkerk, Van Den Eijnden, Vermulst, & Garretsen, 2009). Item responses range from 0 to 4 (0 = 'never' to 4 = 'very often') and are added to produce a final score ranging from 0 to 56 with higher scores signifying higher symptoms. Similar to the IAT, the CIUS includes statements regarding IU with reference to individual aspects of the Internet users (i.e. 'Short of sleep because of the Internet') and their context (i.e. 'others say you should use the Internet less'). Four of the studies used the original version of this instrument (Meerkerk et al., 2006; Thorsteinsson & Davey, 2014; van den Eijnden et al., 2010; van Rooij et al., 2010) and two used a shortened 10-item version (Ciarrochi et al., 2016; van den Eijnden et al., 2008).

The CIAS is a Chinese self-report measure containing 26 items that are rated on a 4-point Likert scale (Chen et al., 2015). Item scores are added resulting in a range of 26–104, with higher scores indicating higher symptoms. Similarly to the IAT and CIUS, items reflecting the impact of PIU on the individual (i.e. 'I feel energized online') and his relationship with his context are included (i.e. 'although using the Internet has negatively affected my relationships, the amount of time I spend online has not decreased'). Four studies used the CIAS to measure dimensions of PIU amongst Taiwanese populations (Chen et al., 2015; Ko, Liu, et al., 2009; Ko et al., 2007 Yen et al., 2012). Although CIAS has good psychometric properties (Chen et al., 2015), it has not yet been adapted in English.

The IAT, the CIUS and the CIAS converge at four main points in terms of the PIU operationalization. First, they conceive PIU on a continuum from minimum to maximum symptoms. Second, they highlight that PIU impacts both the individuals, as well as the interplay between the individuals and their context. Third, they all apply Likert-scales. Fourth, they have all been used with community and not exclusively with clinical samples. These four communalities are in line in with the BMHD that describes

behaviour in general, including risk behaviours such as PIU, to vary along a continuum from minimum to maximum (Bronfenbrenner & Morris, 2006). Furthermore, all of these three tests are reflective of Douglas' IAM model that highlights the impact of PIU on the individual's functionality in regards to both the subjective perception of him/her self and his/her real context (Douglas et al., 2008). It is noted that only two instruments used in the longitudinal PIU studies included in the present review requested the occurrence of IU to be reported without a scale structure. Table 4 provides a summary of assessment instruments, detailing their item number and their scale or form. Despite methodological differences in construct measures, it is important to note that most of the studies displayed high reliability, regardless of which particular instrument was used (see Table 1 for reliability of instruments).

Variables measured in relation to IU-PIU

In accordance with the conceptual framework of this paper; looking at IU-PIU as a behaviour influenced by individual, contextual and Internet activity-related factors, three main groups of studies were identified. The division of interest between the three areas is representative of the attention payed to the influence of the individual, and to a lesser extent, the contextual and Internet activity-related factors on IU-PIU (Bronfenbrenner & Morris, 2006; Douglas et al., 2008). These various 'push' and 'pull' factors (Douglas et al., 2008) can be seen in Table 5. The vast majority of variables reviewed are classified as individual influences on IU-PIU ($n = 22$), fewer as contextual influences ($n = 4$) and only one Internet activity-related variable was found ($n = 1$) to have been examined longitudinally. Findings highlight that the current trend in the longitudinal literature focuses on the individual effects on IU-PIU, and demonstrates the dearth of studies investigating contextual and Internet activity-related influences.

Weight of evidence

The weight of evidence of each the 27 variables in the 29 studies are displayed in Table 6. The majority of variables tested as predictors of IU-PIU had statistically significant results. These variables constitute research trends, which are summarized below and provide the basis for further longitudinal research in the field.

Influence of individual factors on IU-PIU

Predictors of IU-PIU related specifically to the individual Internet user constituted 22 of the 27 variables in the reviewed studies. These included both static (i.e. gender) as well as dynamic-changeable (i.e. psychopathology factors) factors. Of those, 21 variables were found to have statistically significant risk or protective associations with IU-PIU discussed below.

Gender

The influence of gender, as a static (not-changeable, predisposing factor) on an individual's IU-PIU levels was investigated by 12 studies with only three of them not supporting gender-related IU-PIU differences (Gámez-Guadix, 2014; Gámez-Guadix et al., 2015; Jackson et al., 2003). The majority of the findings (7 studies) across different cultural samples converged with males being at higher risk, and the difference between males and females in regards to IU-PIU widening over time (Chen et al., 2015; Choo et al., 2015; Gentile et al., 2011; Haagsma et al., 2013; Hong et al., 2014; Willoughby, 2008; Yu & Shek, 2013). Different hypotheses and interacting factors were proposed to explain the differences revealed; primarily the higher preference of males for online games, males being targeted by the marketing strategies of higher PIU risk applications (such as online games) (Chen et al., 2015; Hong et al., 2014), and males being at higher risk of developing addiction-related behaviours (as PIU has been similarly characterized) (Yu & Shek, 2013) have been noted.

On top of males being at higher risk, gender-related differences in regards to PIU vulnerability due to specific factors have been additionally highlighted. In particular, females presented more severe

Table 4. Instruments used in each study to measure Internet use variable.

Instrument	Internet Addiction Test (Young, 1998)	Problematic Video Game Playing Test (Adaption of IAT)	Internet Addiction Test – Chinese Adaption	Compulsive Internet Use Scale	Compulsive Internet Use Scale – Shortened Version	Frequency Computer Game Use	Frequency Computer Game Use	Generalized Problematic Internet Use Scale 2	Davis Scale for Problematic Internet Use (adaption)	Frequency Internet Use	Frequency Internet Use	Pathological Video Game Use	Pathological Video Game Use	Problematic Gaming	Chen Internet Addiction Scale
Items	20	*20	10	14	10	–	1–2	15	4	1–8	6	10	11	7	26
Scale	5-point Likert	*5-point Likert	5-point Likert	5-point Likert	5-point Likert	Number of Hours	5-point Likert	6-point Likert	5-point Likert	5–8-point Likert	Yes/No	3-point Likert	3-point Likert	5-point Likert	4-point Likert
Study 1	•	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 2	○	○	•	○	○	○	○	○	○	○	○	○	○	○	○
Study 3	•	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 4	○	○	○	•	○	○	○	○	○	○	○	○	○	○	○
Study 5	○	○	○	○	○	•	○	○	○	○	○	○	○	○	○
Study 6	○	○	○	○	○	○	•	○	○	○	○	○	○	○	○
Study 7	○	○	○	○	○	○	○	•	○	○	○	○	○	○	○
Study 8	○	○	○	○	•	○	○	○	○	○	○	○	○	○	○
Study 9	○	○	○	○	○	○	○	○	○	○	○	•	○	○	○
Study 10	○	○	○	•	○	○	○	○	○	○	○	○	○	○	○
Study 11	○	•	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 12	○	○	○	○	○	○	○	○	○	•	○	○	○	○	○
Study 13	•	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 14	○	○	○	•	○	○	○	○	○	○	○	○	○	○	○
Study 15	○	○	○	•	○	○	○	○	○	○	○	○	○	○	○
Study 16	○	○	○	○	○	○	○	○	○	○	○	○	○	•	○
Study 17	○	○	○	○	○	○	○	○	○	○	•	○	○	○	•
Study 18	○	○	○	○	○	○	○	○	•	○	○	○	○	○	○
Study 19	○	○	○	○	○	○	○	•	○	○	○	○	○	○	○
Study 20	○	○	○	○	○	○	○	○	○	○	○	○	○	○	•
Study 21	•	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 22	○	○	○	○	○	•	○	○	○	○	○	○	○	○	○
Study 23	○	○	○	○	○	○	○	○	○	○	○	○	•	○	○
Study 24	○	○	○	○	○	○	○	○	○	○	○	○	•	○	○
Study 25	○	○	○	○	○	○	○	○	○	○	○	○	○	○	•
Study 26	○	○	○	○	○	○	○	•	○	○	○	○	○	○	○
Study 27	○	○	○	○	○	•	○	○	○	○	○	○	○	○	○
Study 28	○	○	○	○	○	○	○	○	○	○	○	○	○	○	•
Study 29	○	○	○	○	•	○	○	○	○	○	○	○	○	○	○
Total	4	1	1	4	2	3	1	3	1	1	1	1	2	1	4

○ = Instrument not used, • = Instrument used.
*Details not recorded in research article, instead provided by author of research article.

Table 5. Individual, contextual and activity-related variables measured in relation to IU-PIU.

	A	C	I	I	I	I	I	C	I	I	I	I	I	C	I	I	I	I	I	I	C	I	I	I	I	I	I
	Medium of Internet use	Parenting/ family factors	Withdrawal	Gender	Psychotic experiences	Depression	Hostility/ aggression	Cyberbullying	Substance use	Self-control/ impulsivity	Social skills/ competence	Emotional regulation	Academic disposition	Friendship quality/ social support	Loneliness	Well-being/life satisfaction	Anxiety	Social anxiety	Obsessive compulsive traits	Personality traits	Classroom environment	Physiological Indicators	ADHD	Self-esteem	Sensitivity to reward/ punishment	Autism spectrum	Cognitive Style
Study 1	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 2	○	●	○	●	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○
Study 3	○	○	●	○	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○
Study 4	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 5	○	●	○	●	○	○	○	○	○	○	○	○	●	●	○	●	○	○	○	○	○	○	○	○	○	○	○
Study 6	○	○	○	●	○	○	●	○	○	●	●	●	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○
Study 7	○	○	○	○	○	●	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 8	●	○	○	○	○	●	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○
Study 9	○	○	○	●	○	●	○	○	○	●	●	●	●	○	○	○	●	●	○	○	○	○	○	○	○	○	○
Study 10	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 11	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 12	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	●
Study 13	○	○	○	○	●	●	●	○	○	○	●	○	○	○	○	○	●	○	●	○	○	○	○	○	○	○	○
Study 14	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 15	●	○	○	○	○	○	○	○	○	○	○	○	○	●	○	●	○	○	○	○	○	○	○	●	○	○	○
Study 16	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 17	○	●	○	●	○	○	○	○	○	○	●	○	●	●	○	○	○	○	○	○	○	○	●	○	○	●	○
Study 18	○	○	○	●	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 19	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 20	●	●	○	○	○	○	●	○	○	○	○	○	○	○	○	●	○	●	○	●	○	○	○	●	●	○	○
Study 21	●	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○
Study 22	○	●	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 23	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○
Study 24	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	●	○	○	○	●	○	○	○	○	○	○	○
Study 25	○	○	○	●	○	●	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	○	○	○	○
Study 26	○	○	○	●	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Study 27	○	○	○	○	○	○	○	○	○	○	●	○	○	○	●	●	○	○	○	○	○	○	○	●	○	○	○
Study 28	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○
Study 29	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○
Total	7	6	1	13	2	7	5	1	3	4	5	2	5	3	2	7	3	3	1	2	2	1	2	4	2	1	1

● = assessed, ○ = not assessed.
I = individual factor C = contextual factor A = activity-related factor, ADHD = attention deficit hyperactivity disorder.

Table 6. Predictors of Internet Use/Abuse/Addiction.

Variable	Studies	Total *N*	Ratio of statistical significance (%)
Medium of Internet use	4, 8, 10, 11, 15, 20, 21	6968	100
Parenting/family factors	2, 5, 14, 17, 20, 22	9412	100
Withdrawal	3	524	100
Gender	2, 5, 6, 9, 16, 17, 19, 22, 23, 25, 26, 29	21,913	83.3
Psychotic experiences	1, 13	229	50
Depression	3, 7, 8, 9, 13, 19, 25	8117	57.1
Hostility/aggression	6, 13, 20, 21, 25	6966	60
Cyber-bullying	7	845	100
Substance use	7, 18, 26	4589	0
Self-control/impulsivity	6, 9, 16, 26	8094	100
Social skills/competence	6, 9, 13, 17, 27	7805	20
Emotional regulation	6, 9	6483	100
Academic disposition	5, 6, 9, 17, 24	9583	80
Friendship quality/social support	5, 15, 17	2785	100
Loneliness	8, 27	773	50
Well-being/life satisfaction	2, 5, 15, 20, 24, 27, 29	7350	28.5
Anxiety	3, 9, 13	3675	33.3
Social anxiety	9, 20, 25	5844	66.6
Obsessive compulsive traits	13	59	100
Personality traits	12, 20	634	50
Classroom environment	21, 24	1004	100
Physiological indicators	23	374	100
ADHD	17, 25	3446	100
Self-esteem	6, 15, 20, 27	4117	50
Sensitivity to reward/punishment	20, 28	2810	100
Autism	17	1153	100
Cognitive style	12	117	100

Notes: ADHD = Attention Deficit Hyperactivity Disorder. Personality traits included Extroversion/Introversion, Neuroticism & Exploratory Excitability. The ratio of statistical significance is derived by the number of studies resulting to statistically significant results divided by the number of the studies that examined the variable of reference.

symptoms of online gaming-related PIU, due to their less effective stress management of challenging family dynamics (Coyne et al., 2015). Additionally, amongst Taiwanese adolescent's, higher hostility levels were a significant predictor of PIU in males, while more significant predictors in females were attention deficit and hyperactivity disorder (ADHD) traits, social phobia and depression (Ko, Liu, et al., 2009). Finally, an Australian study concluded that in the group of PIU adolescents, females presented poorer mental health than their male peers across four years of high school (Ciarrochi et al., 2016).

Psychopathology

The associations between IU-PIU behaviours and psychopathology have been emphasized by several longitudinal studies in adolescence and young adulthood. Specifically, the links between IU-PIU and anxiety, social anxiety, depression and general psychological distress have been examined mainly as predictors, and less as potential consequences of IU-PIU, across predominantly Asian populations (i.e. Korean, Singaporean) and over different periods of time ranging from one to seven years (Cho et al., 2013; Gámez-Guadix, 2014; Ko, Liu, et al., 2009). The link between mood disorder and anxiety manifestations with PIU was predominantly explained on the basis of seeking relationships online (to potentially compensate for the lack of adequate face-to-face relationships) and using the Internet as an emotion regulation strategy (Gámez-Guadix, 2014). Similarly to depression and anxiety, obsessive-compulsive behaviours were found to predict PIU among first-year university students (Dong et al., 2011). This could be viewed in support of the definition of Compulsive Internet Use discussed earlier in this paper. Furthermore, it may be reflective of people using the Internet to escape from difficult life experiences (Cho et al., 2013). Finally, there have been contradictory findings considering the association between psychotic symptoms and PIU, with one study suggesting that an increase in psychotic symptoms over two-months related to significantly higher PIU (Mittal et al., 2013), and a second study resulting in no

significant associations (Dong et al., 2011). However, forms of psychopathology, including depression, anxiety and social phobia, were also found to be outcomes of online gaming related PIU (Gentile et al., 2011). Conclusively, the relationship between mental health and PIU appears to be bi-directional, as although poor mental health can be a strong precursor to PIU, studies have also found that PIU can predict poor mental health (Ciarrochi et al., 2016; Dong et al., 2011; Gentile et al., 2011; van den Eijnden et al., 2008). Finally, three studies looked at substance use and IU amongst adolescents, with no predictive or protective relationships identified (Gámez-Guadix et al., 2013, 2015; Sun et al., 2012). These findings illustrate the differences between PIU and other forms of addictions, converging to the absence of cross-addictive behaviours (transformation of one addictive behaviour into another) between substance abuse and PIU in particular.

The association between psychopathology and PIU becomes potentially clearer when it refers to more pervasive and developmental symptoms such as ADHD and ASD characteristics. Specifically, a two-year study of Taiwanese adolescents supported that characteristics of ADHD such as low impulse control, delay aversion, and situational attention may make IU more appealing, thus resulting in PIU (Ko, Liu, et al., 2009). Another Taiwanese four-month study of children and adolescents reported that high ADHD-related symptoms and low autistic traits were associated with higher risk and severity of PIU (Chen et al., 2015). In this context, longitudinal studies examining concurrently (through the use of cross-lagged statistical analysis) the causal and outcome role of PIU in relation to forms of psychopathology need to be prioritized.

Academic disposition

An individual's academic disposition was found to consistently relate, both as a precursor and as an outcome, to one's level of IU-PIU across different cultures. Specifically, more academically orientated adolescents in Canada and Korea, who tended to experience higher school-performance related stress, presented lower PIU behaviours compared to their peers (Hong et al., 2014; Willoughby, 2008). In line with these, poor academic achievement was found to be predictive of PIU amongst Taiwanese adolescents (Chen et al., 2015), while Yu et al. (2015) supported that higher school engagement functioned as a PIU protective factor. In consensus with the bi-directional relationship suggested between academic-disposition and PIU, a study of Singaporean adolescents found that Internet gaming PIU was a significant predictor of poorer academic performance (Gentile et al., 2011). Despite the differing focus between studies (i.e. academic motivation, grades and achievement, stress), there is consensus in regards to the link between academic disposition and PIU in adolescence. At this point it should be noted that none of the longitudinal studies reviewed here investigated the academic disposition and PIU association amongst emergent adults. This appears to be an area of study that needs to be addressed, as the association between academic-performance and PIU could vary across different developmental phases (Bronfenbrenner & Morris, 2006).

Personal attributes

Besides gender, psychopathology and academic disposition, there were six other areas of personal attributes that were longitudinally studied as PIU risk and protective factors. These were identified as the following: (a) *Personality traits* (b) *self-control and impulsivity*; (c) *hostility*; (d) *self-esteem*; (e) *positive development and life satisfaction* and (f) *social and cognitive skills*. Specifically, in regards to *personality traits*, higher extroversion and neuroticism have been related to higher PIU behaviours over time. Social features of the Internet have been supported to account for the finding that extroverts use the Internet more than introverts (Thorsteinsson & Davey, 2014). Following this line of thought, the higher propensity for anxiety and the lack of emotional control that more neurotic individuals experience, combined with escaping through the Internet, have been suggested to explain their higher PIU levels (Jackson et al., 2003).

In regards to *self-control and impulsivity*, higher levels of self-control were found to act protectively for PIU, while more impulsive behaviours were supported to be a PIU risk (Haagsma et al., 2013). Specifically, lower self and emotional control were found to be antecedents of PIU in a four-year longitudinal study

of Korean adolescents (Hong et al., 2014). Similar were the outcomes of a Singaporean study, where poor impulse and emotional regulation were associated with higher PIU over a period of two years (Gentile et al., 2011). Impulsive online interactions, novelty seeking, higher vulnerability to immediate incentives and sensitivity to reward (related to impulsivity) were suggested to explain the risk effect of low self-control on PIU (Gámez-Guadix et al., 2015). Reward opportunities offered by the Internet, and the variety and arousing experiences that the virtual world provides have been supported to potentially captivate impulsive users (Ko et al., 2007; Yen et al., 2012).

Findings were consistent in regards to *hostility* acting as a PIU risk across both European and Asian samples. In particular, a Greek study showed higher hostility to predict higher severity of PIU symptoms amongst adolescents (Stavropoulos et al., 2015). In line with this, Korean studies have found hostility to be the most significant predictor of PIU among male adolescents over a two-year period (Ko, Liu, et al., 2009) and to be predictive of PIU remission (Ko et al., 2007). Two main interpretations have been suggested by the studies reviewed here. First, the Internet world may function as the outlet of expressing hostility and aggression in ways that would be unacceptable face to face (Ko, Liu, et al., 2009; Stavropoulos et al., 2015). Second, the Internet provides a physically safer context for young people to experiment and express their hostility, while developing their own sense of identity (Ko et al., 2007).

Longitudinal findings in regards to the potential risk effect of low *self-esteem* on PIU have been inconsistent between Asian and European studies. Specifically, higher and lower self-esteem have been found to be a PIU protective and PIU risk factor, respectively, amongst Korean and Taiwanese adolescents (Hong et al., 2014; Ko et al., 2007). However, no significant association between self-esteem and PIU was revealed in a German study (Kowert, et al., 2015). These mixed results could be explained by cultural differences that may exist between individualistic and collectivist societies in terms of self-expression and identity development, that need to be addressed by further research (Stavropoulos, Alexandraki, & Motti-Stefanidi, 2013).

In terms of protective factors of IU-PIU, *positive adolescent development* (Yu & Shek, 2013) and higher basic *psychological needs satisfaction* (Yu et al., 2015) were associated with lower PIU. Interestingly, adolescent online gamers report higher life satisfaction than those that don't play online. This finding that was attributed to the social value likely added, due to being a member of an online gaming community (Kowert et al., 2015). Online gaming has been supported to provide positive experiences by facilitating opportunities to develop and maintain peer connections (Kowert et al., 2015). However, *social skills* were not found to have a significant longitudinal association with IU-PIU (Chen et al., 2015; Dong et al., 2011; Kowert et al., 2015). Finally, despite the established associations between IU and a person's *cognitive style* (such as preferences for visual stimuli, abstract perceptual preferences), predictive relationships revealed were trivial (Jackson et al., 2003).

Influence of contextual factors on IU-PIU

Besides individual level factors already described, contextual IU-PIU predictors related to family, peers and school classroom contexts constituted 4 of the 27 variables reviewed here.

Parenting/family context

Significant associations have been consistently supported between parenting and family-related factors and levels of IU-PIU. Specifically, a home environment, where there is good communication about IU was shown to lower an adolescent's PIU risk (van den Eijnden et al., 2010; Yu & Shek, 2013). Furthermore, less protective parenting (Chen et al., 2015), low family functioning (Ko et al., 2007), lower parental education and divorced or less positively related parental couples, were found to be related to higher PIU (Willoughby, 2008). In this context, adolescents with closer relationships with their parents showed decreased video game PIU symptoms over time. Paradoxically, parental restriction of online gaming was not revealed to have a significant impact on PIU levels (Choo et al., 2015).

Peer context

Another contextual factor considered was the connection between peer relationships and IU-PIU. Adolescents who were cyber-bullied used the Internet significantly more than their peers who were not subjected to online bullying, while individuals who were both cyber-bullied and acted as cyber-bullies themselves, reported higher IU than those who were solely bullied over the same six-month period (Gámez-Guadix et al., 2013). Furthermore, two studies looked at the quality of friendships and social support as predictors of IU-PIU. One found higher friendship quality to predict higher IU (Willoughby, 2008), and the second found lower support and social adjustment to be predictors of PIU (Chen et al., 2015). Further, social IU (i.e. use of social network sites or instant messaging) was found to result in lower IU a year later compared to using the Internet in a non-social context (Thorsteinsson & Davey, 2014). These findings converge to the contribution of functional peer relationships as a protective PIU factor, indicating that IU may both promote and disadvantage socialization, depending on the characteristics of the user as well as his/her peer context.

Classroom environment

More recently, researchers have explored the associations between the context of the school classroom and IU-PIU. Amongst adolescents, Stavropoulos et al. (2015) found students that were Massive Multiplayer Online Role Play Gamers (MMORPG's) had significantly lower symptoms of addictive PIU when the classroom comprised a higher percentage of MMORPG players. Suggested explanations for this finding included that students, who play MMORPG's, have a shared activity or interest that brings them together, reducing isolation, increasing social ties and that playing MMORPG's can itself be a social activity used for interpersonal communication and interaction (Stavropoulos et al., 2015). In regards to the classroom context in general, Yu et al. (2015) found that adolescents who felt that their teachers provided them with more opportunities and decision-making space were less likely to engage in online gaming. This relationship was mediated by psychological satisfaction and school engagement factors. Specifically, students with higher perceived teacher autonomy support and positive psychological satisfaction were more likely to be motivated to engage in school, and less likely to develop PIU (Yu et al., 2015).

Influence of the activity (the Internet itself)-related factors

On top of individual and contextual predictors of IU-PIU, measures related to the Internet activity itself were included in only 1 of the 29 reviewed longitudinal studies.

Form of IU: communication vs non-communication

Adolescents who primarily used the Internet for social networking and communicating with friends through instant messaging were found to be significantly less likely to experience PIU compared to those who primarily used the Internet for non-communicative purposes (Thorsteinsson & Davey, 2014). However, another study found that chat room use associated with PIU amongst adolescents six months later (van den Eijnden et al., 2008). Despite different findings, these two studies support how different IUs can influence an individual's IU-PIU, as is suggested by the conceptual framework of this study. Overall, there seems to be a significant lack of longitudinal research focusing on the differing Internet communication uses, and how these may impact on IU-PIU amongst adolescents and emergent adults.

Form of application

Research examining the impact of different applications facilitating IU-PIU along the IU-PIU continuum has included adolescents and emergent adult populations. A study by Meerkerk et al. (2006) found significant links between PIU and using the Internet for social chatting, gaming, dating, purchasing items and erotica, with erotica found to have the highest potential to predict PIU a year later. As earlier mentioned, chat room use predicted high IU six months later (van den Eijnden et al., 2008). A second study of Dutch adolescents found that downloading, social networking, various online-chat applications and gaming were PIU predictors, with gaming being the strongest one over time (van Rooij et al., 2010).

The latter is consistent with findings in both Taiwanese and Greek longitudinal studies (Ko et al., 2007; Stavropoulos et al., 2015). In line with this, it is noted that adults who initially identified themselves as having online gaming PIU reported higher symptom severity 18 months later compared to regular gamers (King, Delfabbro, et al., 2013).

Discussion

This systematic review aimed to track the longitudinal research trends in the field of IU-PIU in adolescents and emergent adults and to identify research needs that should be prioritized by future studies. The results highlight that IU-PIU behaviours constitute an area of ambiguity comprising inconsistencies in terminology used to describe excessive IU behaviours and multiple, differing, yet largely reliable, assessment instruments. Uniformly, researchers have primarily focused on the over-time impact of individual factors on IU-PIU behaviours (i.e. psychopathology, academic disposition, personal attributes) in adolescent/emergent adult populations across different countries, while fewer studies examined contextual (i.e. family, peers and classroom-related factors) and Internet activity-related factors (i.e. Internet application used). Of note, is that over half of the studies reviewed (17/29) were published within the last three years. This highlights the increasing recognition (amongst researchers on a global level) that more longitudinal studies are required to achieve a better understanding of IU-PIU behaviours in adolescence and emergent adulthood. This is a broader area that remains much in need of ongoing longitudinal research, particularly of that involving contextual and Internet activity-related factors.

Definitions and measures of IU-PIU

A commonality of the literature reviewed in defining PIU, was the consensus that, independently of the term used, behaviours of problematic or excessive use if the Internet do occur, and result in negative outcomes for the concurrent and the future adaptation of young individuals (adolescents and young adults) (Cho et al., 2013; Dong et al., 2011; Mittal et al., 2013; Stavropoulos et al., 2015). In this context, there is a need for an alignment in regards to one, unifying definition for excessive/problematic use of the Internet, which could potentially signify both the addictive and the compulsive elements of PIU. Similarly, whilst the majority of studies utilized measures of IU-PIU that were dimensional (minimum to maximum IU-PIU) with good reliability, there were 13 different scales attempting to measure the behaviour (Cho et al., 2013; Dong et al., 2011; Mittal et al., 2013; Stavropoulos et al., 2015). A continuous (dimensional) measure of PIU that would be implemented consistently by researchers is required.

Individual factors

The majority of studies reviewed here, assessed individual factors associated with IU-PIU. In particular, psychopathology characteristics such as anxiety, social anxiety, depression, general psychological distress and developmental symptoms of ADHD and ASD were found to be predictive of PIU, with some of these variable also being identified as a consequence of PIU behaviours (Chen, Chen, & Gau, 2015; Cho et al., 2013; Gámez-Guadix, 2014; Ko, Liu, et al., 2009). The bi-directional relationships between psychopathology and PIU should be further examined by future longitudinal research (possibly through the use of cross-lagged analyses designs).

The majority of studies looking at gender differences and PIU found males to be at significantly higher risk of developing PIU over time (Chen et al., 2015; Choo et al., 2015; Gentile et al., 2011; Haagsma et al., 2013; Hong et al., 2014; Willoughby, 2008; Yu & Shek, 2013). The longitudinal literature reviewed here supported the mediating role of other variables in this association. These included less effective stress management of challenging family dynamics, higher ADHD, social phobia and depression symptoms for females (Coyne et al., 2015; Ko, Liu, et al., 2009). However, findings in relation to factors mediating gender-related differences on IU-PIU appear limited, and should be a focus for the future.

Bi-directional relationships between academic factors and levels of IU-PIU have been identified across different studies examining adolescents (Chen et al., 2015; Gentile et al., 2001; Hong et al., 2014; Willoughby, 2008; Yu et al., 2015). However, there is a dearth of longitudinal findings in relation to the links between academic and work achievement in emergent adult populations. In line with this, future research could additionally benefit from examining this associations over a broader period of time, concurrently embracing adolescence and adulthood.

In terms of personal attributes a series of significant longitudinal associations have been identified. Personality traits of higher extroversion and neuroticism were related to higher PIU behaviours over time (Jackson et al., 2003; Thorsteinsson & Davey, 2014). Higher self-control and lower impulsivity reduced PIU risk, while more impulsive behaviours were revealed to be an antecedent of PIU longitudinally (Gámez-Guadix et al., 2015; Gentile et al., 2011; Haagsma et al., 2013; Hong et al., 2014; Ko et al., 2007; Yen et al., 2012). Hostility was found to be a predictor of both PIU and its remission across studies examining different cultural populations (Ko, Liu, et al., 2009; Stavropoulos et al., 2015). Furthermore, positive development and life satisfaction were associated with lower PIU (Yu et al., 2015). However, results for the relationship between PIU and self-esteem were mixed with Asian and confirming a negative predictive association between the two and European studies not concluding a significant link (Hong et al., 2014; Ko et al., 2007; Kowert et al., 2015). Finally, a weak association was revealed between cognitive skills and PIU (Jackson et al., 2003). In the light of these findings, future research should prioritize examining cross-cultural variations in the association between self-esteem and PIU, as well as to expand the frequency and number of measurements to more accurately captivate fluctuations during adolescence and emergent adulthood.

Contextual factors

Of contextual factors reviewed in the current systematic literature review, the significance of family-related factors has been acknowledged. Positive parenting and family-related factors consistently demonstrated protective effects on PIU (van den Eijnden et al., 2010; Yu & Shek, 2013). On the contrary more dysfunctional family context was predictive of PIU (Chen et al., 2015; Choo et al., 2015; Ko et al., 2007; Willoughby, 2008). In line with this finding further research should deepen the available knowledge in the field by emphasizing on more specific aspects of family relationships such as flexibility and cohesion.

The research also suggests different aspects of peer relationships and use of the Internet for social purposes can be predictive and protective of PIU behaviours (Chen et al., 2015; Gámez-Guadix et al., 2013; Thorsteinsson & Davey, 2014; Willoughby, 2008). Future research should consider looking into different facets of social peer interactions both online and offline and possibly include socio-metric questionnaires for more actuarial and objective measurements.

Furthermore, two of the reviewed studies assessed associations between classroom factors and IU-PIU in adolescence, indicating significant associations. Students who were MMORPG players in classrooms with a higher percentage of MMORPG players showed less PIU symptoms (Stavropoulos et al., 2015), as did students who felt more supported by their teachers (Yu et al., 2015). Research into PIU and the classroom-school context is limited, with further research needing to study classroom-school factors that potentially act as precursor and/or as protective PIU factors.

Internet-related factors

In regards to Internet-related factors having been longitudinally studies in relation to IU-PIU, the type of Internet application, especially when this refers to online gaming has been until now the main point of interest. Various forms of Internet applications demonstrated significant predictive associations with PIU longitudinally (Meerkerk et al., 2006; van den Eijnden et al., 2008; van Rooij et al., 2010). Specifically, use of the Internet for online gaming was a consistently strong predictor of PIU amongst adolescents and emergent adults (King, Delfabbro, et al., 2013; Ko et al., 2007; Stavropoulos et al., 2015; van Rooij et al., 2010;). Besides the already acknowledged contribution of the online application of use, there

is a need to further research other possible 'pull' factors (Douglas et al., 2008). These could include online flow (i.e. the level of absorbance by a virtual activity) and presence (i. e. the level of absorbance by the virtual context) as longitudinal predictors of PIU (Douglas et al., 2008). Finally, the relationship between the use of the Internet for social networking versus non-communicative purposes produced mixed results with some studies indicating a positive and others a negative contribution to the user's well-being (Thorsteinsson & Davey, 2014; van den Eijnden et al., 2008). Further research identifying how individual level factors could differentiate the associations between communicative and non-communicative uses of the Internet with PIU behaviours are needed.

Limitations

The current review investigated all longitudinal studies (minimum of two months between time points) with populations of adolescents/emerging adults, where IU-PIU was the dependent variable. Future research could benefit from assessing and comparing all developmental stages (from young children through to elderly adults), across multiple time waves, which would provide greater insight into the trajectories of the effects of these factors and their associations with IU-PIU.

This systematic literature review included studies from both Western and Eastern countries. However, the possible cultural influences on predictors of the development of behaviour along the IU-PIU continuum has not been discussed. Future research should emphasize and further investigate the discrepancies in longitudinal IU-PIU findings across different cultures.

Conclusion

Research involving IU-PIU has focused on individual effects whilst to an extent overlooked the influence of contextual and activity-related predictors. Provided that the development of behaviour, that places an adolescent/emergent adult at the high end of the IU-PIU continuum is influenced by all three of these areas, more balanced emphasis across individual, contextual and Internet-related factors needs to be adopted by future longitudinal research to achieve a comprehensive insight into adolescent/emergent adult IU-PIU behaviours. This can more effectively inform prevention and intervention policies that could maximize the benefits of IU and minimize the negative repercussions of PIU in youth.

Disclosure statement

No potential conflict of interest was reported by the authors.

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the area have enabled him to strengthen an international reputation as Internet and Internet gaming addiction expert. His research on Internet addiction behaviors has been funded by the European and Greek National funds. He will contribute in data collection, data analyses and will overlook the effective facilitation of the study in Australia.

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