Cumulative risk and Chinese adolescent problematic internet use: the mediating role of self-esteem

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CUMULATIVE RISK AND CHINESE ADOLESCENT PROBLEMATIC INTERNET USE:
THE MEDIATING ROLE OF SELF-ESTEEM

By

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CUMULATIVE RISK AND CHINESE ADOLESCENT PROBLEMATIC INTERNET USE:
THE MEDIATING ROLE OF SELF-ESTEEM

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Xian Li

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Abstract

A decade of research has documented the adverse effect of multiple ecological risks on adolescent problematic Internet use (PIU), yet existing research provides rather segmental explanations, and few studies offer a comprehensive and integrated account. A better theoretical and empirical understanding of the associations of multiple ecological risks and PIU, as well as the underlying mechanisms, could help inform intervention practices and policies to mitigate adolescent PIU.

Embracing the bio-ecological perspective of human development, the current study takes full advantage of the cumulative risk approach, and examined a moderated mediation model that links cumulative risk (that comprises eight ecological risk factors originating in family, SES, and school), self-esteem, and adolescent PIU. The direct effects of cumulative risk on adolescent PIU, the mediating role of self-esteem, as well as gender moderation were tested in the model.

A total of 2621 adolescents (53.3% girls, $M=13.56$ years, $SD=1.06$) from four middle schools in southern China completed surveys. Structural equation modeling revealed that the effects of cumulative risk on adolescent PIU could be partially explained by decreased self-esteem. Multiple group comparisons further uncovered that the mediation effect of self-esteem was only significant for boys but not for girls. Theoretical and practical implications and limitations were discussed.
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Chapter 1. Introduction

The Internet is ubiquitous in modern society. In 2016, more than 46% of the world’s population has connected to the Internet (International Telecommunications Union, 2016). The Internet has become increasingly integrated into daily social, educational and professional activities, and online activity via the support of various devices and platforms is very prevalent among young adults and adolescents. According to the report of PEW (2015), 92% of American teens (aged 13-17) go online daily. China, as the country with most users, has over 287 million young Internet users (aged 6-24), among which 52% are of minor status.

However, growing concerns about problematic Internet use (PIU) have accompanied the rapid expansion of Internet usage. Excessive usage of the Internet may bring severe negative consequences such as psychological, social, occupational and/or academic difficulties (Beard & Wolf, 2001; Carli et al., 2013; Gentile et al., 2011; Ko, Yen, Yen, Chen, & Chen, 2012; Zhou et al., 2011). Problematic Internet use (PIU) has stimulated a surge of research interest in the two recent decades (Chou & Hsiao, 2000; Block, 2008; Griffiths, 2000; Gosling & Mason, 2015; Spada, 2014; Young, 1998).

Adolescents are at high risk for PIU, because of their immature self-control skills and availability of free time. Research on PIU continues to document deteriorating effects of Internet use among the adolescent population in many parts of the world (Cheng & Li, 2014; Kuss, Griffiths, Karila, & Billieux, 2014, Ferraro, Caci, D'amico, & Blasi, 2006; Gámez-Guadix, Villa-George, & Calvete, 2012; Lin & Tsai, 2002; Siomos, Dafouli, Braimiotis, Mouzas, & Angelopoulos, 2008). Adolescent Internet addiction has emerged as a major public health concern in recent years (Spada, 2014). The prevalence of PIU is especially high in some Asian
countries like China (Cao, Su, Liu, & Gao, 2007; Leung, 2004), Singapore (Mythily, Qiu, & Winslow, 2008) and South Korea (Ha, & Hwang, 2014; Jang, Hwang, & Choi, 2008). In China, legislation was enacted in 2005 to restrict adolescent access to Internet cafes as a means of mitigating the increasing prevalence of PIU.

Given the ubiquity of the Internet in modern society, understanding the etiology of PIU will be of great public health significance. Increasing interest in PIU prevention and intervention programs has directed attention to multiple ecological risks for adolescent PIU, yet the existing research provides only rather segmental explanations; few studies have offered a comprehensive and integrated account of the prevalence of PIU. Because of the large adolescent Internet user population (116 million Internet users are between the ages of 12-18 years; China Internet Network Information Center, 2016) and the high prevalence of Internet addiction in China (Weinstein, Feder, Rosenberg, & Dannon, 2014), examination of factors related to internet addiction among Chinese adolescents will be especially useful.

The current study examines the direct effects of cumulative ecological risks on adolescent problematic Internet use. Cumulative risk, which represents the amount of total risk exposure, is constructed by summing the standardized scores of eight socio-ecological risk factors. The risk variables were drawn from different aspects of the immediate environment of adolescents (family, peers and school), and have been selected based on their demonstrated relative potency in predicting adolescent PIU. Previous research has shown that some of these ecological factors are related to the development of adolescent self-esteem, and that low self-esteem has been found to be a risk factor for PIU, which suggests the possibility of a mediation effect. The current study therefore also investigates the mediating role of self-esteem in the relationship of cumulative risk and adolescent PIU.
Chapter 2. Literature review

Problematic Internet use

The concept of PIU

Problematic Internet use (PIU) can be broadly defined as “the uncontrollable usage of Internet that creates psychological, social, school and or work difficulties in a person’s life” (Beard & Wolf, 2008; Spada, 2014). The idea of problematic Internet use or Internet addiction was originally proposed by pioneer researchers Goldberg (1996), Griffiths (1996) and Young (1996). The early work began with clinical case studies that described the stereotypical symptoms of excessive Internet users (Griffiths, 1996; Young, 1996). Young (1996), for example, recorded a female individual who spent increased amount of time in online chat rooms regardless of negative real-life consequences and eventually developed social withdrawal. After the initial small-sample case studies, Young (1998) conducted the first exploratory survey study in a sample of 496 Internet users using the diagnostic criteria adapted from the *Diagnostic Statistical Manual of Mental Disorders IV* (DSM-IV) criteria for pathological gambling. Based on these criteria, 396 individuals were classified as dependent Internet users and 100 as non-dependent users. Dependent users spent eight times more time online than non-users. This milestone study has been cited 3849 times in Google Scholar, and most of the problematic Internet use and Internet addiction research studies today are based on this pioneering work.

Problematic Internet use, as a new maladaptive behavior that was born in the Internet technology era, has been given various names, which include: compulsive computer use (Black, Belsare, & Schlosser, 1999), excessive Internet use (Mythily et al., 2008), pathological Internet use (Davis, 2001), problematic Internet use (Davis, Flett, & Besser, 2002), Internet dependency
(Scherer, 1997); computer addiction (Shaffer, Hall, & Bilt, 2000), Internet addiction (Brenner, 1997; Young, 1998) and virtual addiction (Greenfield, 1999). In the first decade of the 21st century, with the rapid spread of smart phones and the increasing popularity of social networking sites and online gaming applications, other similar or related types of addiction or problematic use were identified. Among these were online gaming addiction (Chappell, Eatough, Davies, & Griffiths, 2006; Ko, Yen, Chen, Chen, & Yen, 2005; Ng, & Wiemer-Hastings, 2005), problematic mobile phone use (Bianchi & Phillips, 2005, Takao, Takahashi, & Kitamura, 2009), mobile phone addiction (Choliz, 2010, Park, 2005); Facebook addiction (Andreassen, Torsheim, Brunborg, & Pallesen, 2012; Griffiths, 2012) and social network addiction (Karaiskos, Tzavellas, Balta, & Paparrigopoulos, 2010; Kuss & Griffiths, 2011).

The assessment of PIU

Although a significant amount of empirical research on problematic Internet use has been done in the last two decades, review findings suggest that no general conceptualization or official diagnostic criteria have been established, thus various measurement tools have been used for assessment (see Kuss, Griffiths, Karila, & Billieux, 2014, for a detailed review). In general, researchers have reached consensus that PIU has common characteristics and features such as “excessive use, craving, tolerance, withdrawal and negative repercussions” (Block, 2008; Spada, 2014). Kuss and colleagues (2014) conducted a systematic review of 68 empirical quantitative studies that were published after 2000 and included large samples of participants (at least 1000). The results identified a total 21 different self-reported types of assessment tools of PIU within the 68 papers. Along with another 18 miscellaneous classification approaches, the three most commonly used measurements were located. These were Young’s (1998) Internet Addiction
Diagnostic Questionnaire (IADQ), the Internet Addiction Test (IAT, Young, 1998) and the Chinese Internet Addiction Scale developed by Chen and colleagues (2003).

The Internet Addiction Diagnostic Questionnaire (IADQ, Young, 1998) is an 8-item self-report survey based on pathological gambling diagnostic symptoms, which include: preoccupation, increasing tolerance (leading to desire for longer screen time or better equipment), loss of control, withdrawal, negative consequences, denial, and escapism. Meeting five or more of the dichotomously scored (yes or no) questions suggests Internet addiction. Slightly different than the IADQ, the Internet Addiction Test (IAT) is a more elaborated 20-item scale that is based on the criteria from substance dependence and pathological gambling (Young, 1998). It is a Likert type scale ranging from 1 “not at all” to 5 “always” that is designed for categorical assessment. A score of 70-100 indicates a significant problem and a score of 40-69 indicates frequent problems with Internet use. Both of the scales have been translated and adapted for research in different cultural settings, such as China, Taiwan, Korea, Greece, Spain, Finland and Turkey (Kuss et al., 2014). A later section of this paper will provide a more detailed description of these studies.

The Chinese Internet Addiction Scale (CIAS, Chen et al., 2003) is a 4-point Likert type scale that includes 26 questions regarding weekly online hours and Internet use experience, compulsive use, tolerance, withdrawal symptoms of Internet addiction, and the consequential effects on users’ school performance, physical health, social activities and relationships. A cut-off score of 64 indicates Internet addiction. A total of 16 empirical studies have utilized Chen’s CIAS as an assessment tool, mostly by the Yen and Ko research team in Taiwan (Ko et al., 2005, Ko et al., 2012; Yen, Ko, Yen, Chang, & Cheng, 2009a; Yen, Yen, Chen, Chen, & Ko, 2007).
The prevalence of PIU in different countries

Problematic Internet use has been recognized globally, and the adolescent population in many parts of the world has been identified as experiencing Internet addiction (see Cheng & Li, 2014 for review). Different prevalence rates (ranging from 1% to 35%) have been reported because of the use of various assessment tools (Spada, 2014).

In general, a lower prevalence rate has been reported in European and western adolescent samples. For example, a prevalence rate of 1.98% was found in a representative sample of 3237 Norwegian youths (Johansson & Gotestam, 2004); 4% of PIU was found in 3560 high school students in US (Liu et al., 2011); a rate of 5% in 1131 high school students in Spain (Lopez-Fernandez, Freixa-Blanxart, & Honrubia-Serrano, 2013) and 5.8% in 2533 Italian high school students (Poli & Agrimi, 2012); finally, a PIU rate of 8.2% was identified in 2200 Greece adolescents (Siomos et al, 2008). However, much higher prevalence rates have been reported in Asian countries. For instance, 18.8% of the participants in a sample of 9405 Taiwanese adolescents were classified as Internet addicted (Ko, Yen, Liu, Huang, & Yen, 2009); Cao and coworkers (2011) collected a sample of 17599 high school students from 8 cities in China and calculated a 8.1% PIU prevalence rate; in South Korea, Kim et al., (2006) found that 1.6% of 1537 high school students were Internet addicted but 38% were possibly addicted; a two-wave longitudinal study carried out in 3328 Hong Kong middle school students found Internet addiction prevalence rates of 26.4% and 26.7%, for the two waves respectively (Shek & Yu, 2012). These various prevalence rates might be partially due to the different assessment tools, but they are also likely to reflect the role of social-cultural context in the conceptualizations and interpretations of the phenomenon.
**Gender differences in PIU**

Gender differences in the prevalence of adolescent PIU have been observed in multiple studies, yet the specific findings have been very inconsistent. A large proportion of studies has found that male adolescents are more likely to develop PIU. For example, a study in 11 European countries identified 5.2% of males and 3.8% of females as suffering from PIU (Durkee et al., 2012); 3.6% boys and 1.9% girls were identified as addicted users from a Korean national web-based survey (Ha, & Hwang, 2014); male gender significantly predicted problematic Internet use in Turkish university students (Odacı & Çıkrıkçı, 2014); finally, males were found to have 50% increased odds of being addicted to the Internet compared to females in a Chinese adolescent sample (Lam et al., 2009).

On the other hand, a few researchers have reported a higher PIU prevalence rate in female samples. Thus, in a US study conducted by Liu and colleagues (2011), girls (11.81%) more frequently reported excessive use of the Internet than boys (8.9%). Consistent with this finding, Mihara and coworkers (2016) surveyed 100,050 Japanese middle school students and found prevalence rates of PIU to be 9.8% in females and 6.2% in males. Possible reason for the higher prevalence of PIU in females might be the content of Internet usage examined in particular studies. While boys are more likely to play online games, as reported in many studies across cultures (Fisoun, Floros, Siomos , Geroukalis, & Navridis, 2012; Kim, Namkoong, Ku, & Kim, 2008; Ko et al., 2005; Siomos, et al., 2008), girls’ preference lies in the social aspect of Internet use. For example, communication and connection opportunities are widely available on social networking sites, and cellphone texting and blogs are particularly attractive for female Internet users (Mihara et al., 2016).
Nonetheless, only a few studies have shown a greater prevalence of PIU for females, and most studies show a preponderance of males. Some other studies have reported no significant gender difference in the prevalence of PIU (Carbonell, Chamarro, Griffiths, Oberst, Cladellas, & Talarn, 2012; Odaci, 2011; Subrahmanyam & Lin, 2007). Therefore, further investigation is needed for this area.

**Risk factors for PIU**

A wide range of factors in the social-ecological environment has been shown to put the adolescent at risk for PIU. These include social demographic factors, risks in the family process such as parent-child attachment, and social interactions with teachers and peers in schools.

The demographic risk factors include low SES and residence in a rural area (Guo et al., 2012; Li, Zhang, Lu, Zhang, & Wang, 2013; Yen et al., 2007). For instance, Guo and colleagues (2012) studied a group of 3254 children from low income families and found a higher prevalence of PIU in those children who had been born in rural China, but who migrated back and forth into cities with their migrant worker parents. Yen and co-authors (2009a) also found that living in a rural area predicted Internet addiction for Taiwanese adolescents. In a 6-wave longitudinal study carried out in Hong Kong, Shek and Yu (2016) observed that family economic disadvantage in the first wave was positively related to adolescents' Internet addictive behaviors six years later.

Numerous risk factors in the family process have been reported. These include family conflicts (Lam, Peng, Mai, & Jing, 2009), negative parenting (Yen et al., 2007; Zhang, Li, & Li, 2015), and lack of parental supervision and poor parental bonding (Lam et al., 2009; Li, Li, & Newman, 2013). On one hand, Li and colleagues (2013) found that parental psychological control (a parenting approach considered to be negative) may increase adolescent problematic
Internet use. A study by Siomos et al. (2010) of 2017 Greek adolescents and 1214 parents revealed complementary findings, that higher perceived parental care and lower levels of perceived overprotectiveness were correlated with less Internet overuse (gaming, pornography and use of social networking sites). Similarly, Lin, Lin and Wu (2009) reached the conclusion that supportive parental monitoring decreased Internet addiction in Taiwanese high school student sample. When taken together, these empirical studies point to the robust role of family process and parent-child interactions in adolescents’ problematic Internet use.

Several aspects of the school experience have been linked to PIU. Among these are weak school connectedness (Yen et al., 2009a), low support from peers and teachers (Li, Li, Wang, Zhao, & Bao, 2013; Wang et al., 2011), and poor school performance (Mythily et al., 2008; Xu et al., 2012). Also, noxious peer environments, such as social involvement with drinking friends or Internet overuse peers, have been reported in several studies (Li, Newman, Li, & Zhang, 2016; Yen et al., 2009b; Zhang, Chen, Liu, Deng, & Fang, 2012; Zhou & Fang, 2015), primarily through the mechanism of social learning and peer contagion.

Some theorists and empirical evidence have suggested the compensatory effect of Internet use in fulfilling the psychological needs and social interactions that problematic users lack in their real life (Kardefelt-Winther, 2014a; Li, Zhang, Li, Zhou, Zhao, & Wang, 2016; Li, Zhou, Li, & Zhou, 2016). As a result, individuals with unsatisfactory social relationships may demonstrate increased reliance on the Internet.

The cumulative nature of PIU ecological risks

Ecological risk refers to a characteristic of the social and natural environment that is associated with adverse developmental outcomes (Wright & Masten, 2005). In the past several
decades, the effects of multiple ecological risks on adolescent/human development have been of great interest for developmental psychologists and behavioral scientists. Work in this area of inquiry has been guided primarily by the following considerations: 1) the bio-ecological model of human development that emphasizes that individual development is affected by the ecological risk factors of various aspects such as family, peers, school and community (Bronfenbrenner & Morris, 1998); 2) Research evidence that has shown that accumulated risk is associated with an elevated level of children's negative outcomes, and the negative impact of multiple risk factors is much stronger than those of single risk factors, suggesting that the effect of cumulative risk should be the major focus (Rutter, 1999; Sameroff, 2000); 3) The risk factors experienced by individuals do not operate independently as they usually co-occur. For instance, low SES is a complex construct of multiple risk factors which include low income, resource deprivation, single parent status, low educational attainment, minority status, and/or immigrant status (Huston & Bentley, 2010).

The cumulative risk approach is consistent with the bio-ecological model of human development which points out that adverse human behavior is the product of different ecological risks working simultaneously. As a result, cumulative risk out-performs singular risk exposure in predicting developmental outcomes. Also, the cumulative risk approach implies that the effect of multiple risk exposure is qualitatively different from the effect of singular risk exposure, a point of view that has been supported by the empirical evidence (Atzaba-Poria, Pike, & Deater-Deckard, 2004; Gerard & Buehler, 2004; Rutter, 1999; Sameroff, 2000). For example, young children exposed to five or more risk factors would have threefold increase in psychological distress when compared with peers who exposed to no or one risk factor (Sameroff, Seifer, Zax, & Barocas, 1987). Also, Atzaba-Poria, Pike and Deater-Deckard, (2004) collected parent and
child interview and videotape data from 125 families in UK. They observed that risk factors operated in a cumulative manner, with higher levels of risk exposure predicting higher levels of children's problem behaviors.

Consistent with the theoretical framework and empirical evidence reviewed above, the PIU risk factors from the social-ecological environment do not occur independently, rather, they cluster and place the adolescent at risk for PIU synergistically. For example, Yen and colleagues (2009b) examined 8941 Taiwanese adolescents and highlighted the co-existence of multiple risk factors in addicted users’ life experiences, which included low family monitoring, school detachment, family conflicts, having peers with drinking problems, and rural home residence. A study of 4400 Chinese college students by Huang et al., (2009) reported similar results with the co-occurrence of poor school achievement, lack of family love and depression. However, existing research studies provide limited explanation for the etiology of PIU. A cumulative risk approach allows demonstration of the linear correlation between the amount of risk exposure and the propensity for PIU revealed in the research, and thus clarification of the theoretical underpinnings of the relationship between cumulative risk and adolescent PIU.

**Self-esteem**

In recent decades, scholars have produced a substantial body of research on the environmental sources and underlying mechanisms that explain the high prevalence of PIU in Chinese adolescents. What is the process by which cumulative risk affects adolescent PIU? Whether cumulative risk influences adolescent adjustment through the mediation of certain variables is still a question. The current study investigates the mediating role of self-esteem in the pathway between cumulative risk and adolescent PIU.

Self-esteem is the self-evaluative part of the self concept, and reflects a person’s
judgment or attitude toward his/her overall worth (Leary & Baumeister, 2000). Self-esteem is the core component of the self system and is essential for positive human development. According to Maslow (1954) and others (Crocker & Park, 2003; Greenberg, Pyszczynski, & Solomon, 1986; Pyszczynski, Greenberg, Solomon, Arndt, & Schimel, 2004), the need for self-esteem is one of the basic human needs and therefore critical for psychological well-being. Empirically, research evidence has confirmed the robust links between self-esteem and quality of functioning in multiple psychological domains, as well as successful adjustment overall (see Baumeister, 1998 for a comprehensive review). Longitudinal investigation has revealed that self-esteem can act as protective coping resource for various life challenges in both direct and/or indirect ways (Egan & Perry, 1998; Murrell, Meeks, & Walker, 1991).

Socioeconomic status (SES), a very important indicator of social standing, is significantly associated with an individual's self evaluation or self-esteem. In general, high SES individuals score higher in self-esteem, although the association may vary in different populations and age groups (Baumeister, Campbell, Krueger, & Vohs, 2003; Greenier, Kernis, & Waschull, 1995). In a meta-analytic review, Tewenge and Campbell (2002) concluded that there was a significant and positive relationship between SES and self-esteem for the adolescent population in USA. This link is intuitively plausible as the beneficial effect of high SES facilitates adolescent development by enabling positive experiences and sufficient resources, which contribute to optimal developmental outcomes.

One of the major contributors to self-esteem is social support, first from parents, then from friends, classmates and teachers. An adolescent's self-esteem will suffer if he/she does not feel valued by the important people in his/her life. Ample empirical research has demonstrated that the relationship with parents is particularly important in predicting an adolescents' self-
esteem. For instance, adolescents from authoritative families and securely attached to their parents have higher levels of self-esteem (DeHart, Pelham, & Tennen, 2006; Martinez & Garcia, 2008; Newman et al., 2015; Song, Thompson, & Ferrer, 2009). Self-esteem has in turn been associated with higher school achievement and positive psychosocial functioning (Bean, Bush, McKenry, & Wilson, 2003; Cripps & Zyromski, 2009, Hickman, Bartholomae, & McKenry, 2000). By contrast, adolescents who experience negative parenting and have poor parental attachment tend to have low self-esteem and are more likely to exhibit poor social relations (Allen & Land, 1999), low achievement (Milevsky, Schlechter, Klem, & Kehl, 2008; Newman et al., 2015) and substance abuse (Mosher, Rotolo, Phillips, Krupski, & Stark, 2004).

The school and learning community is an important developmental context for adolescents. Social support from the school and learning environment is essential for healthy psychosocial development. A substantial body of research has demonstrated that positive school experiences (e.g., teacher and peer support, optimal school climate and good academic performance) positively predict adolescent self-esteem, which in turn links to positive behavioral functioning and psychological adjustment (Jia et al., 2009; Tian, Liu, Huang, & Huebner, 2013; Way, Reddy, & Rhodes, 2007; Way & Robinson, 2003).

Gender differences in self-esteem have been researched for several decades. Literature consistently suggests a small gender difference in self-esteem in favor of males (Feingold, 1994; Kling, Hyde, Showers, & Buswell, 1999). Adolescence is a particularly important developmental period for the formation of self-esteem. Meta-analyses have shown that the gender gap in self-esteem peaks in adolescence, however, the difference remains a small one (Kling et al., 1999). There is both cross sectional (Simmons & Rosenberg, 1975) and longitudinal evidence (Block & Robin, 1993) that shows that boys' self-esteem increases whereas girls’ self-esteem declines over
time during the adolescent period. One of the possible explanations for why adolescent girls score lower than boys in self-esteem is the impact of puberty on physical development. The physical changes of puberty, along with the increase in self-consciousness (Harter, 1990), put girls in a more vulnerable position than boys regarding self-esteem. However, because the research in this area was done two decades ago, it will be useful to investigate the situation with a current cohort of adolescents.

*Self-esteem as a mediator of cumulative risk and adolescent PIU*

Existing literature offers indirect theoretical support for the mediation path of self-esteem in the relation of cumulative risk and adolescent PIU. According to the self-system beliefs model (Sandler, 2001), protective ecological factors (e.g., parental warmth, secure attachment, teacher and peer support, positive school climate) positively predict adolescent self-esteem (Jia et al., 2009; Lynch & Cicchetti, 1998; Tian et al., 2013; Way et al., 2007; Way & Robinson, 2003), which links to positive psychosocial outcomes as described above. Empirically, self-esteem has been found to mediate the relationship of ecological risks and negative adolescent outcomes such as depressive symptoms (Prelow, Weaver, & Swenson, 2006). Also, a series of related studies provides empirical evidence for the mediation path: On one hand, ecological risks (e.g., negative parenting, low SES, poor school engagement, low school performance) adversely affect self-system beliefs (e.g., self-esteem), which increase the likelihood of PIU (Li et al., 2013); on the other hand, low self-esteem has been shown to be a risk factor for adolescent PIU (Armstrong, Phillips, & Saling, 2000; Aydm & San, 2011; Kim & Davis, 2009; Ko, Yen, Chen, Chen, & Yen, 2007; Niemz, Griffiths, & Banyard, 2005; Young & Rogers, 1998). For example, Wang and colleagues (2013) surveyed 9532 adolescents and young adults from nine cities in China, and detected a negative association between symptoms of problematic Internet use and self-esteem, a
finding consistent with the conclusion that increased Internet use might lead to decreased self-esteem.

On a related note, Ehrenberg and colleagues (2008) examined the role of self-esteem in the use of communication technologies (mobile phone addiction) in a group of 200 Australian university students. They found that those individuals with lower self-esteem spent increased time using instant messaging (IM), and reported stronger IM addictive tendencies (Ehrenberg, Juckes, White, & Walsh, 2008). Despite evidence of multiple links between risk factors, self-esteem and PIU, there is a lack of research in the current literature explicitly examining the mediating role of self-esteem in the pathway between cumulative risk and adolescent PIU.

**Methodological consideration**

*Moderated mediation model:*

From the methodological improvement point of view, a recent researcher (Kardefelt-Winther, 2014a) raised the criticism that the direct effect approach does not contribute much to the understanding of the etiology of PIU, because it fails to address confounding variance from possible mediation or moderator variables in the interactive process. For example, in a study of factors predicting excessive online gaming (one subtype of problematic Internet use), when stress was entered into the regression equation, the direct effects of loneliness and social anxiety on excessive online gaming became insignificant, which indicated the likelihood of a mediation process operating in the backstage (Kardefelt-Winther, 2014b). Also, research has found that the association between sensation seeking (a dimension of temperament) and adolescent PIU was significant in adolescents who had experienced low authoritative or low permissive parenting, but was not significant in for those who had experienced high authoritative or high permissive parenting (Zhang et al., 2015), which highlighted the importance of a potential moderation
process in the model.

*Modeling multiple risk exposure:*

In the literature, multiple risk exposure for poor developmental outcomes has been typically modeled using two approaches: OLS (ordinarily least square) multiple regression and the cumulative risk index. Each technique represents an important way of conceptualizing multiple risk exposure.

The OLS regression method enters all the risk factors as predictors into the regression equation, and utilizes the total R² as the index of multiple risk exposure on the outcome variables. This method does not aggregate the risk factors, so it allows us to examine the relative importance and unique effect of each risk factor in predicting children’s developmental outcomes, as indicated by the significance and absolute value of each risk factor’s regression coefficient. However, the drawback is that the OLS multiple regression method does not take into account the “co-occurrence” of ecological risks, thus high correlations among risk factors would induce the issue of “high multicollinearity”. For example, the co-occurrence of low maternal education, neighborhood disorganization and residential crowding can severely distort regression inference (Evans, Li, & Sepanski Whipple, 2013), which might result into an overall significant regression equation but with none of the individual risk factors having a significant effect on the outcome (Buchinal, Robert, Hopper & Zeisel, 2000). Also, the OLS regression model requires a relatively large sample size to offset the cost of losing many degrees of freedom by treating all the risk factors as predictors. Therefore, the OLS regression model is not optimal for a small sample study due to its restricted statistical power.

Alternatively, multiple risk exposure can be modeled by using the cumulative risk index approach. A cumulative risk index is built by summing the individual risk factors that the
children were exposed to. The risk exposure can be aggregated into either a summary continuous score or an aggregate of dichotomized scores. (The method section provides a detailed description of cumulative risk index construction). Instead of regressing the outcome on all the risk factors, the outcome variables are simply regressed on the cumulative risk index score. This approach has high face validity, parsimony, and it consistently predicts developmental outcomes (Sameroff, Gutman, & Peck, 2003). Because there is only one predictor in the model, the cumulative risk index is conceptually straightforward for statistical analytical interpretation, and is suitable for small sample sizes, especially when there is investigation of mediation or moderation (Buchinal et al., 2000). However, this approach has disadvantages; it equally weights each risk factor, which loses information about individual risk factors, and cannot identify what risk factors are most relevant for the development outcome.

The Present Study

In order to advance the methodology for studying PIU, in the current study a mediation model has been constructed with self-esteem mediating the effect of cumulative risk on adolescent PIU. Further, to clarify the gender effect in PIU as well as the gender difference in self-esteem, gender has been included as a moderator in the mediation model. Specifically, the current study addresses three research questions. The first examines the direct effects of multiple risk factors (using a cumulative risk summary score) on adolescent Problematic Internet Use (PIU). The second investigates the mediating role of self-esteem in the relation of cumulative risk and adolescent PIU, as shown on the conceptual model in Figure 1. The third research question concerns a possible gender difference in the above mediation model. The first two research questions are closely related to each other. The direct association is the foundation for exploration of mediation effects; the mediation effect will bring deeper understanding of the
direct effect. Based on the literature review summarized above, the following hypotheses are proposed: 1) cumulative risk will positively predict adolescent PIU (Hypotheses 1); 2) Given that cumulative risk might affect PIU through other mediators and thus full mediation is unlikely to happen, self-esteem will partially mediate the pathway between cumulative risk and adolescent PIU (Hypotheses 2); 3) gender will moderate at least some, if not all, paths in the mediation model (Hypotheses 3). The potential gender moderation is conceptually illustrated in Figure 2.

In addition, previous research has indicated that demographic variables such as age, family composition, home location (e.g., urban, sub-urban and rural) are significantly associated with adolescent self-esteem (Dong & Lin, 2011; Tewenge & Campbell, 2002), and PIU (Li et al, 2013; Li et al, 2014; Niemz et al, 2005; Siomos et al., 2008). In order to clarify the distinct effect of cumulative risk, these and other covariates are controlled in the statistical analyses.
Chapter 3. Methods

Participants

A total of 2621 Chinese adolescents (53.5% girls) were recruited from 4 middle schools (Grade 7 to Grade 9) in southern China by a stratified sampling method. Two of the schools were located in urban areas and the other two were from rural areas; within the four schools, half of them were academically selective schools and half were regular schools. Selective schools usually have better quality teachers, facilities and resources, and thus attract more capable students. Both types of school have been selected to achieve a range of variation of student characteristics. Adolescents were between the ages of 11 and 17 (M = 13.56 years, SD = 1.06), 35.3% of them were in Grade 7, 32.6% in Grade 8 and 32.1% in Grade 9. Finally, 25% of the adolescents were only children, and 7% of participants came from single-parent families.

Procedure

This study was approved by the Institutional Review Board of University at Albany. The data were collected in middle school classrooms between February and April of 2016. Trained data collectors (undergraduate students) administered the questionnaires using scripts and a manual of procedures so as to standardize the data collection process. Written consent and assent were obtained from school administrators, parents and students before data collection. Students were informed that their participation was completely voluntary and they could decline participation at any time. Participants received a pen and an eraser as incentives after they completed all questionnaires.

Measures
The instrument battery comprised eight scales assessing risk factors from family, SES and school, as well as two surveys for self-esteem and PIU. In addition to these ten measures, students reported demographic information including family size, number of siblings, family location (rural, suburban, urban,) and school type (selective or regular), to provide a more detailed description of their background. The instruments were compiled into one self-reported assessment battery. As described in the section below, all the measures had been validated for reliability and validity in Chinese adolescent samples in previous studies.

*Cumulative Risk Index Construction*

Previous research and theory demonstrate that a cumulative risk index could be constructed from either a summary score gained from risk factors, or by counting the number of risk factors experienced. The summary score approach aggregates the standardized values of multiple risk factors whereas the counted index approach sums the number of dichotomous risk factors. Both approaches have the advantages of being parsimonious, straightforward and statistically sensitive with small sample sizes, and thus have been widely used in the literature (Burchinal et al., 2000; Evans et al., 2013; Sameroff, Gutman, & Peck, 2003). However, compared with the counted index that loses the variability of risk factors due to the dichotomization, the summary score approach retains the full information of each risk variable and provides greater power in predicting child outcomes. It therefore has enjoyed increasing popularity in the field of cumulative risk research (Ackerman, Kogos, Youngstrom, Schoff, & Izard, 1999, Atzaba-Poria, Pike, & Deater-Deckard, 2004; Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005; Felner et al., 1995; Pollard, Hawkins, & Arthur, 1999). Furthermore, when Burchinal and colleagues (2008) investigated the effect of cumulative social risk on infant cognitive development, they compared the summary score approach with the counted index approach and
found that the cumulative risk index built by summary scores was a stronger predictor of parenting skills and infant cognitive outcomes than the counted index. For the above reasons, the cumulative risk index represented by summary scores was used in the present study.

In the current study, cumulative risk score was created by summing the standardized scores of the following risk factors: low parental education, family economic strain, harsh parenting, poor parent-child attachment, low teacher support, low student support, deviant peer affiliation and poor academic achievement.

1. Parental education. Adolescents reported their father’s and mother’s highest level of completed education on a 7-point scale (two items) ranging from “1 = no education; 2 = elementary school; 3 = junior high school; 4 = high school; 5 = 2-years college; 6 = 4-years college; 7 = graduate school and above”. The education scores from the two parents were combined and recoded, then standardized into Z scores, with higher standard scores reflecting higher risk of “low parental education”. In the current study, 15.6% of the fathers and 23.8% of the mothers had no education or just elementary school education; 44.8% and 44.2% of them had junior high school education, 22.4% and 17.9% had high school education. 6.0% and 6.1% attended 2-years of college, 8.7% of the fathers and 6.4% of the mothers had finished 4 years of college and 2.5% of the fathers and 1.5% of the mothers had post-graduate degrees. These education background statistics are consistent with Chinese census data (the sixth national population census of the People's Republic of China, 2010).

2. Family Economic Strain. Family economic strain was assessed with a 4-item scale adapted from the economic strain scale by Wadsworth and Compas (2002). Adolescents were asked to rate the frequency of family economic strain (e.g., "My family does not have budget for family
entertainments") during the past 12 months (1 = never happens; 2 = sometime happens; 3 = often happens; 4 = always happens). Participants’ mean score of family economic strain was 1.32 (SD = 1.06), and 12.2% of the participants indicated their family sometimes to always encountered financial hardship (scored 2 or above). The item scores were averaged and converted into standard scores, with higher values representing greater risk of “family economic strain”. The alpha reliability statistic was .76 for the current study.

3. Harsh Parenting. Adolescent maternal parenting style was assessed with the 11-item authoritarian subscale from the previously tested Parenting Style and Dimensions Questionnaire (Li, Zhang, Li, Wang, & Zhen, 2012; Robinson, Mandleco, Olsen, & Hart, 2001). Previous literature has shown that this questionnaire is psychometrically sound (Locke & Prinz, 2002; Olivari, Tagliaabue, & Confalonieri, 2013) and particularly appropriate for Chinese adolescents (Dong & Lin, 2011; Li et al., 2012; Zhou et al., 2008). Given the high prevalence of authoritarian parenting that has been found in the literature about Chinese parenting, and practices such as spanking, verbal threatening and psychological control that have been typically found in Chinese families (Chen, Dong, & Zhou, 1997; Xu, Farver, & Zhang, 2009), in the current study an authoritarian parenting measure was used to capture an adolescent's experience of being raised in a Chinese family. Specifically, the authoritarian subscale of the Parenting Style and Dimensions Questionnaire measures three dimensions that pertain to authoritarian parenting practices: spanking/physical punishment; verbal aggression; and peremptory commands (e.g., "She uses physical punishment as a way of disciplining me"). Five point Likert responses were provided, ranging from “1 = never” to “6 = always”, with higher scores indicating higher prevalence of that parenting style. Scores on authoritarian parenting were averaged and standardized, with higher values indicating greater risk of “Harsh parenting”. For the current study, the authoritarian
parenting scale demonstrated good reliability (α = .87). In the current sample, the mean score of harsh parenting was 2.4 (between a little of the time to some of the time), with 7.4% of the participants reporting that they experienced harsh parenting at least about half of the time. Previous research in China has shown that harsh parenting was predictive of multiple negative children's outcomes such as aggression and poor social functioning (Jia, Wang, & Shi, 2014; Xu et al., 2009; Zhou, Eisenberg, Wang, & Reiser, 2004), low life-satisfaction (Chen, 2014), poor mental health (Xia & Qian, 2001); low self-regulated learning (Huang & Prochner, 2003), and poor school performance (Chen et al., 1997).

4. Parent-child attachment. Parent-child attachment was measured by the parent version of the Inventory of Parent and Peer Attachment (Armsden & Greenberg, 1987; Li, Zhang, Li, Mai, Wang, & Xing, 2009). The 13 items assess the trust, communication and alienation in parent child interaction (e.g. "My parent trusts me"). Five point Likert responses were provided, ranging from “1= never” to “5 = always”, thus, the higher the score, the better the parent-child attachment perceived by the adolescents. In the present study, the alpha reliability statistic is .87. In the current sample, the mean score of parent-child attachment was 3.45 (SD = .73), which indicates that the adolescents overall felt attached to their parents with a frequency between Sometimes and Often. These scores were recoded and standardized, with higher scores indicating greater risk of “poor parent-child attachment”. The mean score of poor parent-child attachment was 2.55 (SD = .73).

5. Teacher Support. Teacher support was assessed with a previously validated teacher support subscale from “School Climate Measure" (Jia et al., 2009; Tian et al., 2013). The teacher-support subscale consists of 7 items focusing on emotional support from teachers (e.g., "Teachers believe I can do well"). All items have a 4-point response scale (1 = never, 4 = always). In the present
study, the alpha reliability statistic was .80. In the current sample, the mean raw score of teacher support was 2.75 (SD=.54). These scores were recoded and standardized, with higher values indicating higher risk of “low teacher support”. The mean score of low teacher support was 2.25 (SD = .54).

6. Student support. Student support was assessed with the student support subscale from the “school climate” measure (Jia et al., 2009; Tian et al., 2013). This subscale consists of 12 items assessing the mutual support among student peers (e.g., "Students care about each other"). All items have a 4-point response scale (1 = never, 4 = always). In the present study, the alpha reliability statistic was .84. The mean raw score of student support was 3.12 (SD = .47). After recoding, the scores were standardized into the variable “low peer support”, with higher values indicating higher risk of low peer support. The mean score of low peer support was 1.89 (SD = .47).

7. Deviant peer affiliation. Adolescent affiliation with deviant peers was assessed with eight items adapted from prior published questionnaires (Fergusson & Horwood, 1999; Kendler et al., 2007; Li et al., 2016). Adolescents were asked to indicate how many of their friends have shown each of eight deviant behaviors (tobacco and alcohol abuse, cheating on school tests, stealing or shoplifting, property destruction, truancy, physical and verbal aggression) during the prior year, e.g., “How many of your friends got drunk in the last year?” Responses were rated on a 5-point scale (1 = none to 5 = almost all). For the current study, the scale demonstrated good reliability (α = .84). These scores were standardized, with higher values representing greater risk of “deviant peer affiliation”. The mean score of Deviant Peer Affiliation was 1.55 (SD=.54).
8. *Academic performance.* Academic achievement was measured with three questions regarding the participant's self-evaluation of performance in the three core courses of Chinese, Math, and English. A representative item is “How do you evaluate your performance in Math?” (1 = Poor, 2 = Below average, 3 = Average; 4 = Above average, 5 = Outstanding). In the current study, the alpha reliability statistic was .74. The mean score of perceived school performance was 2.91 (SD = .93). These were recoded and standardized such that higher values indicate a greater risk of “poor school achievement.” The mean score of poor school performance was 3.09 (SD = .93).

9. *Self-esteem.* Adolescent self-esteem was assessed with the Chinese version of Rosenberg’s (1965) 10-item self-esteem scale. Each item has a 4-point response scale ranging from 1 = "strongly disagree" to 4 = "strongly agree". The scale provides an overall evaluation of a person’s worth or value, and has been widely used in research in different cultural contexts (Schmitt & Allik, 2005). Satisfactory reliability and validity have been established in research with Chinese participants (Chen, Cheung, Bond, & Leung, 2006; Lumei, 2006, Newman et al., 2015). In the current study, the self-esteem scale demonstrated good reliability (α = .83). Responses were averaged, with higher scores representing higher self-esteem. The mean score of self-esteem was 2.83 (SD = .51). In the structural equation modeling analysis, item parcels have more power and yield more efficient estimates of model parameters than do item-level solutions (Bandalos & Finney, 2001), thus we used the average scores of three item parcels (3-3-4 items in each parcel) to represent the latent construct of self-esteem, which was entered as the mediator variable in the current model.

10. *PIU.* The outcome variable of PIU was assessed with 10 items from Young’s (1998) diagnostic questionnaire for screening of Internet dependency. This scale has demonstrated good reliability and validity in Chinese adolescent samples in both middle school (ages 12-15) and
high school (ages 16-20) (Cao & Su, 2007; Li et al., 2010; Li et al., 2013; Wang et al., 2011). In addition, similar items have been used in the National Children’s Study of China project (Dong & Lin, 2011). Adolescents were asked to indicate how true each item was for them (e.g., “I jeopardized or risked the loss of friendship, or school performance because of the Internet”) on a 6-point scale (1 = not at all true to 6 = always true). Responses were averaged, with higher scores representing greater likelihood of PIU. A confirmatory factor analysis was performed to assess the single factor model, and the model adequately fit the data (CFI = .97, SRMR = .042, RMSEA = .10 [.70 -.12]). The Cronbach’s alpha reliability statistic was .87 in the current sample. In the SEM analysis, the latent construct of PIU was indicated by the average scores of three item parcels (3-3-4 item in each parcel).

To summarize, in the current moderated mediation model, cumulative risk was the independent variable, self-esteem was the mediator and PIU was the outcome variable in the model. In addition, I examined all possible gender differences in the paths within the mediation model.

Statistical analyses overview

Structural equation modeling (SEM) was conducted for the data analysis. SEM techniques were chosen for their ability to model variable relationships using maximum likelihood estimation, which are considered to be particularly suitable for analyzing large cross-sectional data (Kline, 2005). The adequacy of data-model fit was determined by examining a combination of indices that are recommended by experts (Hoyle, 2012; Hu & Bentler, 1999): the significance of Chi square $\chi^2 (p>.05);$ the Comparative Fit Index (CFI) value equal to or above
0.95; the Root Mean Square Error of Approximation (RMSEA) value equal to or below 0.06; and the Standardized Root-Mean-Square Residual (SRMR) value equal to or below .09.

First, descriptive statistics for the variables of interest and control variables will be presented, followed by bivariate associations among these variables. In order to reveal the unique association of each risk predictor with adolescent PIU, a latent variable regression was conducted by regressing adolescent PIU on eight risk factors while controlling for demographic covariates.

Secondly, to establish the mediation model in hypothesis 1 and hypothesis 2, the procedure proposed by Hayes (2013) and Wen and Ye (2014) was used to examine the mediation effect of self-esteem in the relation of Cumulative Risk and adolescent PIU. The procedure requires: (a) a significant association between the independent variable (Cumulative Risk) and the mediator variable (self-esteem); and (b) a significant association between the mediator variable and the dependent variable (PIU) after controlling for the independent variable; (c) a significant coefficient for the indirect path between Cumulative Risk and PIU via self-esteem. Bias-corrected bootstrap 95% confidence intervals (CIs) were used to determine whether the last condition was satisfied; CIs not overlapping with zero indicate a significant indirect effect. The bootstrapping method reduces the size of standard errors and yields stronger confirmation of the predicted mediation relationship, therefore is a better way for estimation of the indirect effect (MacKinnon, Lockwood & Williams, 2004; Preacher & Hay, 2008). In addition, to ensure the stability of the mediation model and estimation coefficients, a model cross-validation procedure was conducted by randomly splitting the full sample into two (approximately) equal size sets (testing set and validating set). The mediation model was first tested on the testing set then validated on the validating set. If the predictive power drops off drastically in the validation
sample, then the proposed mediation model is not meaningful because it has little or no generalizability (Mertler, & Vannatta, 2013; Stevens, 2012).

Thirdly, to test hypothesis 3 that gender moderates at least some of the paths in the mediation model, SEM multi-group analyses were conducted in the testing set data. The reason for using the testing sample rather than the full 2621 participants was to avoid repeated data usage for the same model. A six step multi-group comparison procedure was followed: (1) test the overall testing sample; (2) test the samples of boys and girls separately and see if the meditational model holds in both samples; (3) test two samples simultaneously (multi-sample with no path constraints); (4) test the multi-sample with all path constraints of interest; (5) compare the model fit indices in Step 2 and Step 3 by using a significance level of .05 in chi-square difference test for model comparison between the samples of boys and girls; (6) conduct a follow-up individual test of inequality if there is erosion of fit indices in step 5; if not, stop and conclude structural invariance in both groups.
Chapter 4. Results

Preliminary Analyses

Most continuous variables in this study were approximately normally distributed (except for family economic hardship, harsh parenting and deviant peer affiliation). Data were screened for violations of multivariate assumptions including normality of residuals, homogeneous variances of residuals across predictors, linear relationships between variables and absence of correlations between prediction errors. Correlations were computed to aid interpretation of regression results, especially given the likelihood of multi-collinearity among risk variables (Burchinal et al., 2000). Out of the 2621 participants, there were 6.6% missing data. Little's MCAR test is significant ($\chi^2 = 7535.054$, $df = 6682$, $p < .001$), which indicated that the data were not missing completely at random. Missing data were handled using full information maximum likelihood estimation, which provides less bias and improves reliability of results compared to more conventional methods of handling missing data such as listwise deletion (Widaman 2006). The final analytical sample included 2448 participants.

Because multiple data analyses with different sample sizes were conducted in the current study, an overview is provided below of the participant numbers to provide a better understanding of the data usage in each analysis. First, the descriptive and bivariate correlation statistics were calculated with all the 2621 participants in SPSS 23, then all the subsequent analyses were computed with Mplus7.0 (Muthén, & Muthén, 1998-2012). Test of the unique associations of eight risk factors in PIU were done in the sample of 2448, then the data were randomly split into two equal halves for the mediation model cross validation, in which the testing sample included 1222 adolescents and the validation sample included 1227. Finally, to avoid repeated data usage for the same model, multiple group comparison was conducted to
investigate potential gender moderation within the testing sample (577 boys and 645 girls) only.

Table 1 presents descriptive statistics (means and standard deviations) and the correlation matrix for all study variables. It can be seen from Table 1 that the mean score of PIU (range from 1-6) was 2.47 (SD = 1.03), however, the mean score of PIU was significantly lower for girls (M = 2.2) when compared with boys (M = 2.8). In the current sample, 216 of the adolescents (55 girls and 161 boys) were classified as at risk for Internet addiction, which makes the overall prevalence rate of PIU to be 7.2%. This prevalence rate is consistent with Chinese national data (Li, Zhang, Lu, Zhang, & Wang, 2014) and recent literature reviews (Cheng & Li, 2014; Kuss et al., 2014). The gender specific prevalence rates were 3.9% for girls and 13.1% for boys. Note that the dichotomization of the Internet addiction variable is for descriptive purposes only; all the subsequent analyses maintained the continuous nature of this variable.

Correlation among the demographic variables, cumulative risk, self-esteem and PIU

As presented in Table 1, gender, age, school type, family location and number of siblings and family members were all significantly correlated with cumulative risk, self-esteem and PIU. Significant correlation coefficients ranged from .02 to .32 (absolute value). Specifically, gender (male) was positively correlated with cumulative risk (r = .10), self-esteem (r = .08) and PIU (r = .28), which was consistent with studies in the literature that adolescent boys were more likely to suffer from problematic Internet use than girls. Family area of location (degree of development of the area) was positively correlated with self-esteem (r = .13), negatively correlated with cumulative risk (r = −.32) but not correlated with PIU, which indicated that participants from more developed areas had higher self-esteem and less cumulative risk. School type was
negatively correlated with self-esteem ($r = -0.08$) and positively correlated with cumulative risk ($r = 0.26$) but not correlated with PIU, which indicated that adolescents from regular (non-selective) schools had lower self-esteem and more cumulative risk. Number of siblings was negatively correlated with self-esteem ($r = -0.12$) and PIU ($r = -0.04$), but positively correlated with cumulative risk ($r = 0.26$), which means adolescents with more siblings had lower self-esteem and PIU but more cumulative risk.

*Correlation among the risk variables, cumulative risk, self-esteem and PIU*

Self-esteem was negatively correlated with all eight risk variables, with significant correlation coefficients ranging from $-0.17$ to $-0.47$. PIU was positively correlated with all risk variables except low parental education; significant correlation coefficients ranged from $0.07$ to $0.35$. Cumulative risk index score was positively associated with PIU ($r = 0.37$, $p < 0.001$), indicating that Cumulative Risk Index score did represent a risk factor for adolescent PIU. Self-esteem was negatively associated with cumulative risk ($r = -0.50$, $p < 0.001$), indicating that higher levels of self-esteem were associated with lower levels of cumulative risk. Finally, lower levels of self-esteem were associated with higher levels of Internet addiction ($r = -0.25$, $p < 0.001$).

**Primary Analyses**

*Testing the unique effects of individual risk factors in predicting PIU*

To test the unique effects of eight risk factors on adolescent PIU controlling for demographic covariates, latent variable path analysis was conducted using the full-information maximum likelihood estimation method in Mplus7.0. The criterion variable was PIU; the demographic covariates were child gender, age, area, school type, number of siblings and number of family members; eight risk variable predictors were low parental education, family
economic strain, harsh parenting, poor parent-child attachment, low teacher support, low student support, deviant peer affiliation and poor academic achievement.

**Testing the Measurement Model**

A two-step structural equation modeling procedure was performed to test the hypothesized model. The first step involved testing the measurement portion of the model, in which 10 variables (8 risk factors, mediator self-esteem and outcome variable PIU) were allowed to correlate freely with one another, and the indicators were loaded on their respective factors. Except parental education (which has only two items thus represented by a manifest variable), all the other variables were modeled as latent factors represented by the average scores of item parcels and organized as follows: (a) family economic hardship: four items (1-1-1-1); (b) low academic achievement: three items (1-1-1); (c) poor parent-child attachment was indicated by the average score of three items parcels (4-4-5); (d) harsh parenting was indicated by three items parcels (3-3-4); (e) low teacher support was indicated by three items parcels (2-2-3); (f) low student support indicated by three items parcels (4-4-4); (g) deviant peer affiliation was indicated by four items parcels (2-2-2-2); (h) self-esteem was indicated by three items parcels (3-3-4); and finally PIU was indicated by three items parcels (4-4-4). Results showed satisfactory fit for the measurement portion: $CFI = .973$, $SRMR = .025$, $RMSEA = .031 [ .029 - .032 ]$, $\chi^2 = 1342.28$, $df = 389$, $p < .001$. Because the Chi-Square statistic is sensitive to sample size and nearly always rejects the model when using large sample (Hau, Wen, & Cheng, 2004, Hooper, Coughlan, & Mullen, 2008), the significant Chi-square value is not unexpected given the current sample size of over 2000.

**Testing the Structural Model**
In the structural model, PIU was regressed on seven demographic covariates and eight risk factors. Results showed acceptable data-model fit: CFI = .913, SRMR = .068, RMSEA = .048 [.047 - .05], $\chi^2 = 3999.50$, df = 570, p < .001. In the analyses, a significant gender effect was found for PIU ($\beta = .21$, p < .001), indicating that boys have a higher likelihood of engaging in PIU. School type (regular school = 1, selective school = 0) negatively predicted PIU ($\beta = -.05$, p < .05), indicating that those adolescents enrolled in selective schools have slightly less tendency to engage in PIU. No significant effects were found for child age, area of family location, number of siblings and number of family members.

The results for predicting PIU from eight risk factors were presented in Table 2. In summary, poor parent-child attachment, harsh parenting, low student support, deviant peer affiliation and poor academic achievement positively predicted adolescent PIU ($\beta$s = .11 ~ .19, p < .001). Contrary to my expectations, low parental education negatively predicted PIU ($\beta = -.09$, p < .01), and no significant effects were found for family economic hardship ($\beta = .015$, p > .05) and low teacher support ($\beta = .04$, p > .05).

**Testing the mediation role of self-esteem between cumulative risk and PIU**

To determine the stability of the mediation model and estimation coefficients, in both the testing sample (N = 1222) and the validation sample (N = 1227), the partial mediation model depicted in Figure 1 was tested; this contained the mediator self-esteem and the direct path from the cumulative risk to PIU. The cumulative risk score was created by summing the standardized scores of the all eight risk variables. For the reason of simplicity, the demographic covariates were not presented in the figure.
Results revealed satisfactory data-model fit in both samples: (1) for the 1222 testing sample, CFI = .987, SRMR = .027, RMSEA = .033 [.024 - .041], $\chi^2 = 97.51$, df = 42, p < .05; (2) for the 1227 validation sample, CFI = .992, SRMR = .026, RMSEA = .026 [.017 - .035], $\chi^2 = 77.35$, df = 42, p < .05. The data-model fit indices were comparable to each other and fit statistics in the validation sample were even slightly better than in the testing sample. Also, the regression path coefficients in the mediation model were consistent across both samples, which demonstrated strong coefficient stability and convincing model generalizability. Table 3 summarizes the standardized parameter estimates for direct effect, indirect effect and total effect in the mediation model.

[ INSERT TABLE 3 HERE ]

[ INSERT TABLE 4 HERE ]

[ INSERT FIGURE 3 HERE ]

Given below are the results from the testing sample as an illustration for the mediation model. In the testing sample, demographic covariates such as gender ($\beta = .24$, p < .001) and area of family location ($\beta = .11$, p < .01) were positively associated with PIU, number of siblings ($\beta = –.08$, p < .001) negatively predicted PIU, but age, school type and number of family members did not predict PIU.

As shown in Figure 3, cumulative risk was negatively associated with self-esteem ($\beta = –.557$, p < .001), which in turn predicted adolescent PIU ($\beta = –.135$, p < .001). The indirect effect of cumulative risk ($\beta = .075$) on PIU through self-esteem was significant with a 95% confidence interval (CI) of –.0427 to –.0205 in a 10,000 bootstrap sample. Cumulative risk also had a residual direct association with adolescent PIU ($\beta = .325$, p < .001). Cumulative risk and self-
esteem account for 23.3% of the variance in PIU ($R^2 = .233$, $p < .001$). When these results were taken together, both hypotheses 1 and 2 were supported.

**Testing the gender difference in the mediation model**

In order to test the hypothesis that gender would moderate at least some of the paths in the mediation model, SEM multi-group analyses were conducted within the 1222 testing sample. The testing sample includes 577 boys and 645 girls. A six-step multi-group comparison procedure as described in the data analysis overview was followed. As shown in Table 4 of the data fit indices, test of the overall testing sample (Model 1), and separate examination in the boys (Model 2) and girls (Model 3) samples, all yielded satisfactory data-model fit, thus the two samples were tested simultaneously (Model 4 multi-sample without path constraints). To accommodate all possible gender differences, equality constraints were imposed on all three structural paths (Model 5 multi-sample with all path constraints): (1) the path from cumulative risk to PIU; (2) the path from cumulative risk to self-esteem; (3) the path from self-esteem to PIU. A significance level of .05 in the chi-square difference test was used for model comparison between Model 4 and Model 5.

Both the model with constraints (Model 5), CFI = .99, SRMR = .029, RMSEA = .026 [.01 - .04], $\chi^2 = 128.87$, df = 85, $p < .001$, and the model without any constraints (Model 4), CFI = .992, SRMR = .026, RMSEA = .026 [.01 - .04], $\chi^2 = 115.6$, df = 82, $p < .01$, yielded satisfactory fit. However, model comparison revealed that the model with constraints had a significant worse fit than the unrestricted model, $\chi^2_{\text{diff}} = 13.27$, df = 3, $p < .01$, which suggests gender differences exist in the mediation model. The omnibus follow-up individual test, in which the constraints were tested one at a time against the model without constraints, detected
significant gender differences in the path from self-esteem to PIU: self-esteem predicted PIU ($\beta = -0.243$, $p < .001$) in the male sample but was not significantly related to PIU among female ($\beta = 0.04$, $p > .05$). Due to the insignificant path from self-esteem to PIU, the indirect effect from cumulative risk to PIU in the female group was not significant. In other words, gender moderated the path from self-esteem to PIU (the second stage of mediation), and the mediation model was held only in the male population. Table 5 summarizes the standardized path estimates for the whole testing sample and both gender groups and Figure 4 illustrates the final moderated mediation model.

[ INSERT TABLE 5 HERE ]

[ INSERT FIGURE 4 HERE ]
Chapter 5. Discussion

Decades of research on adolescent PIU have documented the adverse effects of multiple ecological risks (Li et al., 2010; Li et al., 2016; He & Hong, 2013; Tang et al., 2014; Tsitsika et al., 2009; Yen et al., 2007). However, most of these studies examined a single or a specific set of risk factors, ignoring the co-occurrence of developmental risks, as well as the fact that the critical element in youths’ PIU was not any particular array of risk factors, but rather the overall accumulation of risks to which they are exposed. In addition, the underlying mediation and moderation process of how multiple risk factors are associated with PIU has not been well understood. A better theoretical and empirical understanding of the effects and mechanisms of cumulative risk could help inform intervention practices and policies to mitigate adolescent PIU. Based on the ecological theory of human development, using the cumulative risk summary score method to capture adolescents’ overall risk exposures across multiple developmental contexts, the current study systematically uncovered how ecological risk factors cumulatively impact the propensity for adolescent PIU. The study adds to the literature by illuminating the relationship between ecological risks and adolescent PIU in a novel and comprehensive way.

Recent literature has found that the etiology of adolescent PIU can be accounted for by the complex interplay between an individual's own characteristics and his/her ecological-environment (Li et al., 2010; Li et al, 2013; Li et al, 2016; Yu, Li, & Zhang, 2015; Zhang et al., 2015). The current study encapsulated these interactive perspectives by constructing a moderated mediation model to investigate whether cumulative risk would indirectly predict adolescent PIU through self-esteem, and whether the same mediation effect would hold across populations of both boys and girls. The findings contribute answers to the questions of “how” and “for whom” multiple ecological factors confer risks of PIU on adolescents.
Findings of the overall model

Overall, results showed significant direct effects of cumulative risk on both self-esteem and PIU, and that self-esteem negatively predicted PIU. When cumulative risk and self-esteem were entered into the model at the same time, the direct effect of cumulative risk on PIU dropped but the residual effect was still statistically significant, which suggested a mediation model in which the effects of cumulative risk on adolescent PIU were partially explained by decreased self-esteem. Specifically, cumulative risk decreased adolescent self-esteem, which in turn predicted higher problematic Internet use. In other words, self-esteem mediated the association between cumulative risk and PIU. Thus, adolescents who encounter multiple risks in their social ecological environment are more likely to develop low self-esteem and subsequently develop excessive usage of Internet. The following sections discuss each of the paths in the mediation model.

The path from cumulative risk to PIU

The direct links between cumulative risk and adolescent PIU were detected in several analyses. The positive direct effect of cumulative risk on PIU found in the testing sample was successfully replicated in the validation data with a similar regression coefficient. In addition, multiple group comparison yielded comparable positive parameter estimation between boys and girls in the path from cumulative risk to PIU, which suggests that the effect of cumulative risk operated in the same manner for boys and girls. These results lent strong support to hypothesis 1 that cumulative risk would positively predict adolescent PIU, as, for both boys and girls, the cumulative impact from multiple ecological stressors is the significant cause of adolescent PIU.

The findings also provide further empirical evidence for the bioecological development
perspective that maladaptive behaviors (such as PIU) are the outcome of multiple sources of risk exposures from different aspects of people's intermediate environment. Furthermore, the significant direct effect of cumulative risk on PIU supports the principal of equalifinality in developmental psychopathology that the same end state can be reached from differential initial conditions and/or through diverse processes (Cicchetti, & Rogosch, 1996). In the current context of PIU, the same developmental outcome (i.e., PIU) could be traced back to the cumulative exposure of multiple risks factors, although the individuals who were identified as having PIU might have different patterns of risk combination and each risk might have differed in its strengths.

The unique effect of individual risks on PIU

After taking a closer look at the cumulative risk and examine the individual risks, it was found that six out of the eight risk factors had significant unique effects on adolescent PIU, as shown in Table 2.

For the demographic risk factors, in contrast with the previous studies that showed that adolescents from low SES backgrounds and who resided in rural areas would have a higher likelihood of PIU (Guo et al., 2012; Li, Zhang et al., 2013; Yen et al., 2007), the current results revealed that neither the effect of family residence location nor the effect of family economic strain on PIU were significant. Unexpectedly, a small negative association was found between low parental education and PIU, which indicated that adolescents with more educated parents were somewhat more likely to develop PIU. In general, high parental education is likely to imply high family income, and higher family income has been found to be correlated with Internet addiction in both Chinese (Cao et al., 2011) and Turkish adolescents (Ak, Koruklu, & Yılmaz,
Methodologically, the summary score of the cumulative risk index approach is derived from the intercorrelations among the various risk factors and requires a certain degree of covariation among risk factors (Evan et al., 2013; Ghiselli, Campbell, & Zedeck, 1981). Given the substantive covariations among parental education, family economic strain and rural home location, which are all indicative of social-economic status, the insignificant predictions of family residence location and family economic strain were likely due to the negative confounding effect of low parental education (Graham, 2003; MacKinnon, Krull, & Lockwood, 2000).

In regard to the variables in the present study relating to family context, it was found that both poor parent-child attachment and harsh parenting positively contributed to adolescent PIU. The results in this respect are consistent with previous literature that family functioning and parent-child interactions are among the most salient predictors of adolescent problematic Internet use (Li, Garland, & Howard, 2014). Both overprotective and negative parenting would lead to a greater alienation of the youth from their parents which consequently would increase the chance of Internet indulgence and technology abuse (Bax, 2013). Punitive parenting practices with low warmth and high psychological control (Huang, Zhang, Li, Wang, Zhang, & Tao, 2010; Li et al., 2013), and insecure parent-child attachment (Lam et al., 2009; Schimmenti, Passanisi, Gervasi, Manzella, & Famà, 2014) would significantly impede an adolescent’s sense of worth (self-esteem), self-control, problem solving skills and stress coping mechanisms, which engender the maladaptive behaviors of PIU.

In the school context, three out of four risk factors were found to be positively predictive of PIU, with deviant peer affiliation, weak student support and poor school performance all having unique effects on PIU. Low teacher support was not a significant predictor of PIU in the
current sample. Again, this might be due to the statistical covariation of the other three school domain risk factors. Mostly likely, the effect of low teacher support on PIU was mediated by deviant peer affiliation, and thus lost its significance. All these results were in line with previous studies that have shown that adolescents with weak school bonds and low support from peers and teachers are more susceptible to problematic Internet use (Yen et al., 2009; Wang et al., 2011; Li, Li et al., 2013). Social learning, pressure and reinforcement from deviant peers who have already developed dependent usage of the Internet might be another trigger for PIU (Li, Newman et al., 2016; Yen et al., 2009b; Zhang et al., 2012; Zhou & Fang, 2015). Further, poor school performance has been found to be a typical characteristic of problematic Internet users in other studies (Mythily et al., 2008; Xu et al., 2012). However, the question remains regarding the direction of the effect of school risk factors and PIU. Taking school achievement as an example, it is possible that the time and effort required for successful schoolwork has been devoted instead to the device screen resulting in unsuccessful academic performance. Alternatively, it could be argued that poor performing students were more likely to use the Internet to cope with their stress. As school failure could be the cause or consequence (or both) of problematic Internet use, further longitudinal investigation to clarify the causal relationship would be beneficial.

Nonetheless, in addition to the unique effects, the interplay among these eight risks and PIU is much more complex; each factor may employ different mechanisms of conferring risk for PIU (mediation and/or moderation). For example, according to the family stress model (Conger & Conger, 2008; Conger, Conger, & Martin, 2010), family economic disadvantage (low SES, rural area residence) is likely to increase family stress, which is likely to spoil both parenting quality (by leading to more harsh parenting, less maternal warmth and sensitivity) and parent-child attachment. The associated decrease in parental monitoring and supervision, will in turn
contribute to adverse developmental outcomes such as school failure, conduct problems, depression and problematic use of the Internet. This logical pattern has been found to be particularly distinctive among "left behind children" (Gao, Li, Kim, Congdon, Lau, & Griffiths, 2010; He et al., 2012). It is also possible that school risks interactively impact PIU, such that students with low peer and teacher support (which are indicative of poor social control and connection; Carver, & Scheier, 1982) might be pushed to seek friendship, acceptance and support in a noxious peer environment. In this way, adolescents would develop PIU through deviance training (Li, Newman et al., 2016). Furthermore, empirical evidence has also been located showing that risk factors across domains (parent–adolescent relationship, school connectedness, deviant peer affiliation) jointly contribute to an adolescent’s gaming addiction, through sequential and chain mediation effects including school connectedness, and deviant peer affiliation (Zhu, Zhang, Yu, & Bao, 2015). The strength of the cumulative risk index approach is its simplicity, parsimony and efficiency, in capturing the effect of multiple risk exposures on adolescent PIU, regardless of the specific process and mechanisms involved for each risk factor.

The meditational path from cumulative risk to PIU via self-esteem

In the overall model, we found that self-esteem partially mediated the path from cumulative risk to PIU, with cumulative risk associated with reduced adolescent self-esteem, which in turn contributed to a higher tendency for problematic Internet use. As far as I know, the current study is the first to investigate the meditational role of self-esteem (an individual personality characteristic) in the relation between cumulative risk and adolescent PIU.

Indeed, self-esteem, as a personality trait that is fundamental to individual identity and self-evaluation, has long been associated with addictive behaviors and substance use (Marlatt,
Baer, Donovan, & Kivlahan, 1988). In general, individuals who hold negative self-evaluations are more likely to seek relief and escape from their poor self-beliefs through ‘mind-altering” substances or addictive activities such as drugs, drinking, gambling and video gaming (Craig, 1995; Greenberg, Lewis, & Dodd, 1999). Specifically in the context of problematic Internet use, Armstrong et al. (2000) found low self-esteem to be predictive of the weekly amount of online time and Internet addiction. The results of the current study showing that self-esteem was negatively associated with PIU were consistent with the above findings and empirical evidence reported by other researchers (Aydm & San, 2011; Kim & Davis, 2009; Niemz, Griffiths, & Banyard, 2005). In the Internet world, individuals with deficiencies in self-esteem are able to construct another social identity or personality to gain a sense of power, accomplishment and a better evaluation of self, as suggested in Griffith’s (2000) cases studies. Such temporary compensation is likely to be the driving mechanism that links low self-esteem to PIU.

**Gender moderation**

In addition to the overall sample findings, multiple group comparison showed that the mediation effect of self-esteem was significant only for the boys but not for the girls. In other words, gender moderated the meditational role of self-esteem in the relationship between cumulative risk and PIU. For the boys, cumulative risk decreased self-esteem, which in turn contributed to a higher likelihood of PIU, but the relationship between self-esteem and PIU was not significant among girls. This gender-specific mediation was consistent with the early work by Ko and colleagues (2005) that Internet addiction was associated with lower self-esteem in males but not in females. Also, the finding confirmed previous literature that adolescent boys are at a higher risk for problematic Internet use (Lachmann, Sariyska, Kannen, Cooper, & Montag, 2016; Lam et al., 2009; Li & Krikup, 2007; Ko, Yen, Yen, Chen, & Wang, 2008; Yen et al.,
Empirically, I did not find self-esteem to be a significant mediator between cumulative risk and PIU among girls, so the overall significant mediation effect found in the full sample (boys and girls) was mainly coming from the male participants. Specifically in the current female sample, I found the direct effects of cumulative risk on both self-esteem and PIU, but lower self-esteem was not predictive of more PIU. Theoretically, several possible reasons might cause the insignificant mediation of self-esteem in the female group. One possibility is that the mediation effect of self-esteem was not statistically detectable due to the low variability of PIU in the current female group, as evidenced by a much lower PIU prevalence rate (3.9% vs 13.1%) and mean score (2.2 vs 2.8) in the female participants. Given that the current sample is a community-based non-clinical middle school student sample, the low prevalence rate and mean score of PIU in girls was not unexpected. If other samples or clinical populations with a wider variation of PIU in the female group were available, different results might be observed.

Because the current inquiry included only self-esteem as a mediator, it is also conceivable that in the female group, the effect of cumulative risk on PIU was truly unmediated. Excessive Internet use might not be the behavioral manifestation or outlet for girls with low self-esteem who encounter cumulative risk. Because PIU has been found to be comorbid with other psychiatric symptoms such as depression (Liang, Zhou, Yuan, Shao, & Bian, 2016; Lin, Ko, & Wu, 2011; Morrison & Gore, 2010), anxiety (Bakken, Wenzel, Götestam, Johansson, & ØREN, 2009), alcohol abuse (Yen, Ko, Yen, Chen, & Chen, 2009b), and attention deficit and hyperactivity (Ho et al., 2014), it is plausible that those girls who suffer cumulative risk express their low self-esteem through other psychological symptoms such as depression or anxiety. Thus, future research should explore whether other mediational pathways might account for what
appears in the results presented above as a direct effect. Nonetheless, more empirical investigation would be needed to clarify the gender specific effect in our future research.

**Implications for prevention and intervention**

Unlike other types of addictive behaviors such as substance abuse and gambling, two unique characteristics of problematic Internet use or Internet addiction should be taken into account in any intervention. First, Internet technology and digital devices are ubiquitous in our daily lives; second, a certain level of Internet use (for work and education) is necessary for us to function in the modern society. Therefore, complete abstinence from the Internet is unrealistic and impossible. Rather, the goal of prevention and intervention should focus on developing effective strategies to regulate Internet use behavior in a healthy way, such as skills of knowing how and when it is appropriate and necessary to turn off the device and screen.

Cognitive behavioral therapy, group therapy, and family therapy have all been shown to be effective methods for the treatment of problematic Internet use (Davis, 2001; Du, Jiang, & Vance, 2010; Gong, Wang, Ye, & Liang, 2010). Specifically for online gaming addiction (an important subtype of PIU), Xu, Turel and Yuan (2012) evaluated different preventive skills and concluded that dissuasion, or restriction of resources (money and equipment) did not work, whereas transferring an adolescent's attention to other beneficial activities and parental monitoring were more effective. In addition, some general strategies that have been shown to be effective in reducing other risk behaviors such as alcohol or drug use and gambling could also be recommended for problematic Internet use prevention. These strategies include: promoting skills of self-control and self-efficacy (Kim et al., 2008; Li et al., 2013); developing effective strategies for coping with stress and negative emotions (Li, Wang & Wang, 2009; Rehbein, & Baier, 2013); enhancing self-esteem (Ko et al., 2007); and encouraging participation in creative, exploratory-
Based group activities (Ko et al., 2007).

Given the current results that ecological risks across multiple domains have unique contributions to adolescent PIU, intervention practices for problematic Internet use should not solely focus on treating the at-risk individual. Rather, future outreach and prevention efforts should go beyond the individual level and extend to the family, school teachers and peers, even to the community level, as each of these factors are part of the formative ecological environments for adolescents at risk for problematic Internet use (Vondráčková & Gabrheľík, 2016). For example, in the family domain, family therapy for Internet addicted teenagers has been shown to be effective in reducing adolescents’ addiction symptoms (Gong et al., 2010). In the school domain, Walther, Hanewinkel and Morgenstern (2014) utilized a cluster randomized controlled trial to evaluate a teacher-led media literacy program regarding computer gaming and Internet use behavior with 2303 German adolescents. The results showed significant intervention effects with a smaller increase in gaming time and frequency, as well as a smaller number of excessive gamers, in the treatment groups compared to the control groups.

Specifically for the male samples, consistent with previous studies I found a much higher prevalence rate and mean score of PIU, as well as a significant mediation path from self-esteem to PIU. Therefore, there needs to be a strong emphasis on PIU intervention and prevention among the male population. However, it is important to note that the current gender moderated mediation result did not warrant a gender-specific approach regarding the intervention strategies, so fostering skills and a positive mindset to maintain a healthy level of self-esteem under cumulative risk exposure, would be a beneficial intervention for both boys and girls. However, given the overall findings that cumulative risk is strongly predictive of both PIU and self-esteem in both genders, the intervention effort should focus on improving the developmental contexts
for the adolescents and reducing overall risk exposure.

_A macrosystem level of reflection for Chinese adolescent PIU_

Bronfenbrenner and Morris’s (2006) ecological systems theory of human development posits that individual development is influenced by the surrounding environmental contexts - a multi-level system that includes the macro-system, exosystem and more proximate micro-system environment. Both socio-cultural and physical environments have impact on children’s development (Trentacosta, Davis-Kean, Mitchell, Hyde, & Dolinoy, 2016). Negative developmental outcomes such as problematic Internet use, are not only directly shaped by micro-system factors like family process, peer groups and school contexts, but also indirectly influenced by the neighborhood and community characteristics within children’s exosystems. At the larger macrosystem level, socio-cultural values, economic and political climate, law and regulations all contribute to an adolescent’s risk for problematic Internet use. While the current inquiry mainly focused on the microsystem-level of cumulative risk exposure within home, school and peers, our intervention efficacy and prevention efforts could be further strengthened by incorporating broader ecological contexts that contribute to the development of adolescent problematic Internet use. Based on consideration of macrosystem level risk exposure, the section below is a reflection on the PIU/Internet addiction situation for adolescents living in the modern Chinese society. It describes the stress and risks for PIU from the cultural and educational ideology, social practice and values, economic climate and policy, as well as law and regulations.

First, the socio-cultural emphasis on scholarly achievement imposes unique risk for problematic Internet use for Chinese adolescents. Traditionally, Chinese people have been deeply appreciative of the role of education as social ladder for career and personal success.
(Chao, 1996; Chen & Uttal, 1988; Lin & Fu, 1990). Because of this cultural value, Chinese adolescents are under enormous pressure for scholastic performance. The dogmatic education system in China has long been criticized for the flaws of an examination-oriented curriculum, teacher-centered instruction and rote learning (Pepper, 1996). In recent decades the Chinese government has attempted educational reform by implementing quality education (素质教育), a more balanced curriculum that encourages creativity, critical thinking and individuality. However, the belief of Xue er you ze shi (学而优则士, means a good scholar can become an official that enjoys power and wealth) has been deeply rooted in the Chinese culture and social values, thus test-orientated education is very robust and resistant to change (Dello-Iacovo, 2009).

Under this rigid and hypercompetitive societal context, college admission has life-long consequences, art or athletic talents are less valued, and test scores are regarded as flagship standards that are the only criterion for students’ accomplishment in the minds of school officials, teachers and parents. The overwhelming stress upon school success may have been further intensified by the One Child Policy (Green, 1988), in which significant educational investment, as well as much higher parental and social expectation, was put on each child’s shoulders (Hesketh, Lu, & Xing, 2005).

Adolescence is a special developmental stage during which the individual gains a stronger sense of self-awareness and increasing need for autonomy and competence (Ryan & Deci, 2000). Under the multiple stressors such as excessive homework, test pressure, fierce peer competition, and social and parental expectations, coping with pressure and frustration become challenging tasks. As a result, many adolescents experience difficulty in gaining motivation and accomplishment in school, a lack that further exacerbates their poor adjustment and life satisfaction. For the Chinese youth, the Internet is a place without family obligation, academic
task or social restrictions (Bax, 2014). Many adolescent find the virtual world to be a welcoming refuge to escape from their real life stress, where they can regain freedom, power, confidence and well-being. Away from parents and teachers’ watchful eyes, cyberspace such as online game platforms, chat rooms and social networking sites, provide adolescents the opportunity to carve out their own identity, or experiment with a preferred social self (Chayko, 2016). For example, in a massive multiplayer role-playing online gaming site (Cole & Griffiths, 2007), as well as the joys of game playing itself, the attainment of social status and feeling of being involved and valued in the gaming communities can be very appealing for those frustrated adolescents who are in need of competence, connection and autonomy in real life. These online social interactions offer adolescents a sense of belonging, motivation and purpose, which further entices excessive gaming and Internet addiction.

Secondly, the economic and social change fueled by the Internet and information technology innovation in the past decade, also contributes non-negligible risk factors for adolescent problematic Internet use. Asian countries such as China and Korea, report the highest rate of PIU, in part because of their large technology sectors and online game market (Montag et al., 2015). According to the latest global games market report (Newzoo, 2016), China, with a quarter of the global share, has become the largest video games market in the world. The affordable products from domestic mobile and digital devices and game manufacturers, has greatly facilitated the consistent growth of the online gaming industry. Internet cafes not only provide the social space and facilities for online gamers, but also an important channel for game producers to promote new games and services. Therefore, there is also growth in the number of Internet cafes. By 2015, China had 146,000 Internet cafes with 20 million users daily, and the number is likely to grow continuously. Parallel with the gaming industry expansion is the rapid
increase in the number of minor gamers. The Chinese 2015 national statistics show that, nearly 90% of Chinese adolescents and young adults own a smart phone and over 70% of them play online games (China Internet Network Information Center, 2016). Meanwhile, loneliness is another risk factor brought by the social economic change that contributes to adolescent problematic Internet use. As social competition get steeper in modern China, Chinese parents have to spend more time (even at the weekend) at work to cover life expenses, with less time and attention being given to their children. Because of the One Child policy, many children have no any siblings, thus making playing computers and digital devices at home alone a common experience for many modern Chinese youths.

Third, the lack of effective regulation, policy and law, can also lead to regrettable results where adolescents’ health and well-being are jeopardized as a result of cyberspace usage. Because the online gaming industry is one of the most profitable industries in China, the government is reluctant or passive about regulating it and related industries (Wallis, 2011); this aggravates children’s risk for exposure to the contaminating Internet environment. For example, only after numerous adolescent deaths caused by non-stop overnight online gaming, did the Chinese government began to implement tighter controls on Internet cafes and place an anti-fatigue monitoring system in gaming platforms (Hsu, Wen & Wu, 2009; Shao, 2010; Stewart, 2010).

The lack of policy and regulation in protecting youth’s cyberspace rights is also reflected in the intervention and treatment of problematic Internet use and internet addiction. Because the concept of mental health is relatively new for Chinese people, the field of professional practices is underdeveloped, and thus mental health services are very limited and lack effective regulation. Since China identified adolescent Internet addiction as a public health concern in 2005
(Minjikian, 2012; Spada, 2014), various Internet detoxification camps or treatment centers appeared. These “bootcamps” are often led by self-proclaimed experts with questionable credentials or training, and feature military-style discipline and a strict goal to pull the adolescent offline and get back to real life (Bax, 2014). Numerous scandals of harmful treatments in these poorly regulated camps have been reported in the news (Ives, 2017; Shlam & Medalia; 2014), including physical and psychological abuse, highly controversial electroshock therapy and psychiatric medication. Many adolescent campers have been reported to have experienced various degrees of physical and psychological trauma after attendance (Bax, 2014; Ives, 2017). Some extreme cases have been described in the media or popular literature. One example is an Internet addicted girl who killed her mother as revenge for a forced abusive detoxification regimen (Bax, 2013; Denyer & Gu, 2016).

To curb such scandals and tragedies, the Chinese government drafted a new law to protect a minor’s rights in cyberspace (Cyberspace Administration of China, 2017). The new law proposed to ban the maltreatment of Internet addicted youth by such techniques as electroshock therapy, and legally prohibited involuntary Internet detoxification treatment for youth. Parents can no longer force treatment on their children. Adding to the 2005 legislation that restricted minors’ access to Internet cafes in the community, a new law further stressed the responsibility for different stakeholders to protect juveniles. For example, the 2017 new law requires Internet technology service organizations and providers (including online gaming service developers and suppliers) to set up an “online gaming curfew and limit” for minor users, so adolescents cannot access their gaming account during certain hours and after a certain amount of accumulated daily/weekly usage. Although the implementation and effectiveness of the new law is unknown, it represents the macro-system effort to prevent or minimize adolescents’ problematic Internet
Overall, the ever-expanding gaming and digital entertainment industry, the exhausted and unavailable parents, as well as the belated governmental law and regulation, all indirectly contribute to an adolescent’s propensity for problematic Internet use. Because the macrosystem risks such as the above-mentioned cultural ideology, educational practices, social and economic changes are instrumental, an effective PIU prevention and intervention program would benefit from taking into account these broader societal and cultural sources of influence, as well as the microlevel factors that were the focus of this study.

Limitations

While this study contributes important findings regarding the relationships between cumulative risk, self-esteem and problematic Internet use, several limitations should be noted. First, because of the cross-sectional nature of the study design, no causal conclusions about observed associations can be made. As one example, poor self-esteem could be the cause or consequence (or both) of problematic Internet use; an individual who suffers from poor self-esteem may be more likely to use Internet for social interaction thus develop PIU. An alternative argument could be made that excessive time using the Internet would affect an individual’s academic or work performance, and physical and mental health, which negatively contributes to lower self-esteem. Future studies should use longitudinal designs to seek evidence for the causal assumptions that were made in this study.

Second, although adolescent self-report has been widely used in the literature to assess adolescent problematic Internet use, future replication should use multiple informants (e.g. peers, teachers or parents) to reduce potential effects of shared method variance. Third, as mentioned earlier, the participants in the current study were drawn from general middle school communities.
The effects of various risk factors on adolescent PIU, although significant, were small. If the design included a clinical sample composed only of adolescents with acknowledged severe problems with PIU (such as those adolescents referred to Internet addiction treatment and intervention camps), the full range and intensity of cumulative risk could have been examined and stronger associations between cumulative risk, self-esteem and PIU would be expected.

Furthermore, the selection of risk variables in the current study was not identical to those examined in other studies of cumulative risk, which may obstruct meaningful comparison with previous studies. Nevertheless, this is a common limitation in this area, because risk factors are selected to be relevant to a specific outcome, and therefore the type and number of risk factors differ in different studies. More specifically, different domains of risks (e.g., academic, interpersonal) may have differential impacts on adolescent PIU (Tang et al., 2014). Therefore, future studies should further examine and compare the associations between domain-specific cumulative risks and adolescent PIU.

The current cumulative index approach enjoys the reputation of being parsimonious, straightforward, consistently predictive of PIU, and especially suitable for mediation and moderation inquiries. However, there is also an alternative way of modeling cumulative risk using OLS multiple regression. Future studies should investigate the merits and limitations of different methodological options.

Finally, although the sample was diverse in its socio-demographic background, all the participants were from mainland China, so that the generalizability of the results to other cultural populations may be limited.

Conclusion

Despite the limitations, as far as can be determined the current study is the first empirical
study to investigate the meditational role of self-esteem (an individual personality characteristic) in the relation of cumulative risk (specifically, ecological environmental risks) and adolescent PIU. With a wide range of risk factors across domains under scrutiny, the study contributes to the field by providing important empirical support for applying the socio-ecological model in the etiology of PIU.

Methodologically, the large representative community sample affords high power for the rigorous statistical analyses in this study. First, most of the variables were modeled at the latent level to remove the measurement error from the variance, which allows a clear picture of the relationships among the variables without the distortion from bias. Secondly, the model cross-validation procedure was performed on two sets of data, thus providing substantive support for the reliability and generalizability of the mediation model with satisfactory data-model fit and comparable parameter estimates. Furthermore, the multiple group SEM techniques allowed investigation of the subtle gender differences in the mediation model.

The findings were that cumulative risk was inversely related to both self-esteem and PIU, and higher cumulative risk exposure was associated with lower self-esteem, which in turn contributed to higher PIU; the multi-group comparison revealed that the mediation effect of self-esteem was only significant in the male population. Thus, prevention programs that aim on enhancing self-esteem might be promising in altering adolescent PIU, especially for adolescent boys. However, the strong direct effect of cumulative risk on PIU and self-esteem in both gender groups highlighted the fact that providing optimal environmental conditions by reducing ecological risk exposure in adolescent developmental environments will be the key for problematic Internet use prevention.

Furthermore, this study established a solid foundation on which to build a programmatic
line of research for the longitudinal investigation of cumulative risk and adolescent development. Such longitudinal study will allow stronger inferences about the direction of effects examined in the present study. For example, the causal relationship between low self-esteem and PIU can be established through multi-wave data.

Finally, this study advanced the real-world understanding of what ecological risks affect adolescent PIU and how they function. It also aids in the design and implementation of intervention programs for policy makers, teachers, and parents to promote adolescent resilience.
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Table 1.

Means, Standard Deviations, and Correlations of the Main Study Variables

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<td>8. Family economic Strain</td>
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<td>10. Harsh parenting</td>
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<td>PIU</td>
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<td>1.03</td>
<td>.28</td>
<td>.04</td>
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<td>.02$^{* *}$</td>
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</tbody>
</table>

*Note. N = 2448. Gender was dummy coded such that 0 = female and 1 = male.

All correlations were significant at the level of $p < .001$ except where noted as ns, ns = non-significant.*
Table 2.

*Testing the Unique Effect of Eight Risk Factors On PIU (N=2448)*

<table>
<thead>
<tr>
<th>Predictor</th>
<th>β</th>
<th>t</th>
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<tbody>
<tr>
<td>Gender</td>
<td>.21</td>
<td>10.79***</td>
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<tr>
<td>Age</td>
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<td>School type</td>
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<td>Area</td>
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<td># of siblings</td>
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<td>-3.22***</td>
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<tr>
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<tr>
<td>Poor parent-child attachment</td>
<td>.14</td>
<td>4.23***</td>
</tr>
<tr>
<td>Harsh parenting</td>
<td>.14</td>
<td>4.93***</td>
</tr>
<tr>
<td>Low teacher support</td>
<td>.04</td>
<td>1.27</td>
</tr>
<tr>
<td>Low student support</td>
<td>.11</td>
<td>3.87***</td>
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<td>Deviant peer affiliation</td>
<td>.19</td>
<td>7.70***</td>
</tr>
<tr>
<td>Poor academic achievement</td>
<td>.11</td>
<td>4.00***</td>
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</tbody>
</table>

*p < .05; **p < .01; ***p < .001.*
Table 3.

Data cross Validation of the Mediation Model

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Standardized Parameter estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>testing sample</td>
</tr>
<tr>
<td>Cumulative risk → PIU (total effect)</td>
<td>.40 ***</td>
</tr>
<tr>
<td>Cumulative risk → PIU (direct effect)</td>
<td>.325 ***</td>
</tr>
<tr>
<td>Cumulative risk → Self esteem</td>
<td>-.557 ***</td>
</tr>
<tr>
<td>Self esteem → PIU</td>
<td>-.135 ***</td>
</tr>
<tr>
<td>Cumulative risk → Self-esteem → PIU</td>
<td>.075 ***</td>
</tr>
</tbody>
</table>

Testing sample: \(N = 1,222\); Validation sample: \(N = 1,227\).

\(*p < .05; **p < .01; ***p < .001.\)
### Table 4.

*Data-Model Fit Indices for the Mediation*

<table>
<thead>
<tr>
<th>Data Source &amp; Indices</th>
<th>CFI</th>
<th>SRMR</th>
<th>RMSEA [CI]</th>
<th>$\chi^2$</th>
<th>df</th>
<th>p</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 Testing whole sample</td>
<td>.987</td>
<td>.027</td>
<td>.033 [.024 -.041]</td>
<td>97.51</td>
<td>42</td>
<td>***</td>
<td>1222</td>
</tr>
<tr>
<td>Model 2 Girls only</td>
<td>.987</td>
<td>.024</td>
<td>.035 [.02 -.05]</td>
<td>65.49</td>
<td>37</td>
<td>**</td>
<td>645</td>
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<tr>
<td>Model 3 Boys only</td>
<td>.996</td>
<td>.025</td>
<td>.02 [.001 -.036]</td>
<td>44.37</td>
<td>37</td>
<td>&gt;.05</td>
<td>577</td>
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<tr>
<td>Model 4 Multi-sample without constraint</td>
<td>.992</td>
<td>.026</td>
<td>.026 [.014 -.036]</td>
<td>115.6</td>
<td>82</td>
<td>**</td>
<td>1222</td>
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<tr>
<td>Model 5 Multi-sample with constraint</td>
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<td>.029</td>
<td>.035 [.026 -.044]</td>
<td>128.87</td>
<td>85</td>
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<td>1222</td>
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</table>

Model comparison between 4 and 5

$\Delta \chi^2 = 13.25$, $\Delta df = 3$, $p < .01$

*p < .05; **p < .01; ***p < .001.*
### Table 5.

*Gender Moderation of the Mediation Model*

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Standardized Parameter estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Cumulative risk $\rightarrow$ PIU (total effect)</td>
<td>.40 ***</td>
</tr>
<tr>
<td>Cumulative risk $\rightarrow$ PIU (direct effect)</td>
<td>.325 ***</td>
</tr>
<tr>
<td>Cumulative risk $\rightarrow$ Self-esteem</td>
<td>-.557 ***</td>
</tr>
<tr>
<td>Self esteem $\rightarrow$ PIU</td>
<td>-.135 ***</td>
</tr>
<tr>
<td>Cumulative risk $\rightarrow$ Self-esteem $\rightarrow$ PIU</td>
<td>.075 ***</td>
</tr>
</tbody>
</table>

Testing sample: $N = 1,222$; Girls: $N = 645$; Boys: $N = 577$.

*p < .05; **p < .01; ***p < .001.*
Figure 1. The Conceptual Mediation Model
Figure 2. Potential Gender Differences in the Conceptual Mediation Model
Figure 3. The Mediating Effect of Self-Esteem between the Relationship of Cumulative Risk and PIU in the Testing Sample

CFI = .987, SRMR = .027, RMSEA = .033 [.024 - .041], $\chi^2 = 97.51$, df = 42, $p < .05$;

Note: N = 1222; * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$;
Figure 4. Gender Moderation of the Mediation Model (Boy Sample/Girl Sample)