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Pathological Internet use and psychopathology among European adolescents

Tony Durkee

Karolinska Institutet

From the Department of Learning, Informatics, Management and Ethics (LIME)
Karolinska Institutet, Stockholm, Sweden

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Tony Durkee

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THESIS FOR DOCTORAL DEGREE (Ph.D.)

By

Tony Durkee

Principal Supervisor:
Dr Vladimir Carli
Karolinska Institutet
Department of Learning, Informatics, Management, Ethics (LIME)
Division of the National Centre for Suicide Research and Prevention of Mental Ill-Health (NASP)

Co-supervisor(s):
Prof Birgitta Floderus
Karolinska Institutet
Department of Clinical Neuroscience
Division of Insurance Medicine

Prof Danuta Wasserman
Karolinska Institutet
Department of Learning, Informatics, Management, Ethics (LIME)
Division of the National Centre for Suicide Research and Prevention of Mental Ill-Health (NASP)

Opponent:
Prof Paul Yip
University of Hong Kong
Department of Humanities and Social Sciences
Division of the Centre for Suicide Research and Prevention

Examination Board:
Prof Per-Anders Rydelius
Karolinska Institutet
Department of Women's and Children's Health (KBH)
Division of Child and Adolescent Psychiatry

Prof Sabine Koch
Karolinska Institutet
Department of Learning, Informatics, Management, Ethics (LIME)
Division of Health Informatics Centre (HIC)

Doc Ester Pollack
Stockholm University
Department of Media and Communication Sciences
Division of Journalism, Media and Communication (JMK)

Strive not to be a success, but rather to be of value.

– *Albert Einstein*

Dedicated to my three children (Jordan, Maya and Ella), with a life-learned lesson that you can achieve anything if you put your mind to it. It was the love and support from my wife (Jennie), however, that encouraged me to keep moving toward my goals and to never give up. I love you all.

Abstract

Background: Internet use and accessibility has grown exponentially across the globe. The highest rates are noted in adolescents and youth. The swift development of technological improvements combined with interactive and enticing online activities has demonstrated to be unprecedented. As a result, the endless possibilities of the Internet become exceptionally appealing, whereby the risk of excessive use becomes elevated. Excessive use of the Internet is a strong precursor for subsequent pathological Internet use (PIU). Considered to be a subtype of a behavioural addiction, the construct of PIU is closely related to the biopsychosocial model of addiction. This suggests that there are genetic, biological, psychological and social components involved in the complex pathways of PIU development. Thus, initiatives that adopt such a multifaceted approach are critically needed in order to attain a better understanding of PIU and related factors.

Objectives: The primary aim of this thesis is to improve our knowledge of adolescent PIU by utilising a multifactorial approach. The objective of *Study I* is to estimate the prevalence of PIU and assess its potential link with demographic and social factors. The objectives in *Studies II* and *III* are to ascertain the correlations between PIU, psychopathology and suicidality, while *Study IV* investigates the association between PIU and health risk-behaviours. The objective of *Study V* is to evaluate the preventive effect of mental health action in schools on PIU and related psychosocial impairments.

Methods and materials: The studies in this thesis were conducted within the framework of the FP7 European Union project: Saving and Empowering Young Lives in Europe (SEYLE). SEYLE is a randomised controlled trial (RCT) assessing the efficacy of mental health interventions based on different strategies and approaches. Adolescents were recruited from randomly-selected schools across study sites in eleven countries, including Austria, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Romania, Slovenia and Spain, with Sweden serving as the coordinating centre. PIU was measured using Young's Diagnostic Questionnaire (YDQ). Social factors, health risk-behaviours, psychopathology and suicidality were measured using validated psychometric instruments. Apposite statistical models were applied in each study in order to assess the respective outcomes of interests.

Results: Findings for each study are described accordingly:

Study I comprised a sample of 11,956 adolescents (female/male: 6731/5225; mean age: 14.9 ±0.89). The overall prevalence of PIU was 4.4%. Prevalence rates of PIU were significantly higher in males than females (5.2% versus 3.8%). Adolescents in Israel had the highest prevalence of PIU, whereas Italy had the lowest. A significant correlation between mean hours online per day and male gender were observed. In terms of online activities, Internet gaming was significantly associated with males, while social networking was significantly correlated with females. Students not living with a biological parent, low parental involvement and parental unemployment showed the strongest association with PIU.

Study II was a systematic review and meta-analysis. An electronic literature search was conducted using the following databases: MEDLINE, PsycARTICLES, PsychINFO, Global Health, and Web of Science. PIU and known synonyms were included in the search as well as psychopathology (i.e. depression, anxiety, symptoms of attention deficit and hyperactivity disorder (ADHD), obsessive-compulsive symptoms, social phobia and hostility/aggression). Effect sizes for the correlations observed were identified from either the respective publication or calculated using Cohen's d or R^2. The potential effect of publication bias was assessed using a funnel plot model and evaluated by Egger's test based on a linear regression. Twenty articles met the pre-set inclusion and exclusion criteria: 75% reported significant correlations of PIU with depression, 57% with anxiety, 100% with symptoms of ADHD, 60% with obsessive-compulsive symptoms, and 66% with hostility/aggression. The majority of studies reported a higher rate of PIU among males than females. Depression and symptoms of ADHD appeared to have the most significant and consistent correlation with PIU.

Study III comprised a sample of 11,356 school-based adolescents (M/F: 4,856/6,500; mean age: 14.9). Results showed that suicidal behaviours (suicidal ideation and suicide attempts), depression, anxiety, conduct problems and hyperactivity/inattention were significant and

independent predictors of PIU. The correlation between PIU, conduct problems and hyperactivity/inattention was stronger among females, while the link between PIU and symptoms of depression, anxiety and peer relationship problems was stronger among males. The association between PIU, psychopathology and self-destructive behaviours was stronger in countries with a higher prevalence of PIU and suicide rates. These findings ascertain that psychopathology and suicidal behaviours are strongly related to PIU. This association is significantly influenced by gender and country suggesting socio-cultural influences.

Study IV involved a sample of 11,931 adolescents who were included in the analyses: 43.4% male and 56.6% female (M/F: 5179/6752), with a mean age of 14.89±0.87 years. Adolescents reporting poor sleeping habits and risk-taking actions showed the strongest associations with PIU, followed by tobacco use, poor nutrition and physical inactivity. Among adolescents in the PIU group, 89.9% were characterized as having multiple risk-behaviours. The significant association observed between PIU and risk-behaviours, combined with a high rate of co-occurrence, underline the importance of considering PIU when screening, treating or preventing high-risk behaviours among adolescents.

Study V included a sample of n=2,831 school-based adolescents. The sample comprised 47.1% male and 52.9% female adolescents (M/F: 1333/1498), with a mean age of 14.83±0.90 years. In order to avoid contamination from the SEYLE interventions, only those who were in the control group were included in this study. Mental health action in schools (MHAS) was defined as adolescents reporting to have received mental health education at their school and was approached by a teacher to discuss psychosocial issues prior to baseline assessment. Outcomes showed that adolescents exposed to MHAS had a 50 percent lower risk for the onset of PIU compared to the unexposed group. When analysing psychosocial impairments, results showed that adolescents in the MHAS group also exhibited a significantly lower incidence of ≥30 percent for emotional distress, depression and coping problems.

Conclusion: Significant correlations between PIU and health risk-behaviours, psychopathology and suicidality were observed among European adolescents. Given the momentous proclivity of evidence-based research, it is clear that PIU is a condition that merits international recognition as a potential disorder. Implementing evidence-based mental health action in schools appear to be effective in the overall risk-reduction of PIU. Of course, the level of efficacy, in terms of prevention efforts, is dependent on the structure of the respective intervention. It is, therefore, critical that an international accord is reached in order to develop a standardized approach to ascertain the nomenclature, taxonomy and diagnostic criteria of PIU. The future direction of PIU research must focus on this fundamental issue in order to legitimize and advance our knowledge and understanding of this condition.

LIST OF SCIENTIFIC PAPERS

I. **Durkee T**†, Kaess M†, Carli V, Parzer P, Wasserman C, Floderus B, . . . Wasserman D. Prevalence of pathological Internet use among adolescents in Europe: demographic and social factors. *Addiction*. 2012;107(12):2210-2222.

II. Carli V†, **Durkee T**†, Wasserman D, Hadlaczky G, Despalins R, Kramarz E, . . . Kaess M. The association between pathological Internet use and comorbid psychopathology: a systematic review. *Psychopathology*. 2013;46(1):1-13.[1]

III. Kaess M†, **Durkee T**†, Brunner R, Carli V, Parzer P, Wasserman C, . . . Wasserman D. Pathological Internet use among European adolescents: psychopathology and self-destructive behaviours. *European Child & Adolescent Psychiatry*. 2014;23(11):1093-102.

IV. **Durkee T**, Carli V, Floderus B, Wasserman C, Sarchiapone M, Apter A, . . . Wasserman D. Pathological Internet use and risk-behaviours among European adolescents. *International Journal of Environmental Research and Public Health*. 2016;13(3):294.

V. **Durkee T**, Carli V, Floderus B, Wasserman C, Sarchiapone M, Apter A, . . . Wasserman D. Mental health action in schools and pathological Internet use in European adolescents. 2016, Manuscript.

† Shared first authorship

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LIST OF ABBREVIATIONS

SEYLE	Saving and Empowering Young Lives in Europe
MHAS	Mental Health Action in Schools
PIU	Pathological Internet use
MIU	Maladaptive Internet use
AIU	Adaptive Internet use
YDQ	Young's Diagnostic Questionnaire
BDI-II	Beck Depression Inventory-II
ZSAS	Zung Self-Rating Anxiety Scale
GSHS	Global School-Based Student Health Survey
SDQ	Strengths and Difficulties Questionnaire
PSS	Paykel Suicide Scale
DSHI	Deliberate Self-Harm Inventory
GLMM	Generalized linear mixed models
ANOVA	One-way analysis of variance
CI	Confidence Intervals
SEM	Standard Error of the Mean
SE	Standard Error
M	Mean

1 INTRODUCTION

Internet use and accessibility has grown exponentially across the globe in recent years, with highest rates observed among adolescents and young people[1]. The rapid expansion of technological advances combined with interactive and captivating online activities has proven unprecedented. As a result, the infinite possibilities of the Internet become exceedingly enticing, particularly among adolescent populations.

Adolescence is a transitional period marked with considerable changes in physical, social and psychological attributes. Societal, familial and peer relationships undergo marked changes during this transient period, as adolescents begin to affirm autonomy over their emotions, behaviours and decisions. These attributes often progress in the course of psychosocial exchanges within different learning contexts. Given the extensive platform for fostering interpersonal and social cognitive skills, the Internet has proven to be a unique and atypical conduit for influencing psychosocial development in adolescents.

Despite these inherent advantages, the extensive advancement in psychosocially engaging and highly interactive online activities may entice young Internet users to spend more time online than originally anticipated. There is concrete evidence indicating that excessive Internet use increases the susceptibility for individuals to develop addictive and pathological traits, especially during the adolescent years.

Pathological Internet use (PIU) has conceptually been regarded as taxonomy of behavioural addiction akin to the nature of pathological gambling. There is surmountable evidence supporting the theory that symptomatic PIU behaviours reflect those observed in other addictive disorders. Research shows that PIU shares psychosocial, biological, neurological and genetic characteristics with both gambling and substance use disorders[2-4]. Compared to other addictive disorders, symptoms of PIU share six core components often denoted in addictions: (i) *Salience* includes preoccupation with online activities that are namely cognitive, emotional and behavioural related; (ii) *Mood modification* occurs when individuals use the Internet to alleviate depressed moods or escape from real-life problems; (iii) *Tolerance* is denoted by the necessity to spend more time online in order to attain the desired effect; (iv) *Withdrawal symptoms* are unpleasant feelings, both physiological and psychological, that arise when the individual attempts to decrease or discontinue their Internet usage; (v) *Conflicts* are denoted by interpersonal and intrapsychic conflicts; and (vi) *Relapse* denotes the unsuccessful attempts to reduce or discontinue Internet use.

Research shows that the adolescent population has the highest risk for developing the respective pathological behaviours compared to all other age-groups; thus, efforts focusing on adolescent PIU should be a priority. This is particularly important as studies have shown that high-risk behaviours developed during adolescence have a compelling likelihood to continue into adulthood, leading the individual to debilitating states throughout the life cycle if left untreated. Empirical data on PIU among adolescents in Europe are scarce. There are significant discrepancies between studies in regards to population, sample sizes, target groups, methodologies and psychometric measures used to assess PIU. This inherently influences the reliability and comparability of the data.

In this thesis, epidemiological data were collected within the framework of the European Union project: Saving and Empowering Young Lives in Europe (SEYLE). SEYLE is a randomised controlled trial (RCT) evaluating the efficacy of mental health interventions among European adolescents. The SEYLE project comprised a sample of 12,395 school-based adolescents who were recruited from randomly selected schools in eleven European countries: Austria, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Romania, Slovenia and Spain, with Sweden serving as the coordinating centre. The geographical span across the eleven participating countries is one of the largest and most diverse populations ever conducted within this field of research.

The five studies included in this thesis were designed using a multifactorial approach. To improve our understanding of adolescent PIU, a comprehensive evaluation of its liaison with social factors, health risk-behaviours, psychopathology and suicidality was employed. In terms of prevention, the final study aims to identify and assess the preventive effect of mental health action in schools on reducing the risk of PIU and related psychosocial impairments. Through the knowledge gained from this thesis, there is an opportunity to utilise these findings to design and implement appropriate interventions, with the primary goal of improving mental health among adolescents.

2 BACKGROUND

2.1 ORIGIN AND NATURE OF THE INTERNET

The Internet was founded in the mid-1960s with endeavours to become a mainstream medium for communications. The year was 1965 when a scientist from the Massachusetts Institute of Technology (MIT) developed a new method referred to as 'packet switching'. Packet switching is a digital network communications procedure in which data is fragmented into blocks or 'packets' allowing for a faster and more efficient transmission of data via network devices. Building on this new technology, in 1969, the Advanced Research Projects Agency Network (APRANET) was created using packet switching and became the first online network system. This new breakthrough was able to connect four computers to a network that hosted four major universities in the beginning of its existence. Following that success, the Transmission Control Protocol (TCP) and Internet Protocol (IP) were designed and APRANET was the first network to implement the protocol suite TCP/IP. It was during this time the actual term "Internet" originated. With the subsequent creation of the Internet Service Provider (ISP) in 1974, nearly a decade later, the Internet was used for the first time. The following year, domains, such as '.com', '.edu', '.gov', and '.net' were established. In 1992, a high-tech Internet browser known as Mosaic was created by the University of Illinois. Mosaic was a unique Internet browser, with a cutting-edge graphical design and user-friendly domain, making it more accessible to the average user. One year later, however, Netscape Navigator was developed and quickly became the most popular Internet browser during that time. As of 1995, the Internet was essentially declared fully commercialized to the general public without restrictions[5] (Figure 1).

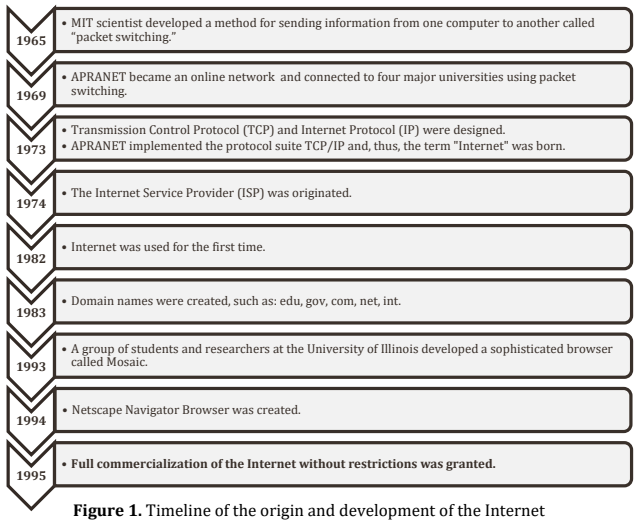


Figure 1. Timeline of the origin and development of the Internet

Since 1995, there has been substantial growth in the functionality, capacity, accessibility and convenience of the Internet and online activities. These improvements have stimulated many individuals to utilize the Internet in their daily lives, both professionally and privately. The distinctive features of the Internet, including interactivity, simplicity and availability, combined with boundless information and enticing online activities, are the main attributes contributing to its attractiveness and appeal among its loyal users worldwide[6]. In essence, the Internet has become a powerful driving force in modern society for all ages, genders and countries across the globe.

2.2 ICT STATISTICS ON INTERNET USE AND ACCESSIBILITY

2.2.1 Internet use and sociodemographics

Out of the estimated 3.2 billion Internet users (43.4%) worldwide in 2015, 45.9 percent were males and 40.8 percent were females[5]. Internet user rates, however, were significantly skewed between developed and developing countries. At the global level, individuals using the Internet in 2015 were substantially higher in developed countries (82.3%) compared to developing countries (35.3%). Inequitable discrepancies in the prevalence of Internet use for both gender and socioeconomic conditions were also observed. In high-income countries, 84.6 percent of males and 80.1 percent of females were active Internet users compared to 38.2 percent and

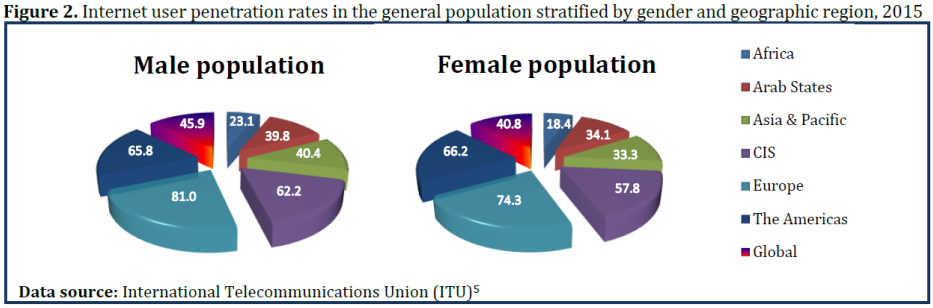
32.3 percent in low- and middle-income countries, respectively. The prevalence of Internet use was essentially two times higher for both males and females in high-income countries in comparison to low- and middle-income countries.

Albeit improvements in gender, socioeconomic and ICT issues during the past several years, there remains a gap between gender and socioeconomic conditions in regards to Internet user penetration rates worldwide. In 2015, statistics showed that the largest gap between males and females was observed in Africa (20.5%) followed by Asia & Pacific (17.6%), Arab States (14.4%), Europe (8.2%), CIS (7.0%) and the Americas (-0.7%). When assessed by socioeconomic conditions, statistics showed that the gender gap in high-income countries was substantially lower (5.4%) compared to low- and middle-income countries (15.4%) and global rates (11.1%)[5].

The considerable differentiation in Internet usage between gender and socioeconomic conditions could be partly due to the large disparities between penetration levels of accessibility. Statistics show that penetration rates of Internet accessibility in high-income countries is 81.3 percent compared to 34.1 percent in low- and middle-income countries. Similar results have shown that households with a computer is substantially higher in developed countries (80.8%) compared to developing countries (32.9%)[5]. It is evident that these statistics are alluding to a direr underlying trend that alas still reflects a large gap between gender and socioeconomic status in modern society. Despite this dissonance, when examining penetration rates by gender and geographic region in high-income countries, outcomes appear comparatively equal.

Data show that Internet user penetration rates among males and females were highest in Europe (81.0 and 74.3%) followed by the Americas (65.8 and 66.2%), Commonwealth of Independent States (CIS) (62.2 and 57.8%), Asia and Pacific (40.4 and 33.3%), Arab States (39.8 and 34.1%) and Africa (23.1 and 18.4 %), respectively (Figure 2).

Figure 2. Internet user penetration rates in the general population stratified by gender and geographic region, 2015



Data source: International Telecommunications Union (ITU)[5]

Similar to gender and socioeconomic profiles between developed and developing countries, Internet usage appears to differ by age-groups. A recent report on information and communications technology (ICT)[7] showed that 100 percent of respondents aged <18 years reported to use the Internet compared to those aged 19-24 years (99%), 25-35 years (90%), 36-45 years (91%), 46-55 years (86%), 56-65 years (88%) and >66 years (65%). An incipient inverse relationship between Internet use and age appears to be emerging.

2.2.2 Trends in Internet user penetration rates by geographic regions

When examining Internet use by world regions, statistics clearly show that Asia and Pacific regions have the highest absolute number of Internet users across the globe (1,506 millions) compared to the Americas (651 millions), Europe (487 millions), Africa (193 millions), Commonwealth of Independent States (CIS) (170 millions) and Arab States (141 millions)[5]. When assessing penetration rates (i.e. Internet users are rated as a percentage of their respective population), however, other world regions emerge with higher rates than those depicted in Asia and Pacific countries.

Figure 3. Internet user penetration rate trends stratified by geographic regions, 2005-2015

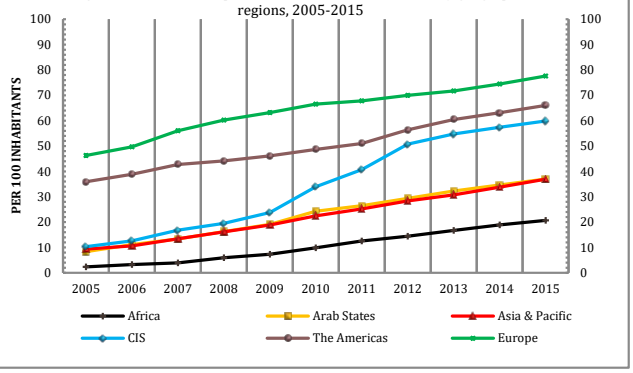


Figure 3 elucidates the trends in Internet user penetration rates from 2005 to 2015 stratified by world region. At the regional level, Europe has the highest penetration rate of Internet users worldwide (77.6%) followed by the Americas (66.0%), Commonwealth of Independent States (CIS) (59.9%), Arab States (37.0%), Asia and Pacific regions (36.9%) and Africa (20.8%), respectively[5]. Penetration rates are considerably close between the Americas and CIS. In 2016, preliminary statistics indicate that rates in the CIS region (66.0%) have surpassed the Americas (65.0%)[5]. The CIS region now ranks second after Europe in terms of Internet user penetration rates. In all global regions, there was considerable growth in Internet user rates from 2005 to 2015. The largest rise in penetration rates was found in the African region, with a substantial increase of 762 percent. Commonwealth of Independent States (CIS) had the second largest increase of 481 percent, followed by Arab States (345%), Asia and Pacific (292%), the Americas (83%) and Europe (67%).

2.2.3 Global trends in penetration rates of Internet use and access

In terms of global penetration rates of Internet users, statistics show that rates have steadily climbed over the last decade in the general population. Percentages more than doubled from 15.8 percent in 2005 to 43.4 percent 2015. Similar to Internet user rates, the global rate of Internet accessibility increases in parallel with the global Internet user rate, ranging from 18.4 percent in 2005 to 46.4 percent in 2015. When assessing households with computers, however, global rates (26.2%) were higher than Internet use and accessibility in 2005, yet the rate is relatively analogous (45.4%) in 2015.

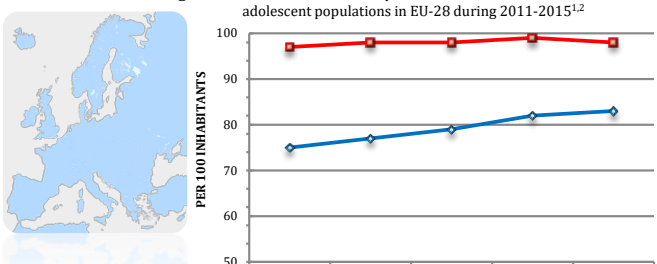
2.2.4 European trends in penetration rates of Internet use and access

European trends concerning Internet user penetration rates are substantially higher than global rates for Internet users, albeit a progressive rise in rates observed over the last decade in the general population was akin to the global trend. European user rates increased 67.0 percent, ranging from 46.3 percent in 2005 to 77.6 percent in 2015. Penetration rates for households with Internet access and owning a computer followed a similar pattern. Internet access in European homes nearly doubled from 42.0 percent in 2005 to 82.1 percent in 2015, while households with computers increased from 52.4 percent in 2005 to 81.9 percent in 2015.

2.2.5 *Trends in Internet user penetration rates between adult and adolescent populations*

Trends in Internet user penetration rates portray a stark contrast between adult Internet users compared to adolescent Internet users. In EU-28, user penetration rates depict a relatively stable trend for both adult and adolescent populations during the last five years. In the adult population, the proportion of Internet users ranged from 75.0 percent in 2011, with a slight increase to 83.0 percent in 2015. In the adolescent population, the margin between the proportion of Internet users in 2005 (97.0%) was only 1 percent compared to users in 2015 (98.0%). Internet user penetration rates were substantially higher in the adolescent population compared to the adult population, with a marginal difference of 22.0 percent in 2011 and 15.0 percent in 2015; thus, indicating the gap between adolescent and adult Internet users appear to be narrowing (Figure 4).

Figure 4. Trends in Internet user penetration rates between adult and adolescent populations in EU-28 during 2011-2015[1,2]



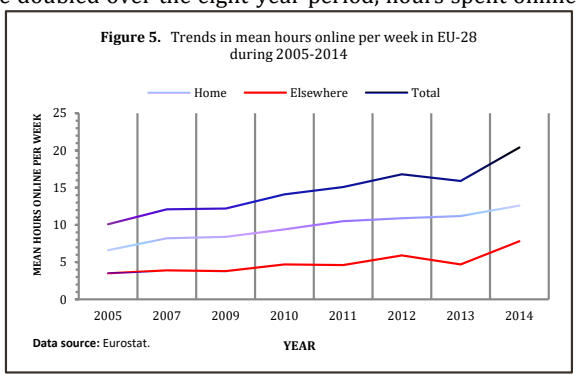
	2011	2012	2013	2014	2015
Adult population (%)	75	77	79	82	83
Adolescent population (%)	97	98	98	99	98

Data source: Eurostat. [1]Adolescent age-range: 16-19 years. [2]Adult age-range: 20-74 years.

2.2.6 *Hours online per week and frequency rates in the general population*

Time spent online among the general population has increased substantially over the past several years. Statistics in EU-28 show that the total number of hours online per week has more than doubled from an average of 10.1 hrs in 2005 to an average of 20.4 hrs in 2014 (Figure 5). A similar pattern applies for those individuals who accessed the Internet from outside their home. Results showed an average increase from 3.5 hrs in 2005 to 7.8 hrs in 2014. Albeit those accessing the Internet outside the home doubled over the eight-year period, hours spent online at home was substantially higher. Individuals accessing the Internet from home spent an average of 6.6 hrs online in 2005 compared to 12.6 hrs in 2014[8]. These results are comparable to those reported in the U.S., which showed mean hours online per week more than doubled from 9.4 hrs in 2000 to 20.4 hrs in 2012. In the U.S., however, a distinct group of Internet users exhibited as much as 30 to 80 hrs online per week, with individual sessions lasting up to 15 hrs per day[9]. This phenomenon is widespread in Asia, particularly in China and Korea[10,11]. It should be underscored that these were extreme cases and considered an exception rather than the rule. Although these occurrences were considered infrequent events during the time of the study, excessive use of the Internet continues to rise at a surmountable rate worldwide.

Figure 5. Trends in mean hours online per week in EU-28 during 2005-2014



Data source: Eurostat.

In EU-28, the frequency of daily and weekly use of the Internet is relatively high, with negligible variations between distinct age-groups. Age-groups 16-19 and 20-24 years had the highest frequency rate of daily (94.0%) and weekly (99.0%) use compared to all other age-groups. In

fact, both daily and weekly Internet use decreased with age. Statistics show that daily and weekly Internet use was 91.0 and 98.0 percent among individuals aged 25-34 years, 86.0 and 97.0 percent among those aged 35-44 years, 81.0 and 95.0 percent among those aged 45-54 years, 75.0 and 93.0 percent among those aged 55-74 years, respectively[8] (Figure 5).

2.3 ONLINE ACTIVITIES BY GENDER AND AGE-GROUP

The Internet is a phenomenon in its own right. It is a medium that is utilized to gain access to online applications, of which provides an extensive array of online activities, spanning across a seemingly endless variety of specific topics and themes. Modern online activities consisting of themes involving socialization, communication and interactivity appear to be the most popular among Internet users. Statistics show that the most prevalent online activities include social networking, chatting or instant messaging, emailing, online gaming, watching videos and reading online newspapers. Individuals using the Internet for telephoning and learning activities, however, are less prevalent[8].

2.3.1 Social networking sites (SNS)

The popularity of social networking sites (SNS) has surged substantially in recent years. This is likely due to its multi-structural features, e.g. instant messaging and interactive communication in real-time, ability to connect with friends and family, socialize with peers, build self-descriptive profiles as an expression of identity, ability to extend and maintain networks and social connections, while allowing for public or private exchanges[12].

Statistics in EU-28 show that social networking is most prevalent among adolescents age 16-19 years (90.0%), followed by young adults aged 20-24 years (89.0%) and adults aged 25-64 years (61.0%). In all age-groups, social networking is higher among females compared to males[8]. Findings from a European study revealed that 82.0 percent of adolescents (15-16 years) had an SNS profile, while 56.0 percent used SNS on a daily basis[13]. These results reflect similar findings from a study conducted in the U.S. assessing adolescents aged 14-17 years[14]. Outcomes showed that 82.0 percent of adolescents used SNS, while 53.0 percent used SNS daily. Tsitsika and colleagues[15] reported that 40.0 percent of adolescent users spend two hours or more on SNS every day. This is supported by a recent study showing adolescents spent an average of 2.6 hours on SNS per day, while intense social networking users spent an average of 3.5 hours daily on SNS[16].

2.3.2 Chatting or instant messaging

Instant messaging (IM) and chatting are prevalent and widespread online activities across the globe. IM provides a service for users to send and receive messages, pictures and videos. The exchange between individuals are interactive and in real-time allowing for continuous communication for as long as both parties desire. Communicating via chat rooms is another option for social interaction. It is quite similar to IM, however, users log on to a virtual room, often based on a specific theme, and communicate with several persons, rather than one-on-one exchanges used in IM. Albeit IM was designed for one-on-one communications, multiple IM functions have recently developed due to technological advances. Multiple IM is essentially texting with a group of individuals' simultaneously, rather than one-one-one exchanges in the original IM application[17].

There are a relatively high percentage of individuals across all age-groups utilizing these specific online applications; however, they are most prevalent among adolescents and young adults. According to statistics in EU-28, 54.0 percent of individuals visit chat rooms and/or instant message. Rates are highest among adolescents and young adults aged 16-19 (87.0%) and 20-24 (84.0%) years compared to adults aged 25-64 (49.0%) years. Percentages are higher among males in the age-groups 20-24 and 25-64 years, whereas females have a higher rate in adolescents aged 16-19 years.

2.3.3 Sending and receiving emails

Email is an online application for sending and receiving electronic messages over a network. It is primarily the most employed activity worldwide used for both personal and professional purposes. The utilization of email is highly prevalent, spanning across all age-groups, genders, professions and educational levels.

In EU-28, data show that emailing is higher among young adults aged 20-24 years (90.0%) and adults aged 25-64 years (87.0%) compared to adolescents aged 16-19 years (86.0%)[8]. When assessing gender, females have a higher percentage of emailing compared to males in both young adult and adult groups, whereas males have a higher rate in the adolescent group.

2.3.4 Internet gaming

Online gaming is essentially a video game that is either partially or primarily played using the Internet. Online games are ubiquitous and available on a large array of platforms. These platforms support multiple devises (e.g. PCs and mobile phones) that often extend across numerous genres. Internet gaming can take form in many different aspects, ranging from single player games to multiplayer real-time virtual worlds, as multiuser domains (MUDs), which combines elements of role-playing, online chat, interactive fiction and player versus player formats. MUDs are the direct precursors of massively multiplayer online role-playing games (MMORPGs). MMORPGs are a combination of role-playing and massively multiplayer online games with the capability to support a substantially large number of players simultaneously. This platform allows players to interact with one another within the realms of the respective video game.

European statistics show that online gaming is substantially higher among adolescents, with 80.0 percent reporting to play games online, while 40.0 percent play multiuser network games. Percentages of playing online games compared to multiuser networked games in young adults was 72.0 percent and 30.0 percent, while in adults, these figures were 48.0 percent and 13.0 percent, respectively. In a study assessing trends between different online video games, findings showed that 48.8 percent of MMORPG players spent between 4-8 hours per day playing games, compared to 29.6 percent among non-MMORPG players[18]. Internet gaming is considerably more prevalent in males than females across all age-groups.

2.3.5 Watching videos or listening to music

An online video platform is a service that allows users to upload, store and play back videos on the Internet. Similar platforms are available for music, often comprising online music databases with tens of thousands of songs available for users to access.

Individuals watching videos and listening to music online appears to be most prevalent among adolescents (59.0%) and young adults (60.0%) in EU-28, with only 42.0 percent of adults reporting to engage in these respective online activities. In all age-groups, watching videos or listening to music is higher in males than females[8].

2.3.6 Reading online newspapers

An online newspaper is essentially the online version of a hard-copy periodical newspaper. Online newspapers are very similar to printed newspapers, wherein they are both bound to the same legal regulations such as defamation, privacy and copyright issues. There has been a considerable shift in recent years, where printed newspapers are becoming more obsolete and replaced by online newspapers. This shift creates more possibilities for newspapers to compete in broadcast journalism at a significantly lower cost.

Statistics show that reading online newspapers across Europe is higher among young adults (65.0%) and adults (62.0%) compared to adolescents (54.0%). Similar to watching online videos, these trends appear to be more prevalent among males than females in all age-groups[8].

2.3.7 Telephoning or video calls

There are numerous online applications (e.g. Skype and FaceTime) that allow users to make both video and audio telephone calls to individuals across the globe. The service only requires an Internet connection and is often free of charge. New functions as video calling and face-to-face features have been gaining popularity in recent years. These functions allow the user to experience direct interactive communications with family, friends and colleagues.

Data show that telephoning and video calling in Europe are higher in adolescent groups, with 51.0 percent reporting to utilize these online applications. Among young adults, 46.0 percent reported to use the Internet for telephoning and video calling, while only 35.0 percent of adults reported to use this particular online function. Across all age-groups, males have a higher tendency to use these respective applications compared to their female counterparts[8].

2.3.8 Learning activities

Online learning activities, or educational technology, is the practice of facilitating education and learning through using, creating and managing technological resources[19]. Educational technologies, in terms of online learning, can take many different forms. Several examples of educational technologies include: (i) online tutorials that introduce new users to a specific application, (ii) online literature in a particular field or subject, (iii) online databases with global and regional statistics, (iv) interactive whiteboards in classrooms with touch screen functions, and (v) online discussion forums[19].

In EU-28, however, the percentage of individuals using the Internet for education and learning purposes is below 50.0 percent in all age-groups. Adolescents have the highest percentage of utilizing online learning applications (43.0%), followed by young adults (40.0%) and adults (19.0%). Online learning activities are higher in adult males, whereas adolescent females have a higher rate than their male peers. In young adults, gender rates were evenly split with 40.0 percent each for both males and females reporting to use the Internet for learning activities.

Overall, the most prevalent online activities rated above 45 percent in the general population across EU-28 included emailing (87.0%), social networking (63.0%), reading online newspapers (61.0%), chatting or instant messaging (54.0%), playing online video games (51.0%) and watching videos or listening to music (45.0%). In order to contextualize these rates, statistics on Internet activities in the U.S. were utilized for comparison. Rates in the U.S. general population were comparatively lower than those reported in the EU, especially in regards to social networking (51.0%), playing online video games (36.0%), watching videos or listening to music (34.0%) and chatting or instant messaging (20.0%). The highest reported online activities in the US involved emailing (87.0%), which is equivalent to European rates, followed by general surfing of the Web (78.0%).

2.4 ADDICTIVE POTENTIAL OF ONLINE ACTIVITIES

There is strong evidence corroborating the addictive potential of certain online activities[16,20]. Research shows that distinct online activities can be highly addictive[21], whereby, users are enticed to spend more time online in order to engage in these respective activities. Albeit some scholars refer to this phenomenon as an addiction to the Internet, it should be elucidated that addiction most likely occurs from the content of online activities and not the Internet itself. The Internet is a form of technology, and technology in itself is neither "good" nor "bad". Individuals do not actually become addicted to the Internet, as the Internet is merely a vehicle to access online applications[22]. The problem is attributed to its "use", rather than the technology itself. Thus, the concept of addiction in reference to the Internet should refer to the pathological nature and addictive behaviours related to its "use" in accessing certain online applications and engaging in specific Internet activities[23].

Evidence suggests that massively multiplayer online role-playing games (MMORPG) entice users to play the game for longer periods of time in order to follow the progressive storyline of their online character[32]. The liaison between MMORPG and excessive use has shown to be significantly associated and linked with multiplayer features, higher experiences of competence, greater autonomy and relatedness during gameplay[33]. In addition to MMORPGs, other genres of Internet gaming, such as MUDS, FirstPerson Shooters (FPS) and real-time strategy games have also proven to be interrelated with excessive time spent online[34,35]. Among gamers, excessive use of playing preferred games online can range from 30 to 60 hours per-week with individual sessions lasting 10 or more hours per-day[36].

SNS (e.g. Facebook and Twitter) has also emerged in recent years, signifying both a surge in time spent online and negative associations with real-life social interactions[37]. Evidence suggests that individuals may feel compelled to update and sustain their online social networks to appeal to their existing relationships, while attempting to attract new friends to join their network. Kuss and Griffiths[38] reported that extraverted individuals appear to utilize SNS for social enhancement, while introverted individuals utilize it for social compensation. In both cases, there seemed to be a substantial interconnection between the two and excessive use.

Research shows that chatting or instant messaging (IM) is an online activity that is frequently utilized by adolescents and university students. Technological advances and the development of new interactive applications (e.g. WhatsApp or Snapchat) has expedited the appeal and popularity of chatting and instant messaging[39]. With the new advancement of multiple IM utilities, users have the ability to text with multiple individuals simultaneously, which has proven to be a popular function, particularly in adolescents. Evidence shows that normal IM users spend an average of 2 hours per day actively texting, while excessive IM users can spend an average ranging from 3 to 5 hours per day[40]. In theoretical terms, the rapid surge of individuals excessively using IM applications could potentially be due to its instantaneous nature, wherein users may inadvertently feel pressured to immediately reply to a text once received. There is also an inherent time latency in which IM users lose track of time when chatting or texting with family or friends. Individuals' excessively using IM applications have a latent risk for developing a probable displacement effect.

In terms of Internet use, the displacement effect theory[41,42] proposes that excessive time online has the propensity to displace real-life activities that are essential for psychosocial development, particularly in adolescents[43,44]. Studies show that excessive use of online applications displaces time for sleeping[45], engaging in physical activities[46], participating in extra-curricular activities[47], performing academic tasks[48] and face-to-face interactions with family and friends[49,50]. Within this theoretical framework, it is evident that the more time individuals spend online exploiting their preferred Internet activities, the risk of developing an addiction becomes significantly elevated[51].

2.5 IDIOSYNCRATIC FORMS OF ONLINE BEHAVIOURS

As Internet addictive behaviours lack any formal nomenclature, the following three categories were developed, for the purpose of this thesis, to distinguish between Internet user types: Adaptive Internet Use (AIU), Maladaptive Internet Use (MIU) and Pathological Internet Use (PIU). The nomenclature of these classifications are based on the theoretical assumption[52], which is supported by evidence-based research[51,53], that this condition follows similar biopsychosocial pathways as other addictive disorders[54]. The three respective Internet user groups (AIU, MIU, PIU) are conceptualized accordingly.

2.5.1 Adaptive Internet use (AIU)

The Internet is particularly appealing to adolescents, given their developmental traits and inquisitive nature. The ability to access up-to-date information on any given topic, facilitate new and existing relationships and indulge in a wide-range of online activities is especially alluring

for youth. The Internet abets the daily life of adolescents and essentially empowers them through the ability to have complete control over their Internet activities and online content.

Most individuals, including adolescents, have positive and beneficial encounters when online. The Internet provides an extensive platform in terms of information, learning, socializing and entertainment. Users often take advantage of these opportunities and develop their knowledge and social skills during online sessions. This group of individuals are referred to as adaptive Internet users (AIU). For adaptive users, the Internet serves as a supportive tool, rather than a source of identity. Adaptive users are able to balance online and offline engagements through prioritizing, self-monitoring and exploring alternative offline options when necessary. In this group, individuals have the ability to self-correct through behavioural modification, discipline and self-regulation[55].

2.5.2 Maladaptive Internet use (MIU)

Individuals exhibiting initial signs of explicit use of a specific online activity, or begin to use the Internet more frequently and for longer periods of time, while neglecting other obligations and commitments, are indicators or even potential precursors of MIU. Maladaptive users are not considered to have reached the level of Internet pathology; rather, they are at an elevated-risk for developing an addiction. MIUs often experience difficulties in controlling impulses, modifying behaviours and exercising self-control. Among this group, excessive use of the Internet begins to displace main areas of daily routines, including school attendance, peer relationships and extracurricular activities[56]. As maladaptive users neglect these important offline activities that are beneficial to psychosocial health, negative effects start to emerge. Initial adverse effects experienced by maladaptive users are often related to sleep disturbances, due to excessive use, and distress when they are unable to go online. Adolescent maladaptive users frequently make significant efforts to maintain or increase their level of Internet use, often bypassing parental control exertions, if necessary[57]. Maladaptive users often attempt to normalize or even legitimize their excessive use. By justifying their perilous online behaviours, users in the maladaptive group essentially give themselves permission to continue using the Internet despite negative consequences. As these compulsive patterns persist, there is an imminent risk their Internet use can transition from maladaptive to pathological.

2.5.3 Pathological Internet use (PIU)

Individuals classified as pathological Internet users often display symptomatic behaviours similar to those observed in other behavioural addictions. Pathological users lack the ability to control impulses and manage their time online. They are often preoccupied with online activities and crave their next online session. Adolescents in this group tend to build-up a tolerance quickly, thus they need to use the Internet more frequently and for longer periods of time in order to achieve satisfaction. Pathological users may jeopardize their relationships with family and friends or neglect important obligations, due to the excessive use of online applications. They may also fabricate their online behaviours to family and relatives in an attempt to conceal the extent of their involvement in the virtual world. In some cases, pathological users may even use the Internet as means to escape or palliate dysphoric moods, such as depression or anxiety. Individuals in this group have greater difficulties in controlling and regulating online and offline activities to the point where it becomes dysfunctional. In line with other addictive disorders, pathological users will often experience negative psychological, social and somatic effects, as a result of their online addictive behaviours[58].

2.6 CONCEPTUALIZING PATHOLOGICAL INTERNET USE

2.6.1 Nomenclature of pathological Internet use

When assessing the nomenclature of addictive behaviours related to Internet use, a review of the scientific literature shows considerable heterogeneity between studies. There is an extensive assortment of terms that have materialized in recent years to categorize this phenomenon, including, but not limited to, 'Internet addiction', 'Internet dependence', 'Internet behaviour

dependence', 'Internet addiction disorder', 'compulsive Internet use', 'problematic Internet use', 'net addiction', 'excessive Internet use', 'Internet overuse', 'cyber addiction', 'computer addiction', 'Internet related disorder' and 'pathological Internet use'. In the latter term, 'pathological Internet use' (PIU) is one of the first and most utilized terminologies in current research. As the term 'pathological Internet use' better reflects the addictive potential of 'using' the Internet to engage in online activities as opposed to being addicted to the Internet itself, this expression will be the applied term throughout this thesis.

2.6.2 Definition of pathological Internet use

According to the American Society of Addiction Medicine (ASAM)[59], addiction is characterized by impairments of behavioural control, diminished recognition of significant problems related to behaviours, interpersonal relationships, consistent cravings and the inability to consistently abstain from the respective substance or behaviour. These relevant physiognomies are frequently observed in pathological users. In an attempt to develop a universal definition of PIU using well-established expressions of other addictive disorders, Shaw and Black[60] conducted an extensive systematic review evaluating definitions, assessments and epidemiological factors for PIU. In terms of its definition, the authors concluded that PIU is "characterized by excessive or poorly controlled preoccupations, urges or behaviours regarding Internet use that leads to impairment or distress." This definition is widely used in scientific-based research and will be used to delineate PIU in the respective thesis.

2.6.3 Differentiating between pathological Internet use and excessive Internet use

Although pathological use and excessive use of the Internet are highly intersecting, it is critically important to underscore that these conditions are two separate entities and should not be used interchangeably. Albeit excessive use is often a symptom of PIU, excessive usage in itself does not customarily denote addictive traits. Excessive use is exemplified by using the Internet to an immoderate degree; however, it does not necessarily involve symptoms related to addiction, such as salience, withdrawal symptoms, tolerance or mood modification. In theoretical terms, PIU is often classified as a behavioural addiction with impulse-control debilities. This is in line with a study conducted by Caplan and colleagues[61], who argued that PIU is an impulse-control disorder with addictive traits, whereas excessive Internet use includes a degree of online activity exceeding individualistic perceptions of planned, usual or normal behaviours related to Internet use. Moreover, in a study by Lee and colleagues[62], the authors investigated the disparities between adolescents with PIU and excessive Internet use by conducting diagnostic interviews. Findings exemplified that the relationship between pathological use and excessive use significantly differentiated in terms of psychiatric comorbidities and psychosocial behaviours. It is, therefore, utterly critical to develop clear and distinctive nomenclature and definitions of PIU, excessive Internet use and other related conditions for future clinical and population-based research endeavours.

2.6.4 Diagnostic criteria of pathological Internet use

The diagnostic criteria of PIU is still very much ambiguous. At present, there lacks an international accord on the diagnosis of PIU. It is neither listed in the 'International Classification of Diseases (ICD)' nor the 'Diagnostic and Statistical Manual of Mental Disorders (DSM)' nosological systems. In the scientific literature, PIU has conceptually been modelled as an impulse-control disorder and derived from the DSM-4 diagnostic criteria of pathological gambling; however, these taxonomies appear to be shifting, due to the new guidelines stipulated in the DSM-5. Despite recent developments, early research has indicated that PIU is a subtype of behavioural addiction, akin to the diagnostic construct of pathological gambling.

In a recent mixed-methods study, both quantitative and qualitative approaches were employed to ascertain whether or not PIU should be classified as a behavioural addiction[63]. Standardized measures were used to assess quantitative data, whereas focus groups were conducted to explore subjective experiences shared by a sample of university students diagnosed with PIU.

Results of the standardized measures and focus groups indicated a considerable overlap between students' symptoms of PIU and the criteria for substance use and gambling disorders in the DSM-5. Findings revealed that the majority of participants exhibiting symptoms of PIU described their online behaviours as an addiction, similar to substance use disorders[63]. By using this mixed-methods approach, the following symptoms of PIU were ascertained: (i) loss of interest in activities other than the Internet, (ii) withdrawal symptoms when offline, (iii) preoccupation with online activities, (iv) craving, (v) using the Internet to escape or relieve negative moods, (vi) lying about Internet usage, (vii) using the Internet longer than intended, (viii) using the Internet excessively despite negative consequences, and (ix) unsuccessful attempts to stop or reduce Internet use[63]. The respective PIU criteria are in liaison with symptoms of both substance use disorders and behavioural addictions stipulated in the DSM-5, suggesting these conditions are, to a large extent, highly overlapping.

2.7 PATHOLOGICAL INTERNET USE AND DSM-5 ADDICTIVE DISORDERS

The major challenge facing PIU research is its conception as an addictive disorder. There are continual discussions within the scientific community as to whether PIU merits inclusion in the DSM nosological system as an official disorder. In the midst of these debates, a major shift in nomenclature, diagnostics and structure of addictive disorders in the DSM-5 were undertaken. The subsequent amendments to the categorical framework of addiction in the DSM-5 are depicted accordingly.

2.7.1 Substance use disorder

In the DSM-5, the APA no longer makes distinctions between substance abuse and substance dependence; rather, all substance-related addictions are now listed under the category 'substance use disorders' (SUDs). The DSM-5 essentially combined the two substance use categories, abuse and dependence, from the DSM-4 and restructured it into a single measure (SUD), which is evaluated on a continuum ranging from mild to severe. Each chemical is now denoted as a distinct subtype disorder (e.g. alcohol use disorder, opioid use disorder, cocaine use disorder, etc.); however, they are all diagnosed with the same overarching criteria. The APA stipulated that the revisions made to SUDs, as a single and separate diagnosis, will better reflect the symptoms experienced by patients.

There is mounting evidence demonstrating significant associations between behavioural addictions and SUDs[64-67]. PIU, in particular, has been shown to share neurological, biological and psychosocial characteristics with both gambling disorders and SUDs[68,69]. Moreover, PIU and SUDs among individuals impart similar personality traits, such as high novelty-seeking and low reward dependence. Psychosocial proneness to low family function, low self-esteem, low life satisfaction and social isolation are all factors associated with both PIU and SUDs[70]. The significant relationship between PIU and SUD could partly be due to sensitization.

Addiction-prone phenotypes for SUDs are likely to have an effect in sensitizing other alternative reinforcers such as PIU. This suggests that individuals susceptible to SUDs would have a higher risk of PIU than those without previous symptoms of substance use. This is corroborated by several studies indicating that subjects with preceding SUDs have a significantly higher risk of PIU compared to those with no known history of substance abuse[71,72].

2.7.2 Behavioural addiction disorder

One of the most momentous changes to the DSM nosological system is the introduction of a category named 'behavioural addiction', which is listed under the classification of 'substance-related and addictive disorders' in the DSM-5. This new category marks several important points at many different levels. For the first time, addiction is not limited to exploited chemicals in substance use disorders, rather it transcends across behaviours into a broader spectrum. The recognition by the APA legitimizes the condition, wherein universal and standardized diagnostic criteria can be developed and implemented for public health research and clinical use.

Moreover, this new classification opens the door for eventual consideration of potential subtype disorders of behavioural addiction, such as PIU and Internet gaming disorder.

The terminology and classification of pathological gambling has also been modified in the DSM-5. In terms of nomenclature, 'pathological gambling' has been changed to 'gambling disorder' (GD). GD was previously classified as an impulse-control disorder in the DSM-4; however, it is now listed as the sole disorder under the new category 'behavioural addiction.' The new term and taxonomy of GD is embraced by current research findings definitively showing that GD is similar to SUDs[73] in terms of brain origin and physiology[67], comorbidity[74], clinical expression[75] and treatment[76].

Research shows that there is a consistent and interconnected relationship between PIU and GD. In a study assessing the link between PIU and GD, findings indicated that individuals exhibiting difficulties in controlling and regulating their Internet use were at a significantly higher risk of GD[77]. Moreover, there is surmountable evidence showing PIU and GD share similar neurobiological and psychological profiles. GD is known to be associated with depression[78], anxiety[79], ADHD[80] and substance use disorders[81] in both adult and adolescent populations. These respective psychiatric disorders are also significantly associated with PIU[82]. Based on these findings, PIU may share similar etiological factors with GD and potentially moderates the liaison between GD and risk-measures[83].

2.7.3 Internet gaming disorder

In the contention surrounding the modifications to addictive disorders in the DSM-5, the integration of behavioural addiction ultimately led to a proposition to include Internet gaming disorder (IGD) as a subtype disorder under the new respective category. As IGD still lacked conclusive scientific-based evidence to include the condition as a subtype disorder in the DSM-5, the APA decided to include IGD in Section III of the manual, stipulating that further research is required. The criteria of PIU and IGD, however, are highly overlapping. In Young's 8-item diagnostic criteria of PIU[9], all eight items reflect the 9-item diagnostic criteria of IGD in the DSM-5[84]. Moreover, both conditions are known to be subtypes of behavioural addiction and significantly associated with similar psychopathologies[85] and psychosocial factors[86]. It should be noted, however, that these two conditions are separate entities; thus, clear and explicit criteria distinguishing the two conditions are important.

2.8 PHENOMENOLOGICAL PERSPECTIVE OF PATHOLOGICAL INTERNET USERS

Despite the contradictions and contentions in approaches to the nosological classification of PIU, a small, but relative, consensus on the phenomenological facets of PIU are reported. In terms of phenomenology, research has shown that there are distinctive themes in the subjective experiences endured by individuals with PIU that are both consistent and correspond between independent studies[87]. In a study assessing the phenomenology of PIU in a sample of university students, findings revealed that the need to spend more time online to achieve satisfaction, obsessive or recurring thoughts about online activities and psychosomatic ailments were significant symptoms identified among individuals with PIU[88]. Bernardia and Pallantia[89] conducted a study assessing dissociative symptoms in pathological users and noted several phenomenological characteristics, including preoccupation with online activities, using the Internet to escape or alleviate depression, risking personal relationships and the inability to decrease or discontinue Internet usage. Pathological users also displayed phenomenological signs indicative of frequent and prolonged use of the Internet, poor interpersonal relationships, isolation from other forms of social interaction and dysfunctional coping skills[90]. The phenomenology of PIU substantially corresponds to the phenomenological characteristics observed in other addictive disorders[87].

2.9 DIAGNOSTIC MEASURES FOR ASSESSING PATHOLOGICAL INTERNET USE

There are a variety of research-based evaluation scales and questionnaires that have been developed over the years to assess PIU (*see* Table 1). One of the earliest and most notorious evaluation tool used to measure PIU is the Young's Diagnostic Questionnaire (YDQ), which was developed by Prof Kimberly Young in 1996[91]. Given PIU appears to be most akin to the nature of pathological gambling, the YDQ was constructed based on the ten-item diagnostic criteria of pathological gambling in the DSM-4. Two items were omitted from the ten-item criteria of pathological gambling in order to provide a more rigorous cut-off score for PIU. This resulted in an eight-item dichotomous questionnaire (YDQ) that encompassed the following symptomatic criteria: spending time online longer than intended, salience, withdrawal symptoms, tolerance, concealing and deception, negative consequences, escapism and loss of control. The YDQ is the most widely utilised unidimensional measure for assessing PIU and has been translated in multiple languages with relatively good temporal stability and internal validity values (*see* Table 1). Albeit the YDQ has shown acceptable psychometric properties, there remain critiques of its validity in terms of criteria and diagnostic scoring. According to Beard and Wolf[92], the criteria reflecting salience, loss of control, withdrawal and time spent online longer than intended could be met without the loss of psychosocial functioning. Their proposition for the diagnostic criteria of PIU involved subjects testing positive on the respective five symptoms described above and at least one of the latter criteria concerning concealment and deception of PIU, negative consequences or escapism. The proposal of this diagnostic scheme to the YDQ, however, has only been used in a small number of studies.

In light of these critiques, Young consequently constructed the Internet addiction test (IAT), which is an expansion of the eight-item YDQ questionnaire. The diagnostic criteria were based on the DSM-4 symptoms of substance dependence and pathological gambling. In addition to the eight items from the YDQ, dimensions related to behavioural and cognitive salience and neglecting important obligations were also included. The IAT is a 20-item measure that is rated on a 6-point Likert scale. The IAT is indubitably the most widely used psychometric instrument for measuring PIU across the globe. It has also been translated into multiple languages and undergone rigours testing of its psychometric properties. The scale has consistently exhibited excellent temporal stability, construct validity and internal validity values (see Table 1).

In addition to the YDQ and IAT measures, there are a number of other psychometric instruments developed based on the DSM-4 criteria of substance dependence and pathological gambling. These include the Internet Addiction Scale (IAS), Compulsive Internet Use Scale (CIUS), Problematic Internet Usage Scale (PIUS) and the Chen Internet Addiction Scale (CIAS). In the latter scale, the CIAS is a 26-item measure that is rated on a 4-point Likert scale. Developed in China, the CIAS criteria assesses the common addictive traits as the other psychometric instruments, however, it also evaluates time management difficulties, which is a unique dimension not accompanied by other psychometric measures. In relation to its psychometric properties, a study comparing the construct validity of the YDQ, IAT and CIAS showed significantly high correlations between the three assessment tools indicating good construct validity for the three respective measures. The CIAS also exhibited robust temporal stability and internal validity values, making it one of the most widely used psychometric instruments for measuring PIU in Asian countries (*see* Table 1).

In contrast to psychometric scales that are based on the DSM criteria of substance dependence and pathological gambling, there are other scales constructed on the basis of cognitive models. These primarily involved the Online Cognition Scale (OCS), the Generalized Problematic Internet Use Scale (GPIUS) and the Generalized Problematic Internet Use Scale (GPIUS-2). The OCS is a 36-item questionnaire comprising a 7-point Likert scale. Items are based on symptoms elucidated in the scientific literature, particularly focused on cognitions rather than behaviours, and adapted from related measures of procrastination, depression and impulsivity. The GPIUS consists of 29 items that are rated on a 5-point Likert scale. The GPIUS comprises symptoms and

criteria based on Davis' cognitive behavioural model[52]. The items form five subscales assessing, namely, cognitive preoccupation, mood regulation, negative outcome, preference for online social interaction and compulsive use. The GPIUS-2 is a modified version of the GPIUS, comprising 15 items that are rated on a 6-point Likert scale. In the GPIUS-2, criteria are based on items from the original GPIUS, however, two additional factors related to online social interaction and self-regulation were introduced. The relative scales based on cognitive models are vigorous measures for assessing PIU and comprise robust psychometric properties, including excellent temporal stability and internal validity values (*see* Table 1).

Table 1. Research-based psychometric instruments for measuring pathological Internet use with an assessment of citation rates and psychometric properties

Psychometric Instrument	Author(s)	Country	AWCR[a]	Structure	Cu-off scores	Dimensions of addiction	Target population	Temporal stability[b]	Internal validity[c]
Young's Diagnostic Questionnaire (YDQ)	Young 1996[9,93]	USA	188.50	8-item self-report questionnaire rated dichotomously	A score of >5 indicates PIU.	Criteria are based on the DSM-4 diagnostic symptoms of pathological gambling with the following dimensions: Preoccupation, tolerance, loss of control, online longer than intended, concealing and deception, withdrawal symptoms, negative consequences and escapism.	Adults Adolescents	$r = 0.81$[94,95]	$\alpha = 0.71\text{-}0.84$[9,96,97]
Internet Addiction Test (IAT)	Young 1998[98]	USA	87.94	20-item self-report measure rated on a 6-point Likert scale	A score of >80 indicates PIU.	Criteria are based on the DSM-4 diagnostic symptoms of substance dependence and pathological gambling with the following dimensions: Eight dimensions of the YDQ combined with behavioural and cognitive salience, neglecting work/school, neglecting social life and anticipation.	Adults Adolescents	$r = 0.87$[95,99]	$\alpha = 0.88\text{-}0.93$[100-103]
Internet Addiction Scale (IAS)	Nichols & Nicki 2004[104]	Canada	77.70	31-item self-report measure rated on a 5-point Likert scale	A score of >93 indicates PIU.	Criteria are based on the DSM-4 diagnostic symptoms of substance dependence and Griffiths' components model with the following dimensions: Salience, mood modification, excessive use and withdrawal symptoms.	Adults Adolescents	$r = 0.98$[104]	$\alpha = 0.91\text{-}0.95$[104,105]
Generalized Problematic Internet Use Scale (GPIUS)	Caplan 2002[106]	USA	53.00	29-item self-report questionnaire rated on a 5-point Likert scale	Higher scores indicate greater severity of PIU symptoms.	Criteria are based on Davis' cognitive behavioural model[52] of PIU with the following dimensions: Mood modification, perceived social benefits, negative consequences of compulsive Internet use, excessive amounts of time spent online, withdrawal symptoms and perceived social control online.	Adults Adolescents	$r = 0.81$[107]	$\alpha = 0.78\text{-}0.91$[105]
Compulsive Internet Use Scale (CIUS)	Meerkerk et al 2009[108]	Netherlands	45.86	14-item self-report questionnaire rated on a 5-point Likert scale	A score of >21 indicates PIU[109].	Criteria are based on the DSM-4 diagnostic symptoms of substance dependence and pathological gambling with the following dimensions: Salience, loss of control, conflict, lying to others about Internet use and withdrawal symptoms[108].	Adults Adolescents	$r = 0.83$[108]	$\alpha = 0.78\text{-}0.92$[108]
Online Cognition Scale (OCS)	Davis et al 2002[110]	USA	40.07	36-item self-report measure on a 7-point Likert scale	Higher scores indicate greater severity of PIU symptoms.	Criteria are based on a systematic assessment of the literature with particular focus on cognitions rather than behaviours with the following dimensions: Diminished impulse control, loneliness, depression, low social comfort and distraction.	University students	$r = 0.90$[110]	$\alpha = 0.94$[110]
Generalized Problematic Internet Use Scale (GPIUS-2)	Caplan 2010[111]	USA	32.83	15-item self-report questionnaire rated on a 6-point Likert scale	Higher scores indicate greater severity of PIU symptoms.	Criteria are based on the original GPIUS, with the exception of two additional factors concerning online social interaction and self-regulation. GPIUS-2 comprises the following dimensions: Excessive online social interactions, deficient self-regulation, compulsive use, cognitive preoccupation, perceived social benefits and social control.	Adults Adolescents	$r = 0.85$[112]	$\alpha = 0.91$[111]

Problematic Internet Use Questionnaire (PIUQ)	Demetrovics 2008[113]	Hungary	16.38	18-item self-report measure rated on a 5-point Likert scale	A score of >41 indicates PIU.	Criteria are based on the South Oaks Gambling Screen (SOGS)[114] and Internet Addiction Test (IAT) with the following dimensions: Obsession, neglect and control disorders.	Adults Adolescents	$r = 0.90$[113]	α=0.87[113,115]
Chen Internet Addiction Scale (CIAS)	Chen 2003[116]	China	12.45	26-item self-report measure rated on a 4-point Likert scale	A conservative score of >67 indicates PIU.	Criteria are based on the DSM-4 diagnostic symptoms of substance dependence and pathological gambling with the following dimensions: Compulsive use, withdrawal symptoms, tolerance, interpersonal and health consequences, and time management difficulties.	Adolescents	$r = 0.83$[116]	α=0.93-0.97[105,117]
Problematic Internet Usage Scale (PIUS)	Ceyhan 2007[118]	USA	0.63	33-item self-report questionnaire rated on a 5- point Likert scale	A score of >16 indicates PIU.	Criteria are based on the DSM-4 diagnostic symptoms of impulse-control disorder with the following dimensions: Continuity with Internet use despite negative consequences, low social benefit and excessive usage.	University students	$r = 0.81$[118]	α=0.82-0.94[118,119]

[a]Age-weighted citation rate (AWCR) measuring citation averages per year (# of citations/age of the article). [b]Test–retest reliability analysis with the following interpretation of coefficients: *Fair* (0.40-0.59), *Good* (0.60-0.74) and *Excellent* (>0.75)[120]. [c]Cronbach's alpha with the following interpretation of coefficients: *Acceptable* (0.60-0.69), *Fair* (0.70-0.79), *Good* (0.80-0.89) and *Excellent* (>0.90)[121-123].

2.10 THEORETICAL MODELS ON PATHOLOGICAL INTERNET USE

2.10.1 LaRose's social-cognitive model of uses and gratifications

Viewed as a psychological communicative feature, the social-cognitive model concerning uses and gratifications focuses on the use of mass media and interpersonal communication to satisfy their needs and desires[124]. Based on the uses and gratification model, media is often ascertained by key components involving communicative behaviours, individual needs, motives to communicate, psychological and social situations, mass media and the pragmatic discretion to media use[125]. In practical terms, this theoretical approach focuses on how media can be utilized to satisfy individuals' affective and cognitive needs for entertainment and personal desires. The Internet essentially functions as an interpersonal utility for social recognition, social maintenance and building relationships. It also provides an array of other functions, such as acquiring information and entertainment purposes. Evidence shows that that the gratifying nature of the Internet (e.g. enhancing social status or entertainment) ultimately influences individuals' online behaviours. Individualistic needs for self-presentation, personal identity and escape from reality are essentially the driving force behind the motivations to use the Internet and the gratification it provides for those respective individuals.

2.10.2 Davis' cognitive-behavioural model of pathological Internet use

Davis[110] developed a cognitive-behavioural model of PIU by categorizing the condition into two separate subtypes: (i) generalized pathological Internet use and (ii) specific pathological Internet use. In the generalized PIU subtype, Internet misuse is independent of the actual Internet content, rather it is based on a dependency to the unique virtual environment that only the Internet can provide, such as massively multiplayer online role-playing games (MMORPG). In the specific PIU subtype, users are considered to have a content-specific addiction, such as online gambling. This form of dependence is presumed to occur even in the absence of the Internet (e.g. gamblers can visit casinos instead of gambling online).

Based on a diathesis-stress model, Davis conceptualizes PIU that involves pre-existing vulnerabilities (diathesis) and life events (stressor). The respective model designates that there are definitive aetiological factors that induce addictive behaviours. These primarily include *sufficient, necessary* and *contributory factors*[52]: (i) *sufficient factors* are aetiological components that essentially ensure the occurrence of symptoms, (ii) *necessary factors* are necessitated in terms of symptomatic manifestation of symptoms, and (iii) *contributory factors* are aetiological elements that significantly increase the occurrence of symptoms. It is the interaction between these three factors that theoretically imposes an addictive pathway of progressing PIU symptoms.

According to this model, causal factors of PIU are placed on a continuum ranging from distal to proximal. Distal causes are contiguous to the onset of the dependency, while proximal causes are towards the end. Psychopathologies are considered a distal necessary cause for the manifestation of PIU symptoms, while exposure to the Internet is considered to be the stressor. It should be noted that the underlying psychopathology alone does not result in PIU symptoms, but is a basic component in the aetiology of the disorder. Depending on the level of response the user receives from their initial online experience ascertains whether they continue to use the Internet. Through a process termed operant conditioning (i.e. a type of learning in which behaviours are modified by its antecedents and consequences), the user develops a pattern of Internet use through positive and negative reinforcement. Positive experiences then serve to condition the individual to repeat the use of online activities to achieve the same positive effect. Maladaptive cognitions are thought to be proximal causes of the disorder and are a sufficient cause for the manifestation of Internet pathology. In terms of ruminative cognition style, this model suggests that individuals are constantly thinking about online activities rather than real-life issues. These types of persons often experience PIU for longer periods of time and with more severe symptoms than those who do not adopt this cognitive style.

2.10.3 Griffith's 'components model' of addiction

According to Griffiths components model of addiction[126], substance use disorders and behavioural addictions, including PIU, develop via biopsychosocial processes that share basic underlying mechanisms and constitute six core components: salience, mood modification, tolerance, withdrawal symptoms, conflicts and relapse. In terms of PIU, the following criteria of the components model are conceptualised. *Salience* refers to preoccupation with online activities on a number of levels, namely cognitive (compulsive thoughts about online activities), emotional (cravings for next online session) and behavioural (neglecting social and personal responsibilities). *Mood modification* occurs when individuals use the Internet to alleviate depressed moods or escape from real-life problems. *Tolerance* is denoted by the necessity to spend more time online in order to attain the desired effect experienced during the initial stages of the addiction. *Withdrawal symptoms* are unpleasant feelings that arise when the individual attempts to decrease or discontinue their Internet usage; this can occur on the physiological level (shaking or tremors) and psychological level (depression or irritability). *Conflicts* are denoted by interpersonal conflicts (jeopardizing personal relationships) and intrapsychic conflicts (subjective feelings of losing control). *Relapse* denotes the unsuccessful attempts to reduce or discontinue Internet use. Griffiths' components model of addiction provides a robust account for both SUDs and behavioural addictions as it elucidates the procurement, progression and management of the respective addiction.

2.10.4 Biopsychosocial model of pathological Internet use

In line with Griffiths' components model, there is substantial evidence showing that the pathways of PIU corresponds within the framework of the biopsychosocial model, similar to other addictive disorders (Figure 8). Studies consistently show that PIU shares biological, psychological and social attributes with both behavioural and substance-related addictions[72,127-132].

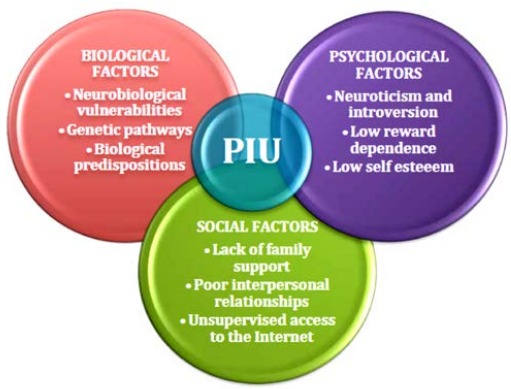


Figure 8. Biopsychosocial model of pathological Internet use

In terms of the biological process, individuals with addiction undergo neurochemical and molecular changes during the initial phase of testing the substance or behaviour to the latter stages of addiction. In the field of neurobiological research, the stimuli of positive reinforcing effects of substance use and behavioural addiction often occur in the mesolimbic dopamine system. In a study assessing the striatal dopamine transporter (DAT), Huo and colleagues[25] revealed that DAT levels in the striatum were significantly reduced among individuals with PIU compared to controls. In support of this finding, another study examined 66 adolescents (33 subjects with PIU and 33 healthy controls), which showed similar results. Liu and Luo [133] reported that low levels of plasma dopamine were significantly correlated with both time spent online and PIU among an adolescent sample.

Research examining the genetic profiles of individuals with PIU targeting the nicotinic acetylcholine receptor subunit alpha 4 (CHRNA4) gene has gained popularity in recent years. In a study by Montag and colleagues[4], findings showed a significant relationship between the polymorphism of the CHRNA4 gene and the risk of PIU. Another study on heritability and PIU using 5247 monozygotic (MZ) and dizygotic (DZ) adolescent twins, who were registered with the Netherlands Twin Register, was recently conducted. Findings showed that 52 percent of

individuals with PIU were determined by environmental factors, whereas the residual 48 percent of PIU individuals were ascertained by heritability[134].

In terms of psychological factors, numerous studies have identified several conditions influencing the development of PIU. Individuals with symptoms of psychological issues often evolve via biological predisposition or acquired through environmental influences. In adolescents, studies have shown that symptoms of loneliness, low self-esteem, low self-concept, low reward dependence, low emotional stability, neuroticism and introversion have been ascertained to increase the risk of PIU[135,136], particularly in vulnerable populations. In regards to personality characteristics, studies have demonstrated harm avoidance, novelty seeking, low conscientiousness and intolerance exacerbating the risk of engendering PIU symptoms[137,138].

In terms of social factors, there are environmental dynamics that induce both health risk-behaviours and mental health issues in youth across the globe. Adolescents reporting intense stress, poor relationships, family conflict, low academic achievement, substance use, lack of parental bonding and parental monitoring, unsupervised access to the Internet and low social adaptation have a significantly higher risk of developing PIU[139,140]. Moreover, adolescents who have family members with SUDs or socialize with peers and siblings who use alcohol can substantially amplify symptomatic risks of PIU[141].

It is often the combination and interaction between biological, psychological and social factors that ultimately induces PIU symptoms. Based on the biopsychosocial scheme, it is evident that PIU development and progressive symptoms correspond within the framework of this theoretical structure. This can prove useful for future research endeavours to expand this model in efforts to better understand the aetiological pathways involved in the evolution of PIU symptoms.

2.11 EPIDEMIOLOGY OF PATHOLOGICAL INTERNET USE

2.11.1 Sociodemographic factors

There are several sociodemographic factors that are present in adolescents with PIU. Regarding gender, males have consistently shown higher rates of PIU compared to their female counterparts. This trend has been consistent in the majority of independent studies conducted across the globe. Household composition is another important element determining the risk of PIU in adolescents. There is evidence suggesting that household composition and familial relationships between adolescents and their parents could also affect the risk-level of PIU[142]. The dynamics between child-parent relationships are extremely influential and have a profound effect on the mental health and well-being of children. Although these data are limited, there are a few studies indicating an association between poor child-parental relationships and the risk of PIU among adolescents[57]. Moreover, sociodemographic factors as living in a city residence, younger age-groups and ethnicity are also potential correlates of PIU[143].

2.11.2 Prevalence rates of pathological Internet use

In the literature, there are a number of studies assessing the prevalence of PIU from across the globe. The majority of these studies, however, applied a wide-range of distinct nomenclature, definitions and psychometric scales assessing PIU. This inevitably makes a direct cross-country comparison even more challenging. In an attempt to standardize this process, epidemiological studies assessing the prevalence of PIU using Young's Diagnostic Questionnaire, with the same cut-off criteria, were identified in the literature and utilized for a subsequent cross-country comparison.

By using Medline, a total of 20 studies assessing PIU prevalence using the YDQ were obtained. Outcomes revealed that the majority of epidemiological studies measuring PIU prevalence were conducted in Asia. Seven studies were performed in China[11,144-149], followed by three studies in Taiwan[150-152]. In Europe, three studies were conducted in Greece[97,153,154] and two studies in

Norway[155,156]. In the remaining studies, one study each was discerned in Australia[157], India[158], Iran[159] and Serbia[160], respectively (*see* Table 2).

In China, there were moderate variations in prevalence rates of PIU ranging from 2.4 to 11.7 percent, with an overall average of 7.8 percent. The highest prevalence of PIU, however, was identified in Taiwan. Prevalence rates of PIU among Taiwanese adolescents varied from 13.7 percent to a staggering 23.4 percent, with an aggregated PIU prevalence of 18.5 percent. Studies assessing the prevalence of PIU in Europe, however, are limited. In spite of this paucity, research assessing PIU among adolescents in Greece revealed a relatively elevated level of PIU prevalence ranging from 8.2 to 15.2 percent, with an average rate of 11.7 percent. In another European country, researchers assessing the prevalence of PIU in Norwegian adolescents noted a relatively low prevalence rate ranging from 1.0 to 1.6 percent, with an overall average of 1.3 percent.

There are also sparse studies assessing the prevalence of PIU among distinct countries. The highest prevalence rate of PIU in these studies was identified in Iran, with a PIU rate of 22.8 percent. In a single-based study assessing PIU prevalence in India, results also showed a relatively high percentage of 21.0 percent. The remaining studies reporting prevalence rates of PIU ranged from 4.6 percent in Australia to 18.7 percent in Serbia (*see* Table 2).

Table 2. Evidence-based review on the prevalence of pathological Internet use using Young's Diagnostic Questionnaire (YDQ)

Authors	Study design	Sample size	Population	Instrument	Cut-off score	Prevalence
Mei et al., 2016[144]	Cross-sectional	N=1,552	High-school students Mean age=15.43, SD=1.89 years Age range=11-20 years China	YDQ	Endorsed ≥5 items on YDQ	5.5%
Parkash et al., 2015[158]	Cross-sectional	N=600	General population Mean age=21.84, SD=2.73 years Age range=18-40 years India	YDQ	Endorsed ≥5 items on YDQ	21.0%
Ac-Nikolic et al., 2015[160]	Cross-sectional	N=553	High-school students Mean age=15.6, SD=0.96 years Age range=14-18 years Serbia	YDQ	Endorsed ≥5 items on YDQ	18.7%
Li et al., 2014[145]	Cross-sectional	N=24,013	High-school students Mean age=12.84, SD=1.78 years Age range=7-16 years China	YDQ	Endorsed ≥5 items on YDQ	6.3%
Wang et al., 2013[146]	Cross-sectional	N=10,988	High-school students Mean age=17.2 years Age range=13-23 years China	YDQ	Endorsed ≥5 items on YDQ	7.5%
Guo et al., 2012[147]	Cross-sectional	N=3,254	High-school students Mean age=12.56, SD=1.83 years Age range=8-17 years China	YDQ	Endorsed ≥5 items on YDQ	3.7%
Siomos et al., 2012[153]	Cross-sectional	N=2,017	High-school students Mean age=15.05, SE=.05 years Age range=12-19 years Greece	YDQ	Endorsed ≥5 items on YDQ	15.2%
Fisoun et al., 2012[154]	Cross-sectional	N=1,270	High-school students Mean age= 15.99, SE=.05 years Age range=14-18 years Greece	YDQ	Endorsed ≥5 items on YDQ	5.3%
Thomas and Martin, 2010[157]	Cross-sectional	N=1,326	University and High-school students Mean age =19.18, SD=3.67 years Age range =12-54 years Australia	YDQ	Endorsed ≥5 items on YDQ	4.6%
Kheirkhah et al., 2010[159]	Cross-sectional	N=1,856	General population Mean age=20.25, SD=4.19 years	YDQ	Endorsed ≥5 items on YDQ	22.8%

			Age range=8-56 years Iran			
Bakken et al., 2009[155]	Cross-sectional	N=3,399	General population Mean age=45.0 years Age range=16-74 years Norway	YDQ	Endorsed ≥5 items on YDQ	1.0%
Gong et al., 2009[148]	Cross-sectional	N=3,018	High-school students Mean age=15.8, SD=2.1 years Age range=11-23 years China	YDQ	Endorsed ≥5 items on YDQ	5.0%
Lin et al., 2009[150]	Cross-sectional	N=1,289	High-school students Mean age=17.46, SD=1.00 years Age range=16-19 years Taiwan	YDQ	Endorsed ≥5 items on YDQ	23.4%
Huang et al., 2009[149]	Cross-sectional	N=3,496	University students Mean age=20.19 SD=1.26 years Age range=16-30 years China	YDQ	Endorsed ≥5 items on YDQ	9.5%
Siomos et al., 2008[97]	Cross-sectional	N=2,200	High-school students Mean age=15.34, SD =1.66 years Age range=12-18 years Greece	YDQ	Endorsed ≥5 items on YDQ	8.2%
Yang and Tung, 2007[151]	Cross-sectional	N=1,708	High-school students Mean age=18.0 years Age range=17-19 years Taiwan	YDQ	Endorsed ≥5 items on YDQ	13.8%
Cao and Su, 2007[11]	Case-control	N=2,620	High-school students Mean age=15.19 years Age range=12-18 years China	YDQ	Endorsed Beard's modified criteria of the YDQ[161]	2.4%
Johansson & Gotestam, 2004[156]	Cross-sectional	N=3,237	High-school students Mean age=14.9 years Age range=12-18 years Norway	YDQ	Endorsed ≥5 items on YDQ	1.9%
Chou & Hsiao 2000[152]	Cross-sectional	N=910	University students Mean age=21.1, SD=2.10 years Age range=12-18 years Taiwan	YDQ	Endorsed ≥5 items on YDQ	13.7%

2.12 PATHOLOGICAL INTERNET USE AND MENTAL HEALTH IN ADOLESCENTS

Given the considerable rise in the prevalence of PIU in recent years, there are legitimate concerns regarding its effect on social and psychological health, particularly among adolescents. Adolescence is a transitional period of exploration and development of one's cognitive, social and physical attributes. It is during this period of life, however, individuals are most susceptible to certain risks that can affect their mental health. Despite the paucity of evidence-based research within the European context, there are independent studies indicating potential associations between PIU and health risk-behaviours (substance use[162]), psychopathology (depression[163], anxiety[164] and attention deficit hyperactivity disorder[165]) and suicidality (suicidal ideation[166] and suicide attempts[167]). As there continues to be mounting evidence indicating psychosocial impairments developed during early adolescence have a considerably high likelihood of continuation into adulthood, it is vital for research to focus on adopting a public health approach that addresses the complex relationship between PIU and mental health issues in adolescents. Given PIU is a relatively contemporary phenomenon, it is critical to acquire sufficient evidence-based knowledge to determine its effect on mental health and suicidality in diverse adolescent populations, particularly with a European perspective.

2.13 CLOSING THE RESEARCH GAP

The relationship between PIU and mental health in adolescents is still relatively obscure. Although there has been a considerable increase in empirical research on PIU in recent years, the ambiguous nature of its classification and diagnostic criteria impedes efforts to better understand the effect PIU has on the psychosocial well-being of adolescents. There are substantial disparities between independent studies in terms of population, target groups, sample sizes, geographic region, ethnicity, homogeneity, methodologies, psychometric measures and cut-off scores. These discrepancies limit cross-national comparisons and ultimately influence the validity, reliability and generalizability of important findings[168,169]. Moreover, there is a high and disproportionate quantity of PIU research conducted in Asia compared to the rest of the world. Due to cultural, social and economic imparities between world regions, findings from PIU research involving Asian adolescent populations may not necessarily be applicable to European adolescents or vice-versa; thus, research on PIU performed in other global regions is necessitated. There is a critical need for conducting large, population-based studies that targets adolescents and utilizes systematic procedures, standardized approaches and homogenous methodologies in representative European samples in order to investigate the complex manifestation of PIU and related psychological disorders. Another challenge in PIU research is the considerable dearth of longitudinal studies evaluating this phenomenon. By implementing longitudinal studies, one can assess potential predictors and risk-factors for PIU. Longitudinal studies can also be utilised to test the effect of specific mental health promotion and preventive strategies on reducing the risk of PIU and related psychosocial impairments.

The gap in knowledge on these particular issues hampers the advancement of forming a unified definition, taxonomy and diagnostic criteria of PIU, thereby hindering the development and implementation of preventive interventions for PIU and psychopathology in adolescent populations. Due to the limited and insufficient data of PIU research in Europe, the respective thesis will attempt to close some of these research gaps within the confines of a European perspective.

3 OBJECTIVES

The primary aim of this doctoral thesis is to improve our knowledge of adolescent pathological Internet use within the European context, by assessing its prevalence in relation to demographic and social factors, health risk-behaviours, psychopathology and suicidality. The secondary aim is to identify and ascertain effective preventive strategies for both PIU and psychosocial impairments.

This doctoral thesis focuses on five specific objectives:

1. To measure the prevalence of pathological Internet use and assess its relationship with demographic and social factors (*Study I*);
2. To systematically scrutinize previous research addressing the potential link between pathological Internet use and comorbid psychopathology (*Study II*);

3. To test the association between pathological Internet use, psychopathology and suicidality (*Study III*);
4. To examine the relationship between pathological Internet use and health risk-behaviours (*Study IV*); and
5. To assess the preventive effect of mental health action in schools on reducing the onset risk of pathological Internet use and psychosocial impairments (*Study V*).

4 METHODS AND MATERIAL

4.1 DATA SOURCE

4.1.1 Saving and Empowering Young Lives in Europe (SEYLE)

This doctoral thesis is performed within the framework of the European Union funded project: Saving and Empowering Young Lives in Europe (SEYLE)[170]. SEYLE is a randomised controlled trial (RCT) that aims to lead adolescents to better mental health through the implementation and evaluation of mental health promoting and suicide preventive interventions among adolescents in Europe. Data were collected during 2009-2010, and a large epidemiological database was created. The SEYLE epidemiological database is the data source used for the respective thesis.

4.2 SAMPLE SELECTION AND RANDOMIZATION PROCEDURES

A catchment area in each study site was selected, and a list of eligible schools was produced. Eligible schools were categorized by size: **large** (≥ the median number of students in all respective schools) and **small** (≤ the median number of students in all respective schools). The inclusion criteria for selecting eligible schools were based on the following conditions: **(1)** schools were public; **(2)** had more than two teachers for students aged 15 years; **(3)** had no more than 60 percent of students of the same gender; and **(4)** contained at least 40 students aged 15 years. Schools were randomised on the basis of intervention, school size, sociocultural factors, school milieu and school system structure at each study site by using a random number generator[171].

4.3 DESCRIPTION OF THE SEYLE STUDY SAMPLE

The SEYLE project involved a consortium of twelve European countries: Austria, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Romania, Slovenia and Spain, while Sweden served as the coordinating centre. The total study sample comprised 12,395 adolescents (M/F: 5,529/6,799; mean age=14.9±0.9) recruited from 179 randomly selected schools across study sites in the respective eleven countries. Representativeness, consent, participation and response rates of the sample were scrutinized and reported in a methodological analysis[171]. The demographics of each study site were found to be relatively representative of their corresponding national population. At the 3- and 12-month follow-ups, participation rates were 87.3 percent and 79.4 percent, respectively. The aggregated response rate of schools was 67.8 percent.

4.4 DATA COLLECTION AND QUALITY CONTROL MEASURES

Structured questionnaires covering a wide-range of dimensions related to behavioural, psychological and social attributes were developed. As part of the main objectives in SEYLE, these structured questionnaires were administered to school-based adolescents across catchment areas in the respective eleven European countries in order to collect epidemiological data on social and demographic factors, lifestyles, health- and risk-behaviours, psychosocial factors, psychopathology and suicidality. A two-stage data cleaning and quality control procedure was performed to ensure accurate and reliable data. The first stage of quality control was to create two data files through an independent double entry process at the local level. Data files were then compared and discrepancies were resolved accordingly. The second stage of quality control was performed centrally. Each local dataset was systematically evaluated for inconsistencies at the central level in order to detect errors that may have been overlooked at the first quality control measure at the local level.

4.5 TRANSLATION AND CULTURAL ADAPTATION OF STRUCTURED QUESTIONNAIRES

Structured questionnaires were translated and culturally-adapted into the official language in each participating country. Forward translations were performed to ensure that any discrepancies or

uncertainties were accentuated. In order to ensure that all translations were congruent, the materials were back translated, in English, from the respective native language. Incongruities were identified and adjusted accordingly. In addition to the translation process, cultural adaptability was also addressed. At each centre, an iterative process involving cultural adaptation theory, cultural linguistic advisors, socio- and medical anthropologists, focus groups, qualitative interviews and documentation were implemented to ensure all translated materials were both sensitive and compliant to the respective culture in each participating country. All structured questionnaires in SEYLE were translated and culturally adapted into 11 languages: Arabic, Estonian, French, German, Hungarian, Hebrew, Italian, Romanian, Russian, Slovene and Spanish.

4.6 PSYCHOMETRIC INSTRUMENTS

Structured questionnaires were administered to adolescents, within the school milieu, at baseline, 3-month and 12-month follow-up evaluations. Validated psychometric scales with robust properties were incorporated into the SEYLE structured questionnaire in order to collect high-quality data comprising demographics, social factors, lifestyles, health risk-behaviours, psychopathology and suicidality. These scales have been translated and culturally adapted into multiple languages and have undergone rigorous testing of their psychometric properties.

The psychometric instruments utilized in this thesis included the following:

1. *Young's Diagnostic Questionnaire* (YDQ)
2. *Beck Depression Inventory-II* (BDI-II)
3. *Zung Self-Rating Anxiety Scale* (Z-SAS)
4. *Strengths and Difficulties Questionnaire* (SDQ)
5. *Global School-Based Student Health Survey* (GSHS)
6. *Deliberate Self-Harm Inventory* (DSHI)
7. *Paykel Suicide Scale* (PSS)

4.6.1 Young's Diagnostic Questionnaire (YDQ)

In the YDQ[9], a diagnosis is based on a pattern of Internet usage during the preceding six months that induces clinical impairment or distress, as designated by the presence of the following eight criteria: **(1)** need for longer amounts of time online to achieve satisfaction; **(2)** staying online longer than originally intended; **(3)** preoccupation with online activities; **(4)** jeopardizing or risking the loss of a significant relationship, job, educational or career opportunity because of the Internet; **(5)** using the Internet as a way of escaping from problems or relieving a dysphoric mood; **(6)** lying to family members, therapists or others to conceal the extent of involvement with the Internet; **(7)** restlessness, moodiness, depression or irritability when attempting to cut down or stop Internet use; and **(8)** repeated unsuccessful efforts to control, cut back or stop Internet use. The 8-item YDQ is a unidimensional measure with a total score ranging from 0 to 8. Based on the YDQ score, Internet users were categorized into three groups: *Adaptive Internet users (AIU)* [scoring 0-2], *Maladaptive Internet users (MIU)* [scoring 3-4] and *Pathological Internet users (PIU)* [scoring ≥ 5].

4.6.2 Beck Depression Inventory-II (BDI-II)

Depressive symptoms were assessed using the Beck Depression Inventory-II (BDI-II)[172]. The BDI-II is a self-report 21-item inventory rated on a 4-point Likert scale that evaluates the severity of depression in both adolescent and adult populations. There is substantial evidence supporting the validity and reliability of the BDI-II across diverse cultures and populations. In this dissertation, however, a modified version of the BDI-II was applied. One of the items in the original BDI-II (*loss of libido*) was removed, as in certain countries, this question was considered unsuitable for an adolescent population. The validity of the BDI-II does not appear to be affected by the omission of this question. To ensure this revised 20-item BDI-II version was reliable, Cronbach's alpha tests were conducted to assess its internal validity. Results showed that the 20-item BDI-II questionnaire was still a reliable measure (α=.864) for assessing symptoms of depression in adolescents. Based on the BDI-II score, the following categories

were denoted: *no depression* (scoring 0-13); *mild depression* (scoring 14-19); *moderate depression* (scoring 20-28); and *severe depression* (scoring 29-63).

4.6.3 Zung Self-Rating Anxiety Scale (Z-SAS)

Anxiety symptoms were measured by using the Zung Self-Rating Anxiety Scale (Z-SAS)[173]. Z-SAS is self-report 20-item measure rated on a 4-point Likert scale assessing trait and state anxiety in adolescents. Based on the total Z-SAS score, anxiety levels were classified into the following categories: *normal range* (scoring ≤44); *mild to moderate anxiety levels* (scoring 45-59); *marked to severe anxiety levels* (scoring 60-74); and *extreme anxiety levels* (scoring ≥75).

4.6.4 Strengths and Difficulties Questionnaire (SDQ)

The Strengths and Difficulties Questionnaire (SDQ)[174] is a self-report 25-item measure rated on a 3-point Likert scale and targets adolescents aged 11-17 years. The SDQ is grouped into five subscales that measure: **(1)** pro-social behaviours, **(2)** emotional symptoms, **(3)** conduct problems, **(4)** peer problems and **(5)** hyperactivity-inattention. Each subscale comprises five items, thus, a total score is generated by summing the respective values. Based on the SDQ score, adolescents were categorized as *normal* (scoring 0-15), *borderline* (scoring 16-19) and *severe* (scoring 20-40).

4.6.5 Global School-Based Student Health Survey (GSHS)

Data on health risk-behaviours were obtained by using questions procured from the Global School-Based Student Health Survey (GSHS)[175]. Developed by the World Health Organization (WHO), the GSHS is a school-based survey measuring health risk-behaviours among adolescents aged 13–17 years. It is a self-report questionnaire comprising 10 core modules assessing demographics, mental health, violence and unintentional injury, sexual behaviours, alcohol and related substance use, tobacco use, hygiene, physical activity, dietary behaviours and protective factors.

4.6.6 Deliberate Self Harm Inventory (DSHI)

Self-injurious behaviours (SIB) were measured using the Deliberate Self-Harm Inventory (DSHI) developed by Gratz[176]. In the original DSHI, the questionnaire comprised 17 items with dichotomized responses 'yes/no'. In this study, a modified version of the DSHI was developed by combining items from the DSHI to simplify and shorten the measure to a 6-item questionnaire. The modified version tested in this study was rated on a 4-point Likert scale and contained the following six items: **(1)** Have you ever intentionally burned yourself; **(2)** Have you ever intentionally carved words or markings into your skin; **(3)** Have you ever intentionally banged your head; **(4)** Have you ever intentionally prevented wounds from healing; **(5)** Have you ever intentionally cut your wrist; and **(6)** Have you ever intentionally hurt yourself in any of the above-mentioned ways so that it led to hospitalization? To ensure the revised 6-item DSHI questionnaire was reliable, Cronbach's alpha tests were conducted to assess internal validity. Results showed that the 6-item DSHI was still a reliable measure (α=.718) for assessing SIB acts.

4.6.7 Paykel Suicide Scale (PSS)

Suicidal behaviours (suicidal ideation and suicide attempts) was measured by the Paykel Suicide Scale (PSS)[177]. The PSS comprised 5 questions that were based on the preceding two weeks: **(1)** have you felt that life was not worth living; **(2)** wished you were dead; **(3)** thought of taking your own life; **(4)** seriously considered taking your own life or even made plans; and **(5)** have you tried to take your own life? Students responding 'yes' to the third **(3)** and fourth **(4)** items of the PSS were considered to have suicidal ideation, while students responding 'yes' to the fifth **(5)** item were deemed to have attempted suicide.

4.7 STUDY DESIGNS

Cross-sectional study designs were employed to calculate the prevalence of PIU and assess its association with demographic and social factors (S*tudy I*); to evaluate the correlation between PIU, psychopathology and suicidality (*Study III*); and to examine the association between PIU and health risk-behaviours (*Study IV*). In *Study II,* a systematic review and meta-analysis design was utilized to systematically explore previous research concerning the correlation between PIU and comorbid

psychopathology. In *Study V*, a longitudinal design was used to ascertain the preventive effect of mental health action in schools (MHAS) on reducing the onset risk of PIU and psychosocial impairments.

4.8 DATA ANALYSES

4.8.1 Statistical procedures for Study I

In study I, a representative sample consisting of 11,956 adolescents (M/F: 5225/6731) with a mean age of 14.9 ± 0.89 years were included in the study. In the respective analyses, both categorical and dimensional evaluations using the YDQ were studied independently. Descriptive analysis of the prevalence for AIU, MIU and PIU stratified by gender and country were conducted. Statistical significance between group proportions were analysed using the Bonferroni-adjusted Wald test after a multinomial regression model, with Internet user group as the dependent variable and country as the independent variable. Mean hours online per-day were calculated and stratified by gender and Internet user group using a two-factor analysis of variance (ANOVA). Goodman and Kruskal's Gamma test was utilized to explore the association between Internet user groups and online activities distinctly for males and females. Gender differences were compared using likelihood ratio tests. In the multinomial regression analysis examining the association between PIU and social factors, Internet user groups were entered as the dependent variable, while social factors were entered as the independent variables. In order to corroborate results from the categorical analysis using the multinomial regression model, a linear regression model was employed using the YDQ total score as a continuous variable. In the 16 variables used in the regression analysis, at least one or more missing values were detected. This yielded a total of 21.2 percent of the sample (n=2534) that had at least one or more missing values in one of the respective sixteen variables. In order to prevent estimation bias by excluding these subjects, missing values were imputed using the multivariate imputation by chained equations (MICE) algorithm. Regression models were then calculated for the imputed data sets and results were combined. Relative Risk Ratios (RRR) and regression coefficients (β) with 95% confidence intervals (*CI*) and *p*-values were reported. A critical value of $p < 0.05$ was considered to be statistically significant for all models.

4.8.2 Statistical procedures for Study II

Study II is a systematic review and meta-analysis with the aim to methodically evaluate previous research in order to ascertain the relationship between PIU and comorbid psychopathology. An electronic literature search of key indicators was conducted using the following databases: MEDLINE, PsycARTICLES, PsychINFO, Global Health, and Web of Science. There were no restrictions on language, time or publication status. Articles were systematically and independently reviewed by the authors. An impartial evaluation regarding the study type, study population, methodology, outcome measures, effect sizes and interpretation of results were conducted. The inclusion criteria for studies involved population-based studies with a large sample size ($n \geq 1200$ subjects), legitimate diagnostic criteria for PIU, subsequent reporting on the correlation between PIU and predetermined psychopathologies, and the psychometric outcome measures assessing psychopathology. This yielded a total of 20 studies for the analysis. The respective twenty articles were rated according to the scheme proposed by the Oxford Centre for Evidence-Based Medicine Results and evaluated by using the following criteria: observation of a full or partial association, significance level, and adjustments for confounders. Full association was considered when a correlation was found for both sexes after multivariate analyses. If a correlation was identified for only one gender, it was classified as a partial association. The geographical distribution of studies was also mapped.

Effect size of the associations was identified by either the original publication or calculated using the data of the respective publications. The calculated effect sizes were either Cohen's d or R^2. In order to compare the different associations, the effect sizes d and R^2 were stated as small, moderate and large in accordance to Cohen d, while ORs were converted into the respective groups in accordance to Chinn. The effect sizes were interpreted as small (d=0.2, R^2=0.01, OR=1.45), moderate (d=0.5, R^2=0.06, OR=2.50) and large (d=0.8, R^2=0.14, OR=4.25). The potential effect of publication bias was also assessed by using a funnel plot graph and tested using Egger's linear regression method. If publication bias was found, a trim and fill method was used to estimate the number of missing studies and adjusted accordingly.

4.8.3 Statistical procedures for Study III

In study III, a representative sample of 11,356 school-based adolescents (M/F: 4856/6500) with a mean age of 14.9 years were included in the analyses. Symptoms of depression were assessed using the Beck Depression Inventory-II (BDI-II). Anxiety was assessed using the Zung Self-Rating Anxiety Scale (Z-SAS). Emotional symptoms, conduct problems, hyperactivity-inattention, peer relationship problems and pro-social behaviours were measured using the Strengths and Difficulties Questionnaire (SDQ). Self-injurious behaviours (SIB) were evaluated using the Deliberate Self-Harm Inventory (DSHI). Suicidal ideation and suicide attempts were assessed using the Paykel Suicide Scale (PSS).

The prevalence of psychopathology and self-destructive behaviours were calculated and stratified by Internet user group. To analyse the relationship between PIU, psychopathology and self-destructive behaviours, a multilevel mixed-effects linear regression analysis was performed. In this model, PIU was entered as the dependent variable, while age, gender, psychopathological scores (BDI-II, Z-SAS, SDQ) and categorical self-destructive behaviours (DSHI, PSS) were entered as level 1 fixed effects, school as level 2 random intercept and country as level 3 random intercept. The estimation method was full ML with independent covariance structure. A subsequent stepwise reduction of the regression model was conducted in order to minimize the Bayes Information Criterion (BIC). Potential interactions of the predictors with gender and country were also explored. Each predictor was analysed as a separate model. PIU was used as the dependent variable, while the predictor, gender, country and interaction terms (predictor*gender) and (predictor*country) were entered as level 1 fixed effects, with school as level 2 random intercept. To avoid estimation problems, we combined the categories 'suicidal ideation' and 'suicide attempts' into one category discerned as 'suicidal behaviours'. Regression coefficients (β) with 95% confidence intervals (*CI*) and *p*-values were reported for the respective models. A critical value of $p < 0.05$ was considered to be statistically significant for all models.

4.8.4 Statistical procedures for Study IV

In study IV, a representative sample of 11,196 school-based adolescents comprising 43.1 percent males and 56.9 percent females (M/F: 4830/6366) with a mean age of 14.88 ± 0.88 years were included in the analysis. Data on health risk-behaviours were obtained by using questions procured from the Global School-Based Student Health Survey (GSHS). The prevalence of individual risk-behaviours among Internet user groups was calculated for males and females. To ascertain statistically significant differences between group proportions, multiple pairwise comparisons using the two-sided *z*-test with Bonferroni adjusted *p*-values was performed.

Extended analyses were conducted to test the effect of individual risk-behaviours on MIU and PIU using generalized linear mixed models (*GLMM*) with a multinomial logit link and full maximum likelihood estimation. In the GLMM analysis, MIU and PIU were entered as the outcome measures with AIU as the reference category, individual risk-behaviours were entered as Level 1 fixed effects, school as Level 2 random intercept and country as Level 3 random intercept. Variance components were used as the covariance structure for the random effects. To study the moderating effect of gender, interaction terms (gender*risk-behaviour) were fitted into the regression model. Adjustments for age and gender were applied to relevant GLMM models. Odds ratios (*OR*) with 95% confidence intervals (*CI*) and *p*-values were reported for the respective models.

In the analysis on multiple risk-behaviours, the mean (*M*) and standard error of the mean (*SEM*) were calculated for Internet user groups and stratified by gender. Box and whisker plots were used to illustrate these relationships. Statistical significance between multiple risk-behaviours and gender was assessed using independent samples *t*-test. One-way analyses of variance (ANOVA) with post hoc pairwise comparisons were employed to assess the statistical significance between multiple risk-behaviours and Internet user groups. Moreover, a regression variable plot was conducted to elucidate the linear relationship between the number of hours online *per* day and the number of risk-behaviours by Internet user group. A critical value of $p < 0.05$ was considered to be statistically significant for all models.

4.8.5 Statistical procedures for Study V

In study V, the objective was to assess the preventive effect of mental health action in schools (MHAS) on reducing the risk of PIU and psychosocial impairments in adolescents. MHAS was conceptualized by two distinct evidence-based actions used in mental health promotion: (1) *education-based action* through providing mental health education at school, and (2) *gatekeeper-based action* through teachers initiating open dialogues with adolescents about their mental health. In order to avoid contamination by students involved in one of the three active interventions in SEYLE, only adolescents participating in the 'control group' were included in the analyses. The study sample comprised 2,831 school-based adolescents, in which 47.1 percent were males and 52.9 percent were females (M/F: 1333/1498), with a mean age of 14.83 ± .90 years.

Means, standard deviations and proportions were calculated for sociodemographic variables and stratified by Internet user group. Statistical significance between Internet user groups was measured using Chi-squared (χ^2) tests for categorical variables and *t*-tests for dimensional variables. Baseline prevalence of PIU and psychosocial impairments in adolescents were calculated for the total sample. To explore variations between subgroups, prevalence rates for psychosocial impairments were computed and stratified by gender and Internet user group. Multiple pairwise comparisons assessing the significance of psychosocial impairments by gender and Internet user group were conducted using the two-sided *z*-test with Bonferroni adjusted *p*-values. In order to study the preventive effect of mental health actions, adolescents testing positive for PIU and psychosocial impairments at baseline evaluation were excluded from the analysis. By analysing incident cases, this method provided the opportunity to calculate the cumulative incidence and compare absolute risk-reductions (ARR) between students exposed and unexposed to mental health actions implemented in European schools. Statistical significance between adolescents' exposure levels (exposed vs. unexposed) were evaluated using Fisher's exact test.

To study the independent effect of education-based action, adolescents who received gatekeeper-based action at school were excluded from the analysis, while the analysis on gatekeeper-based action excluded students previously involved in education-based action at school. In a longitudinal analysis, generalized linear models (GLM) using maximum likelihood estimates (MLEs) were employed to assess the independent effects of education-based action (measured at T0) and gatekeeper-based action (measured at T0) on reducing the onset risk of PIU (measured at T1). Regression coefficients (β) with standard errors (SE) and *p*-values were reported for GLM models.

The effect of MHAS [i.e. the combined effect of education- and gatekeeper-based actions] on PIU and psychosocial impairments were also examined. In this longitudinal analysis, multilevel mixed-effects logistic regression (MELR) models were conducted to assess the preventive effect of MHAS (measured at T0) on reducing the onset risk of PIU and related psychosocial impairments (measured at T1) in school-based adolescents. Robust variance estimates were applied to the MELR models in order to adjust for the clustered data. Odds ratios with 95% confidence intervals (CI) and *p*-values are reported for respective models. Both GLM and MELR models were adjusted for baseline sociodemographic variables. A critical value of $p < 0.05$ was considered to be statistically significant for all models.

4.8.6 Statistical software

Statistical testing of the respective hypotheses for each study (I, II, III, IV and V) was conducted by using either IBM SPSS Statistics 23.0 or STATA 13.0 statistical software.

4.9 ETHICAL ISSUES

The SEYLE epidemiological database is the data source used for the outlined studies. Ethical issues have been scrutinized by the European Commission's ethical committee and fulfil the ethical principles as stated by the EU and Declaration of Helsinki. Submission to local ethical committees in the respective countries involved in the project has been sought and approval has been obtained. Ethical approval has

also been sought for the respective doctoral studies and granted by the Regional Ethical Review Board in Stockholm, Sweden (2012/1750-31/1).

5 RESULTS

5.1 PATHOLOGICAL INTERNET USE AND MAIN OUTCOMES

5.1.1 Sociodemographic factors of the total sample

Table 3 depicts the total sample comprising 11,931 adolescents allocated from eleven different European countries with a mean age of 14.89±.88 years. In terms of gender, 56.4 percent were females and 43.6 percent were males. The majority of adolescents (77.3%) reported to live with their biological parents, with the highest rate observed in Italy (91.6%) and the lowest in Estonia (59.5%). In regards to immigration, 97.2 percent of adolescents reported that they were born in their respective residing country, with the highest rate denoted in Romania (99.6%) and the lowest in Ireland (82.2%). Concerning parents, 85.1 percent of mothers and 83.7 percent of fathers were born in their residing country. For both mothers and fathers, the highest rates were observed in Romania (99.6% and 98.8%, respectively) and the lowest in Israel (64.5% and 61.2%, respectively). In terms of household composition, 8.9 percent of adolescents reported that at least one of their parents worked abroad and 9.8 percent of parents were unemployed. Estonia had the highest rate of parental unemployment (16.4%) compared to the lowest observed in Italy (3.7%).

Table 3. Country-specific sociodemographic variables comprising age, gender, household composition and immigration status in the adolescent sample included in the respective thesis[1,2]

Country	Sample	Age		Gender		Child lives with biological parents	Child born in residing country	Mother born in residing country	Father born in residing country	Parent working abroad	Parent unemployed
	N	M	SD	Male	Female	%	%	%	%	%	%
Austria	948	15.10	.77	37.0	63.0	80.3	95.0	81.6	82.6	5.9	4.8
Estonia	1,031	14.22	.51	45.9	54.1	59.5	97.9	94.5	88.8	12.9	16.4
France	996	15.16	.75	31.8	68.2	79.0	96.7	92.5	89.8	11.5	6.3
Germany	1,435	14.65	.80	47.7	52.3	73.0	92.7	75.1	69.8	3.8	10.5
Hungry	1,008	15.06	.79	41.2	58.8	70.4	97.2	93.9	92.7	3.8	11.5
Ireland	1,062	13.75	.69	54.3	45.7	82.1	82.2	78.6	79.5	7.5	11.4
Israel	940	15.89	.79	79.5	20.5	70.2	83.8	64.5	61.2	38.1	11.8
Italy	1,188	15.31	.66	31.9	68.1	91.6	96.8	91.9	94.9	1.6	3.7
Romania	1,134	15.02	.37	34.4	65.6	83.6	99.6	99.6	98.8	12.8	10.8
Slovenia	1,163	15.21	.71	29.7	70.3	83.1	96.4	86.7	84.1	5.5	7.1
Spain	1,026	14.52	.70	51.6	48.4	74.6	85.9	82.2	84.7	2.9	14.0
Total	**11,931**	**14.89**	**.88**	**43.6**	**56.4**	**77.3**	**92.7**	**85.1**	**83.7**	**8.9**	**9.8**

[1]Sample size is based on all adolescents who completed the 8-item Young Diagnostic Questionnaire (YDQ) at baseline evaluation.[2]Mean (M) and standard deviation (SD).

*5.1.2 **Frequent use of online activities by gender and Internet user groups** (study I)*

Table 4 exemplifies frequent use of the respective online activities stratified by gender and Internet user group. The most frequently used online activities in adolescents included watching videos, followed by downloading music, social networking and e-mailing. With the exception of academic use, frequent use of all online activities was significantly higher in pathological users compared to adaptive users. Significant associations between online activities and Internet user groups were also observed. The strongest associations among adolescents were watching videos, followed by visiting chatrooms and social networking. The associations observed between online activities, however, significantly differed by gender. In male adolescents, the strongest correlated activity included playing online multiuser games, whereas the strongest correlated activity for female adolescents was social networking.

Table 4. Frequent use of distinctive online activities stratified by gender and Internet user group[1]

Online activities	Adaptive users			Maladaptive users			Pathological users		
	Male %	Female %	Total %	Male %	Female %	Total %	Male %	Female %	Total %
Academic use	29.3	40.6	35.6	25.0	34.6	30.8	22.3	35.2	28.6
Reading newspapers	27.4	24.5	25.8	31.9	31.8	31.8	30.3	37.4	33.8
E-mailing	47.9	53.8	51.2	53.6	58.8	56.7	54.3	59.8	57.0
Playing single user games	29.6	11.7	19.5	45.9	14.4	27.1	49.4	17.6	33.9
Playing multi-user games	32.7	4.9	16.4	50.4	8.1	23.0	61.1	11.2	31.6
Chat rooms	45.5	46.0	45.7	59.7	60.9	60.4	64.0	65.0	64.5
Downloading music or videos	61.3	55.7	58.2	71.1	69.6	70.2	72.0	77.2	74.6
Watching videos	71.6	68.7	69.9	85.9	85.2	85.4	83.9	89.3	87.1
Social networks	62.0	74.0	69.0	67.7	88.1	80.9	67.7	85.5	78.2

[1]**Data source:** Durkee et al. 2012.

5.1.3 Mean hours online per-day

Mean hours spent online per-day was shown to be significantly higher among adolescents in the PIU group compared to those in the AIU group. A significant two-fold increase in mean hours spent online was observed between maladaptive users and pathological users. In a linear regression model, a significant dose-response effect was ascertained between mean hours spent online and Internet user groups. When the analysis was stratified by gender, results showed that male adolescents expended significantly more time on the Internet compared to their female counterparts.

5.1.4 Prevalence rates by gender and country

Among the total sample, prevalence rates for AIU, MIU and PIU groups were estimated to be 82.1, 13.5 and 4.4 percent, respectively. Albeit females exhibited a slightly higher prevalence rate for MIU (14.3% in females vs. 12.4% in males), males displayed a significantly higher prevalence of PIU (5.2% in males vs. 3.8% in females). Outcomes demonstrated gender variations in prevalence rates for both MIU and PIU groups across countries. Estonia and Slovenia indicated a higher prevalence of MIU in males, while Romania showed that females had a higher rate of MIU. In cross-national comparisons, the highest rate of MIU (18.2%) and PIU (11.8%) was observed in Israel, while the lowest rate was found in Italy (8.8% and 1.2%). MIU and PIU prevalence rates varied significantly between the participating European countries.

5.1.5 Social factors and accessibility

The relationship between Internet user groups and sociodemographic conditions was assessed in a multinomial regression model and reported as relative risk ratios (RRR). In support of the gender variations observed in the prevalence rates, females had a significantly higher relative risk of MIU, whereas males had a higher relative risk of PIU. Adolescents who reported to not live with a biological parent and those living in metropolitan areas had an elevated risk of both MIU and PIU. In fact, students not living with a biological parent had a three-fold increased relative risk of PIU (RRR=3.0; CI: 1.86-4.86) compared to adolescents living with a biological parent. In the assessment of low parental involvement, significant relative risk ratios were observed in both MIU and PIU groups in adolescents who perceived that their parents do not pay attention to them (RRR = 1.46; CI: 1.30–1.65 and RRR = 2.20; CI: 1.78–2.71); do not know what the adolescent does with their free time (RRR = 1.87; CI: 1.66–2.10 and RRR = 1.93; CI: 1.58–2.35); and do not understand them (RRR = 1.70; CI: 1.50–1.94 and RRR = 2.14; CI: 1.70–2.68). Similar outcomes were also found to be significant for negative peer relationships, parental unemployment and Internet accessibility. In regards to the latter, the linear regression model showed a significant association between Internet accessibility and the YDQ total score.

5.1.6 Health risk-behaviours

The average prevalence rates of health risk-behaviours were also calculated in the adolescent sample. Results showed that the prevalence for AIU, MIU and PIU groups were 19.0, 27.8 and 33.8 percent for sensation-seeking behaviours; 23.8, 30.8 and 35.2 percent for lifestyle characteristics; and 16.4, 24.3

and 26.5 percent for substance use, respectively. Pairwise comparisons examining the statistical significance between MIU and PIU groups showed that the majority of health risk-behaviours did not significantly differ between these two groups. In the PIU group, however, 89.9 percent of adolescents reported to having multiple risk-behaviours. Outcomes revealed that the mean rate of multiple risk-behaviours significantly increased from adaptive use (*M*=4.89, *SEM*=.02) to maladaptive use (*M*=6.38, *SEM*=.07) to pathological use (*M*=7.09, *SEM*=.12). This trend was essentially identical for both males and females.

The association between PIU and health risk-behaviours was assessed using generalized liner mixed models (GLMM). In the GLMM analysis, outcomes revealed that health risk-behaviours were significantly and equivalently associated with both MIU and PIU groups, with the exception of risk-taking actions and truancy. Effect sizes showed that poor sleeping habits (ranging from OR=1.47 to 2.17) were the strongest factors associated with PIU. Adolescents reporting to use tobacco, partake in risk-taking actions, physically inactive and have a poor nutritional diet significantly increased the relative odds of PIU. The analysis on gender interactions indicated that the association between risk-taking actions, poor sleeping habits and PIU were significantly higher in females, whereas the association between truancy, poor nutrition and PIU was significantly higher in males.

5.1.7 Psychopathology and self-destructive behaviours

In the systematic review and meta-analysis, an extensive literature search was performed in order to identify scientific-based evidence supporting or refuting the association between PIU and psychopathology. In the studies meeting the inclusion criteria in the systematic review, 75 percent of the respective articles reported a significant association between PIU and depression, while 57 percent reported a significant correlation between PIU and anxiety. Attention deficit hyperactivity disorder (ADHD), however, was the strongest symptom correlated with PIU.

To support these findings, the relationship between PIU and psychopathology was examined using the European adolescent sample from SEYLE. Significant variations of moderate to severe depression and anxiety between the Internet user groups were observed. The prevalence of depression and anxiety in the AIU group was 5 percent for both psychopathologies. In the MIU group, prevalence rates of depression and anxiety was 17.1 and 16.4 percent, respectively. In the PIU group, however, a significantly higher prevalence of depression (33.5%) and anxiety (27.6%) were ascertained when compared to both AIU and MIU groups. Rates for conduct problems were shown to significantly differ between Internet user groups. In a comparison analysis of AIU, MIU and PIU groups, prevalence rates for conduct problems were 17.5, 31.9 and 41.0 percent, respectively. This escalating trend continued for emotional symptoms (10.8, 23.7, 32%), peer relationships (12.6, 21.6, 31.2%), low pro-social behaviours (14.1, 18.1, 25.1 %) and hyperactivity/inattention (15.1, 28.2, 37.2 %).

Prevalence rates of suicidal behaviours were determined to be significantly higher in pathological users compared to adaptive users. Results showed that suicidal ideation rates among Internet user groups (AIU, MIU, PIU) were 12.7, 31.9, 42.3 percent, respectively. This spiralling pattern was analogous for suicide attempts (0.3, 1.1, 3.1%) and self-injurious behaviours (4.4, 12.2, 22.2%), respectively. In a comparison of proportions between AIU and PIU groups, findings demonstrated a significant and substantial variation between these two groups. Among adolescents in the PIU group, prevalence rates were estimated to be three-fold higher for suicidal ideation and nearly ten-fold higher for suicide attempts when compared to the AIU group.

Multilevel mixed-effects linear regression models were utilized to assess the association between psychopathology, suicidality and PIU. In regards to psychopathology, results indicated a significant correlation between PIU and symptoms of depression, anxiety, conduct problems and hyperactivity/inattention. Adolescents exhibiting psychopathological symptoms of depression and anxiety had the strongest correlation with PIU. In the assessment of suicidality, both suicidal ideation and suicide attempts indicated to be strongly associated with PIU. The stepwise regression analysis

corroborated this assertion as outcomes showed that the strongest independent predictors of PIU were suicidal ideation (β=0.324, p<0.001) and suicide attempts (β=0.552, p=0.002).

The interaction effect of gender and country regarding the association between PIU, psychopathology and suicidality was also examined. In terms of gender, the correlation between hyperactivity/inattention, conduct problems and PIU was significantly stronger among females, whereas the link between anxiety, peer relationship problems, depression and PIU was significantly stronger among males. In the assessment of cross-national interactions, outcomes showed that country distinctly influenced the liaison between psychopathology, suicidality and PIU. The strongest correlations between psychopathology, suicidality and PIU were detected in Ireland and Estonia, whereas the weakest were observed in Hungary, Italy and France.

5.1.8 Preventive effect of mental health action in schools

In a longitudinal analysis using multilevel mixed-effects logistic regression models, the preventive effect of mental health action in schools (MHAS) on reducing the onset risk of PIU and related psychosocial impairments were studied. MHAS was based on adolescents reporting to have received mental health education at their school (education-based action) and was approached by a teacher to discuss psychosocial issues (gatekeeper-based action) prior to baseline assessment. Results showed that the combination of education-based and gatekeeper-based actions (i.e. MHAS) was the most effective strategy in reducing the onset risk of PIU. Adolescents exposed to MHAS had a 50 percent lower onset risk of PIU (OR=0.50, CI: 0.32-0.80) compared to the unexposed group. When analysing psychosocial impairments, results showed that adolescents in the MHAS group also exhibited a significantly lower incidence of emotional distress (OR=0.70, CI: 0.53-0.92), depression (OR=0.69, CI: 0.50-0.93) and coping problems (OR=0.66, CI: 0.45-0.98).

Separate analyses using generalized linear models (GLM) were performed to test the individual effect of education-based and gatekeeper-based actions on PIU. In the former, results showed that students who received education-based action at school had a significantly lower onset risk of PIU (β=-0.115, p<0.032). In the latter, outcomes revealed that gatekeeper-based action was also significant in reducing the onset risk of PIU, however, this was dependent on the type of discussion shared between students and teachers during these encounters. Student and teacher discussions about excessive Internet use indicated the strongest effect in reducing the incidence of PIU (β=-0.469, p=0.003), followed by those who discussed sleeping difficulties (β=-0.438, p=0.027) and those who discussed emotional issues (β=-0.290, p=0.033).

6 DISCUSSION

6.1 INTERPRETATION OF RESULTS

The purpose of the respective thesis was to attain a better understanding of the magnitude and risks associated with PIU in European adolescents and to ascertain effective preventive strategies that are based on scientific merit. In order to achieve this aim, five studies assessing these particular determinants were designed using comprehensive evidence-based methodologies. Interpretation of the results is denoted accordingly.

6.1.1 Prevalence of PIU in European adolescents

In the analysis assessing prevalence rates, outcomes showed that 13.5 and 4.4 percent of students were identified as having either MIU or PIU, respectively. Albeit females exhibited a 1.9 percent higher prevalence rate for MIU, males displayed a 1.4 percent higher prevalence rate of PIU. This is consistent with previous research[130,178,179] and applicable to other addictive disorders. Evidence shows that males tend to have higher rates of substance use disorders than their female counterparts[180]. This suggests that the severity of addictive disorders appears to be gender-specific, which could partly explain why females had higher rates of MIU, while males had higher rates of PIU (*Study I*). The complex etiological pathways of PIU, however, necessitate further study with focus on gender-based research.

In addition to gender aspects, environmental factors have also been implicated as significant determinants influencing PIU prevalence. In cross-national comparisons, results showed that prevalence rates of PIU significantly differed by country. Italy had the lowest prevalence of both MIU and PIU, whereas Israel indicated the largest rate in these respective Internet user groups (*Study I*). The significant difference between prevalence rates of PIU across countries could be influenced by cultural attitudes and viewpoints. Individuals tend to be a product of their environment, wherein they develop behaviours that are congruent and correspond to the general viewpoints observed in their respective society. Adolescents residing in Asia and Pacific countries, for example, often report higher prevalence rates of PIU compared to their counterparts in Western countries. These findings allude to the fact that, like many other conditions, PIU is shaped by sociocultural factors. Thus, qualitative analyses exploring the effect of sociocultural influences on PIU in adolescent populations are critically needed.

6.1.2 Addictive potential of online activities

The most significant online activities in the respective adolescent sample included watching videos, visiting chatrooms and social networking. Results denoted that online activities appeared to be gender-specific. Internet gaming was significantly associated with males, while social networking was significantly correlated with females. Evidence demonstrates that there are certain online activities that overtly induce users to stay online longer than anticipated. Results from a study on massively multiplayer online role-playing games (MMORPG) designated that users are enticed to stay online longer in order to monitor the developing storyline of their online character[181]. Similar to MMORPG, excessive use of social networking sites have also emerged in recent years signifying an increase in mean hours spent online and negative connexions with real-life social interactions[37,182].

The Internet operates on a variable ratio reinforcement schedule (VRRS)[24], suggesting that the combination of the reward system and stimulation from online content appears to be the most significant components in contributing to the addictive nature of online activities. Similar to other addictions, the stimuli from specific online content activates neurotransmitters in the brain, particularly dopamine, which play a major role in reward-motivated behaviours. Abnormalities and dysfunction of dopamine regulation in the prefrontal cortex may underlie the enhanced reinforcement and uncontrolled behaviours in addicted subjects[26,27]. The release of dopamine in the nucleus accumbens have been noted in users utilizing specific online applications[28,29]. This mechanism, in turn, potentiates the positive effects of the respective online activity, thereby reinforcing the behaviour and addictive cycle[30].

On the basis of this theoretical approach, Tsitsika and colleagues[31] argued that certain online activities are more addictive than others. The addictive potential can range from low-risk activities as emailing, watching videos and reading newspapers to high-risk activities as Internet gaming, pornography and social networking. Online activities that encourage users to engage in role-playing, interactive gaming and social exchanges seem to be the most influential in inducing users to stay online longer than anticipated[21].

6.1.3 Mean hours online by gender and Internet user group

Mean hours spent online per day significantly increased from adaptive use to maladaptive use to pathological use (*Study I*). Males tended to spend more hours online than females, which is supported in the literature. Evidence shows that prolonged use of online applications has the proclivity for inducing a displacement effect. This occurs when adolescents begin to displace conventional social and communicative interactions for the virtual world[183,184]. Evidence illustrates that increasing amounts of time spent online displaces important psychosocial factors as physicality[185], proper nutrition[186], face-to-face interactions[44], academic achievements[187], engaging in extra-curricular activities[47] and proper sleeping habits[188]. Adolescents excessively using the Internet are at a high risk for developing negative consequences that disintegrates their quality of life and enhances their risk for social and psychological impairments[189].

6.1.4 PIU and social factors

Findings showed that living in metropolitan areas was significantly associated with both MIU and PIU. The most robust findings from our study, however, concerned household compositions. Adolescents living without a biological parent, low parental involvement and parental unemployment were the most influential factors in determining MIU and PIU (*Study I*). Evidence supports this notion, as studies have shown that health risk-behaviours are known correlates of subsiding familial relationships with regard to school activities, social life, outside activities, supervision and monitoring of the adolescent.

6.1.5 PIU and health risk-behaviours

Prevalence rates of health risk behaviours were considerably high among this European adolescent sample. A significant increase in prevalence rates were observed in pathological users compared to adaptive users. Significant higher trends were noted among pathological users reporting substance use (↑62.0%), sensation-seeking behaviours (↑88.0%) and unhealthy lifestyle characteristics (↑45.0%). Albeit the significant gender differences observed for individual risk-behaviours, multiple risk-behaviours did not significantly vary between genders (*Study IV*). This trend is in contrast to previous research denoting males with significantly higher rates of both multiple risk-behaviours and PIU. In European adolescents, these results strongly indicate that the gender gap for health risk-behaviours and PIU seems to be narrowing.

In the analysis of health risk-behaviours, the highest prevalence among adolescents in both MIU and PIU groups included poor sleeping habits and tobacco use (*Study IV*). Compared to prevalence rates in regions outside the EU, statistics in the Asia and Pacific regions have shown to be considerably lower than those reported in the EU[5]. Apart from the fact that this occurrence is multifaceted, one such probable explanation could be the substantial differences in Internet penetration rates observed at the ecological level. Statistics reported in the Asia and Pacific regions have reported a penetration rate of 36 percent. In the EU, however, penetrate rates were reported to be 78 percent, which is two-fold higher than those observed in Asia and Pacific regions, and ranked as the highest in comparison to all other global regions[5]. The relationship between Internet penetration rates and PIU is still very much obscure, it would be of interest to explore this possible correlation.

In accordance to previous research[190], results showed a strong and significant association between sensation-seeking behaviours and PIU. Sensation-seeking is a personality trait related to deficits in deferred gratification and self-regulation[191]. These qualities in youth are often linked to a perceptual inclination of an 'optimistic bias effect' in which students are more likely to diminish their own risks, while overrating risks of their peers[192]. These deflecting attributes are likely to increase the propensity for adolescents to assimilate PIU and other risk-behaviours. In addition to sensation seeking, there were significant associations observed between substance use and PIU among the adolescent sample (*Study IV*). Substance use is frequently characterized as a risk-behaviour; however, it is also an antecedent of substance abuse. This supports the theory that high-risk behaviours may share analogous underlying mechanisms, wherein the presence of one risk-behaviour may lower the threshold for developing other risk-behaviours.

In the analysis of multiple risk-behaviours, results revealed a significant correlation between multiple risk-behaviours and the YDQ score (*Study IV*). Albeit males conventionally have a higher prevalence of PIU[193] and health risk-behaviours[194], the gender interaction between the YDQ score and health risk-behaviours did not significantly differ. The diminishing gender gap observed between the YDQ score and multiple risk-behaviours are indicative of sociocultural influences. There are essential components within the core of a culture that shapes our morals, decisions, logic and beliefs. These constituents are often internalized and ascertain the subjective reality of individuals[195]. Channelled by socialized dispositions of a specific culture[196], social and behavioural interactions among individuals is relatively

guided by these elements. Based on the widespread cultural dispersion in Europe, the propensity of emergent pathological Internet behaviours is probable to vary between countries.

These outcomes are in line with Jessor's theory on problem behaviour[197]. This psychosocial model aims to explicate behavioural outcomes in adolescents. Based on these psychosocial elements, Jessor developed three conjectural systems comprising behavioural, environmental and personality systems. In the former, Jessor suggests that risk-behavioural constructs tend to cluster, thereby forming a general 'risk-behavioural syndrome'[198]. Based on this model, Jessor explains that these risk-behaviours often derive from adolescents establishing their autonomy and sovereignty from societal and parental influences.

6.1.6 PIU and psychopathology

Prevalence rates of psychopathology were considerably high in the respective adolescent sample. The analysis assessing the proportional change between the prevalence of adaptive use and pathological use showed that rates increased significantly. Among students in the PIU group, significant higher rates were denoted for the prevalence of depression (↑560.0%), anxiety (↑459.0%), conduct problems (↑141.0%), emotional symptoms (↑190.0%), peer relationship problems (↑138.0%), low pro-social behaviours (↑78.0%) and hyperactivity/inattention (↑146.0%) when compared to the AIU group. Similar trends were also observed in students reporting suicidal ideation (↑223.0%), self-injurious behaviours (SIB) (↑450.0%) and suicide attempts (↑200.0%) (*Study III*). Although the prevalence of MIU was significantly higher than those in the AIU group, rates were significantly less than adolescents in the PIU group. This suggests that subthreshold or at-risk individuals could represent a potential target group for early prevention and intervention. Addictive disorders are known to be progressive, thus, detecting and treating individuals at distal stages can potentially prevent the advancement of the respective addiction. This theory coincides with the Grounded Theory (GT) formula[55]. The GT formula stipulates that by identifying at-risk groups (e.g. maladaptive users) and treating them will ultimately provide the opportunity to intervene before the risk progresses into an actual addiction (e.g. pathological users). This model is often referred to as 'staging models' in psychiatry[199] and could serve as a construct for future prevention endeavours.

In the meta-analysis on PIU and psychopathology, 100 percent of the studies meeting the inclusion criteria reported significant associations between PIU and symptoms of ADHD, followed by depression (75%), obsessive-compulsive symptoms (60%) and anxiety (57%). These results are supported by the cross-sectional study assessing the association between PIU and psychopathologies (*Study II*). In the stepwise regression model, results indicated a significant association between PIU and symptoms of depression, anxiety, conduct problems and hyperactivity/inattention. Pathological users often share common physiognomies as interpersonal sensitivity, low self-worth, insecurity and social isolation[200,201], wherein manifestations of psychopathological symptoms of anxiety and depression[202] begin to disclose. Evidence shows that depression precipitates obsessive thoughts of Internet use[52], while dysphoric moods inhibit cognitions that mediate effective self-regulation[203]. In view of operant conditioning, this process induces a vicious cycle in which fosters and exacerbates the online addictive behaviour through continuous reinforcement triggered by the stimuli of online activities[204].

The robust association observed between PIU and symptoms of ADHD is multifaceted. ADHD individuals often lack self-control, which can, in turn, sustain an addiction to the Internet. Evidence also indicates that persons with ADHD suffer from learning disabilities, dyslexia, social and emotional impairments, extreme aggression and externalizing symptoms[205]. There is also a high level of stigmatization associated with ADHD. These could have an interaction effect in the association between PIU and ADHD symptoms.

6.1.7 PIU and suicidality

In the assessment of suicidality, both suicidal ideation and suicide attempts revealed to be the strongest predictors of PIU. The interaction between PIU and suicidality was strongest in Ireland and Estonia and weakest in Italy, Hungary and France (*Study III*). This liaison corresponds with the national suicide

rates and PIU prevalence in these particular countries[193]. Statistics revealed that suicide rates were higher among those aged 15-19 years in Estonia and Ireland compared to adolescents in France, Italy and Hungary[206]. These outcomes conclude that country could be a moderating factor in the association between PIU and suicidality. The moderating role of country could be due to the variability of sociocultural influences. Sociocultural factors as cultural identity, family structure and gender roles are known to affect adolescent behaviours[153,207] and psychological well-being[208]. PIU and related suicidal behaviours detected in adolescents could be a manifestation of the internalized beliefs and values conveyed in their respective country. Research explicitly assessing the moderating role of intercultural influences in the development of PIU and suicidality is still lacking and necessitates further investigations

6.1.8 Preventive strategies for PIU, psychopathology and suicidality

Results showed that individual preventive strategies were effective in reducing the incidence of PIU. Education-based action is a notable mental health promoting strategy for increasing self-awareness, coping skills, autonomy and resiliency. In the respective study, education-based actions proved to be an effective strategy in reducing the onset risk of PIU. Studies show that universal mental health interventions that focus on building cognitive abilities, self-regulation, decision-making skills, social and emotional competence are effective approaches in improving the quality of life among these adolescents. These strategic facets of education-based action are particularly important to counteract the allure of the Internet and online activities. Adolescents with low self-esteem and self-worth can find empowerment through the interactive encounters experienced online, e.g. via social networking, chatting or gaming activities. This can eventually lead to excessive or pathological Internet use and related psychosocial impairments.

Gatekeeper-based action is a derived suicide preventive strategy aimed at reducing the risk of suicidal behaviours among various risk-groups. This type of preventive intervention strategy has gained recognition by the United Nations, and it is well-documented in the scientific literature. This style of training educates specific key persons (e.g. school teachers) on how to firstly identify individuals at high risk for suicidal behaviours (e.g. substance abuse in adolescents) and then refer them to the local healthcare facilities for subsequent treatment. Gatekeeper training, however, is not limited to only suicide prevention; rather, it can be implemented to address mental health issues or even health risk-behaviours. In this study, gatekeeper-based action was significantly effective in reducing the onset risk of PIU, albeit the strategy was dependent on the topic of discussion between teachers and students. The topic of excessive Internet use shared between teachers and students, for example, was most effective in reducing the onset risk of PIU, followed by topics related to mental health issues. These results are crucial, as it shows that gatekeeper-based actions can be tailored made, similar to education- based actions, to target a specific risk-group and develop an effective preventive strategy based on this premise.

It was the combination of education-based and gatekeeper-based actions in schools, however, that proved to be most effective in reducing the onset risk of PIU and psychosocial impairments. Consequently, the strongest effect of mental health action in schools (MHAS) was observed among adolescents with PIU. Outcomes showed that MHAS significantly reduced the onset risk of PIU by half over a 9-month period. In addition, a reduced risk of thirty percent or more was observed for adolescents reporting emotional distress, depression and coping problems over the same time-period. The convergence of evidence-based and gatekeeper-based actions that are implemented within the school milieu are important factors that can be expanded upon for future preventive endeavours in this area of mental health research.

In addition to the efficacy of mental health promoting and prevention strategies, it is important to underscore the significance of the environment when conducting interventions. The environments to which preventive interventions are performed are imperative and considered to be an influential factor in determining the overall success of the respective intervention. Schools are one of the most important settings for promoting mental health among adolescents, as it can pungently influence the

associated risk- and protective-factors of PIU and psychosocial impairments. The school milieu offers a social context that has a substantial effect on reaching adolescents with mental health problems. It imparts a sense of connectedness and social awareness affecting emotional and social competence. This environment also promotes academic importance and the role of education in addressing social and health inequities. Future endeavours in the prevention of PIU and related psychosocial impairments can build upon these effective preventive strategies when developing subsequent interventions aimed at the prevention of PIU and psychosocial impairments among adolescents within the school milieu.

6.1 CHALLENGES FOR FUTURE RESEARCH AND THEORETICAL FRAMEWORKS

The definitions, measurements and diagnostic criteria of PIU are still considerably ambiguous. Despite the latest advancements in PIU research, efforts to understand this phenomenon are impeded by the lack of international consensus on the diagnostic criteria of the condition. It is neither listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM) nor the International Classification of Diseases (ICD) nosological systems. The major challenge facing PIU research is its conception as an addictive disorder.

The large number of conceptual and operational definitions of PIU creates significant challenges and, in some cases, produces barriers for advancing research on this topic. On a very basic level, scholars might question whether these definitions and instruments address the same underlying construct. A cohesive and systematic body of research cannot develop without clear and well-understood conceptual definitions of PIU and effective measures for studying this phenomenon. Inconsistent conceptual definitions and poorly designed measures undermine the cumulative function of research on this important topic. This is most evident with the recent inclusion of IGD in Section III of the DSM-5.

Albeit the addition of IGD in Section III of the DSM nosological system is monumental, there still remains the issue of providing precision and clarity to its definition and diagnostic criteria. It should be underscored that there are major limitations and restrictions to only including IGD in the DSM-5. By limiting the criteria to only addressing Internet gaming, this excludes a substantially large portion of the population who exhibit addictive traits toward other online activities. Interactive activities as social networking, online gambling, pornography, blogging, partaking in chatrooms and instant messaging have also shown to increase the propensity of online addictive behaviours. If IGD were to become an official disorder in the DSM nosological system, this would exclude a significant amount of individuals who are addicted to online activities other than Internet gaming. The inclusion of IGD in Section III of the DSM-5 may trigger the misperception that IGD is the same as PIU and can be considered interchangeable. This is certainly not the case. According to King and Delfabbro[209] and Starcevic[210], PIU and IGD should be considered as two separate conditions.

The future direction of PIU research must begin by establishing universal nomenclature, definitions, taxonomy and diagnostic criteria of PIU. The new structure in the DSM-5 for substance use disorders can be utilized as a model for categorizing behavioural addictions. Substance use disorder is an umbrella category and includes subcategories addressing specific substances, e.g. alcohol use disorder, cocaine use disorder and methamphetamine use disorder. Similar constructs could be employed to PIU, wherein online activities (e.g. Internet gaming, social networking and pornography) would be the distinct subtypes. This would significantly reduce the confusion and misperceptions surrounding PIU and IGD. In order for research to evolve, standardized and sensitive criteria need to be ascertained, whereby clinical diagnoses are developed accurately and distinctively. Based on the large body of research emerging on the topic of PIU, it is strongly recommended to establish these fundamental criteria. This would increase the quality and validity of new findings to which can be utilized to form effective prevention efforts.

6.2 STRENGTH AND WEAKNESS

There are several factors contributing to the strength and novelty of this thesis. One of the most important features is the large, representative, cross-national sample of European adolescents used in

this research. Standardisation and homogeneity of the procedures utilized to collect high-quality data on European adolescents is considered to be a foremost strength of the thesis. Given the representativeness of the study sites, a higher degree of generalizability of the outcomes can be applicable. To our knowledge, this is one of the first research initiatives to assess the effectiveness of specific preventive strategies for PIU and related psychosocial impairments in a representative sample of European adolescents. The longitudinal design in the final study proved to be a key strength of the thesis. It allowed for an evaluation if a potential preventive effect of MHAS on reducing the onset risk of PIU and related psychosocial impairments. The effective prevention strategies identified in this thesis are based on scientific merit and can be built upon in future prevention endeavours of PIU.

There are, however, some limitations of the studies included in the respective thesis. Albeit the cross-sectional studies produced new knowledge on the significant correlates of PIU, it still lacked the prospective study, thus, causality could not be determined. Despite the longitudinal design in the final study, there were some discrepancies of the specific prevention strategies. In terms of education-based action in schools, there is no information on the actual format, content or conceptualization of the intervention itself. This potentially limits the interpretation and replication of these findings. Regarding gatekeeper-based action in schools, there are data on a variety of topics discussed between teachers and students; however, there is no information on the type of training teachers received in order to serve as gatekeepers among their students. Notwithstanding, the respective thesis has produced new knowledge that is novel and applicable for future research on PIU.

7 CONCLUSION

Adolescence is a transitional period characterized by substantial changes in physical, social and psychological attributes. Relationships with peers, family and society undergo distinct changes during this transient period, as adolescents begin to assert autonomy over their emotions, decisions and behaviours. Social skills in adolescents often develop in the course of psychosocial interactions within various learning frameworks. Given the widespread platform for developing interpersonal skills and social cognitions, the Internet has proven to be a new and unique channel for psychosocial development among adolescents. As the Internet provides a wide-range of benefices for its dedicated users, it is also important to recognize the emergence of negative consequences for those using the Internet to an excessive degree.

This thesis sought to improve our understanding of PIU through studying the complex and multifactorial determinants associated with the condition. The results from these studies have demonstrated a relatively elevated PIU prevalence in European adolescents to which had a robust association with household composition and parental involvement (*Study I*). In the systematic review and meta-analysis (*Study II*), a significant association between PIU and psychopathology (i.e. ADHD, depression and anxiety) were observed. These results were then corroborated by the cross-sectional study assessing the relationship between PIU, psychopathology and suicidality (*Study III*). Suicidal ideation and suicide attempts had the strongest correlation with PIU, followed by depression, anxiety, conduct problems and hyperactive/inattention symptoms. A significant liaison between PIU and health risk-behaviours was also observed, namely, sleep disturbances, sensation-seeking behaviours and poor lifestyle choices (*Study IV*).

In the final phase of the thesis, it was critical to identify effective prevention strategies for PIU that can be built upon and are based on scientific merit. Education-based and gatekeeper-based actions are two preventive strategies that significantly reduced the onset risk of PIU. It was the combination of these two prevention approaches, however, that proved to be most effective in reducing the onset risk of PIU, emotional distress, depression and coping problems (*Study V*). Given the momentous proclivity of evidence-based research, it is clear that PIU is a condition that merits international recognition as a potential disorder. Implementing evidence-based mental health interventions appears to be very effective in the overall risk-reduction of PIU. Of course, the level of efficacy, in terms of prevention efforts, is dependent on the structure of the respective intervention. It is, therefore, critical that an international accord is reached in order to develop a standardized approach to ascertain the

nomenclature, taxonomy and diagnostic criteria of PIU. The future direction of PIU research must focus on this fundamental issue in order to legitimize and advance our knowledge and understanding of this condition.

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9 REFERENCES

1. Bremer J. The Internet and Children: Advantages and Disadvantages. *Child and Adolescent Psychiatric Clinics of North America.* 2005;14(3):405-428.
2. Brezing C, Derevensky JL, Potenza MN. Non-substance-addictive behaviours in youth: pathological gambling and problematic Internet use. *Child Adolesc Psychiatr Clin N Am.* 2010;19(3):625-641.
3. Goldstein RZ, Volkow ND. Dysfunction of the prefrontal cortex in addiction: neuroimaging findings and clinical implications. *Nat Rev Neurosci.* 2011;12(11):652-669.
4. Montag C, Kirsch P, Sauer C, Markett S, Reuter M. The role of the CHRNA4 gene in Internet addiction: a case-control study. *Journal of addiction medicine.* 2012;6(3):191-195.
5. International Telecommunication Union (ITU). ICT Statistics. Accessed on October 15, 2015 at: *http://wwwituint/en/ITU-D/Statistics/Pages/defaultaspx*.
6. Shekhawat D, Rathore PS. Internet usage in college: A comparison of users and non users in relation to self-esteem and satisfaction with life. *Indian Journal of Positive Psychology.* 2014;5(2):216.
7. Cole JI, Suman M, Schramm P, Zhou L, Salvador A. *The Digital Future Report. World Internet Project* 2013, pp 181.
8. Eurostat. Statistics database. Accessed on November 6, 2015 at: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/.
9. Young K. Internet Addiction: The Emergence of a New Clinical Disorder. *CyberPsychology & Behaviour.* 1998;1(3):237-244.
10. Heo J, Oh J, Subramanian S, Kim Y, Kawachi I. Addictive internet use among Korean adolescents: a national survey. *PLoS One.* 2014;9(2):e87819.
11. Cao F, Su L. Internet addiction among Chinese adolescents: prevalence and psychological features. *Child Care Health Dev.* 2007;33(3):275-281.
12. Staksrud E, Ólafsson K, Livingstone S. Does the use of social networking sites increase children's risk of harm? *Computers in Human Behaviour.* 2013;29(1):40-50.
13. Livingstone S, Haddon L, Görzig A, Ólafsson K. Risks and safety on the internet: the perspective of European children: key findings from the EU Kids Online survey of 9-16 year olds and their parents in 25 countries. 2010.
14. Lenhart A, Purcell K, Smith A, Zickuhr K. Social Media & Mobile Internet Use among Teens and Young Adults. . *Pew internet & American life project.* 2010.
15. Tsitsika AK, Tzavela EC, Janikian M, et al. Online Social Networking in Adolescence: Patterns of Use in Six European Countries and Links With Psychosocial Functioning. *Journal of Adolescent Health.* 2014;55(1):141-147.
16. Müller KW, Dreier M, Beutel ME, Duven E, Giralt S, Wölfling K. A hidden type of internet addiction? Intense and addictive use of social networking sites in adolescents. *Computers in Human Behaviour.* 2016;55, Part A:172-177.
17. Jacobs GE. Instant Messaging and Texting. 2016.
18. Berle D, Starcevic V, Porter G, Fenech P. Are some video games associated with more life interference and psychopathology than others? Comparing massively multiplayer online role-playing games with other forms of video game. *Australian Journal of Psychology.* 2015;67(2):105-114.
19. Spector JM. *Foundations of educational technology: Integrative approaches and interdisciplinary perspectives.* Routledge; 2015.
20. Kuss DJ, Griffiths MD. Online gaming addiction in children and adolescents: A review of empirical research. *Journal of Behavioural Addictions.* 2012;1(1):3-22.
21. Pontes HM, Szabo A, Griffiths MD. The impact of Internet-based specific activities on the perceptions of Internet addiction, quality of life, and excessive usage: A cross-sectional study. *Addictive Behaviours Reports.* 2015;1:19-25.

22. Sim T, Gentile DA, Bricolo F, Serpelloni G, Gulamoydeen F. A conceptual review of research on the pathological use of computers, video games, and the Internet. *International Journal of Mental Health and Addiction.* 2012;10(5):748-769.
23. Starcevic V. Is Internet addiction a useful concept? *Australian and New Zealand Journal of Psychiatry.* 2013;47(1):16-19.
24. Grecu C. The new generations and the addictions to technology. *European Journal of Science and Theology.* 2013;9(1):99-110.
25. Hou H, Jia S, Hu S, et al. Reduced striatal dopamine transporters in people with internet addiction disorder. *BioMed Research International.* 2012;2012.
26. Zhu Y, Zhang H, Tian M. Molecular and functional imaging of internet addiction. *Biomed Res Int.* 2015;2015:378675.
27. Kim SH, Baik SH, Park CS, Kim SJ, Choi SW, Kim SE. Reduced striatal dopamine D2 receptors in people with Internet addiction. *Neuroreport.* 2011;22(8):407-411.
28. Ko CH, Liu GC, Hsiao S, et al. Brain activities associated with gaming urge of online gaming addiction. *J Psychiatr Res.* 2009;43(7):739-747.
29. Cash H, Rae CD, Steel AH, Winkler A. Internet Addiction: A Brief Summary of Research and Practice. *Current Psychiatry Reviews.* 2012;8(4):292-298.
30. Greenfield D. The addictive properties of Internet usage. *Internet addiction: A handbook and guide to evaluation and treatment.* 2011:135-153.
31. Tsitsika A, Janikian M, Schoenmakers TM, et al. Internet Addictive Behaviour in Adolescence: A Cross-Sectional Study in Seven European Countries. *Cyberpsychology, Behaviour, and Social Networking.* 2014.
32. Hussain Z, Griffiths MD. Excessive use of Massively Multi-Player Online Role-Playing Games: A Pilot Study. *International Journal of Mental Health and Addiction.* 2009;7(4):563-571.
33. Johnson D, Gardner J, Sweetser P. Motivations for videogame play: Predictors of time spent playing. *Computers in Human Behaviour.* 2016;63:805-812.
34. Eichenbaum A, Kattner F, Bradford D, Gentile DA, Green CS. Role-Playing and Real-Time Strategy Games Associated with Greater Probability of Internet Gaming Disorder. *Cyberpsychol Behav Soc Netw.* 2015;18(8):480-485.
35. Metcalf O, Pammer K. Impulsivity and related neuropsychological features in regular and addictive first person shooter gaming. *Cyberpsychol Behav Soc Netw.* 2014;17(3):147-152.
36. Kim SM, Han DH, Lee YS, Renshaw PF. Combined cognitive behavioural therapy and bupropion for the treatment of problematic on-line game play in adolescents with major depressive disorder. *Comput Hum Behav.* 2012;28(5):1954-1959.
37. Meena PS, Mittal PK, Solanki RK. Problematic use of social networking sites among urban school going teenagers. *Ind Psychiatry J.* 2012;21(2):94.
38. Kuss DJ, Griffiths MD. Online social networking and addiction--a review of the psychological literature. *Int J Environ Res Public Health.* 2011;8(9):3528-3552.
39. Sultan AJ. Addiction to mobile text messaging applications is nothing to "lol" about. *The Social Science Journal.* 2014;51(1):57-69.
40. Junco R, Cotten SR. Perceived academic effects of instant messaging use. *Computers & Education.* 2011;56(2):370-378.
41. Murali V, George S. Lost online: an overview of internet addiction. *Advances in Psychiatric Treatment.* 2007;13(1):24-30.
42. Ko CH, Yen JY, Chen CC, Chen SH, Wu K, Yen CF. Tridimensional personality of adolescents with internet addiction and substance use experience. *Can J Psychiatry.* 2006;51(14):887-894.
43. Cabreiro F, Au C, Leung KY, et al. Metformin retards aging in C. elegans by altering microbial folate and methionine metabolism. *Cell.* 2013;153(1):228-239.
44. Nie NH, Hillygus DS, Erbring L. Internet Use, Interpersonal Relations, and Sociability: A Time Diary Study. *The Internet in Everyday Life*: Blackwell Publishers Ltd; 2008:213-243.
45. Choi K, Son H, Park M, et al. Internet overuse and excessive daytime sleepiness in adolescents. *Psychiatry Clin Neurosci.* 2009;63(4):455-462.
46. Grover S, Chakraborty K, Basu D. Pattern of Internet use among professionals in India: Critical look at a surprising survey result. *Ind Psychiatry J.* 2010;19(2):94-100.

47. Nalwa K, Anand AP. Internet addiction in students: a cause of concern. *Cyberpsychol Behav.* 2003;6(6):653-656.
48. Lin MP, Ko HC, Wu JY. Prevalence and psychosocial risk factors associated with internet addiction in a nationally representative sample of college students in Taiwan. *Cyberpsychol Behav Soc Netw.* 2011;14(12):741-746.
49. Lee SJ. Online Communication and Adolescent Social Ties: Who benefits more from Internet use? *Journal of Computer-Mediated Communication.* 2009;14(3):509-531.
50. Dong G, Lu Q, Zhou H, Zhao X. Precursor or sequela: pathological disorders in people with Internet addiction disorder. *PLoS One.* 2011;6(2):e14703.
51. Jorgenson AG, Hsiao RC-J, Yen C-F. Internet Addiction and Other Behavioural Addictions. *Child Adolesc Psychiatr Clin N Am.* 2016;25(3):509-520.
52. Davis RA. A cognitive-behavioural model of pathological Internet use. *Computers in human behaviour.* 2001;17(2):187-195.
53. Wartberg L, Brunner R, Kriston L, et al. Psychopathological factors associated with problematic alcohol and problematic Internet use in a sample of adolescents in Germany. *Psychiatry Res.* 2016;240:272-277.
54. Griffiths M. A'components' model of addiction within a biopsychosocial framework. *Journal of Substance Use.* 2005;10(4):191-197.
55. Dreier M, Tzavela E, Wölfling K, et al. The development of adaptive and maladaptive patterns of Internet use among European adolescents at risk for Internet addictive behaviours: A Grounded theory inquiry. In: Public, ed. National and Kapodistrian University of Athens (N.K.U.A.), Athens: EU NET ADB; 2012:132.
56. Ostovar S, Allahyar N, Aminpoor H, Moafian F, Nor MBM, Griffiths MD. Internet Addiction and its Psychosocial Risks (Depression, Anxiety, Stress and Loneliness) among Iranian Adolescents and Young Adults: A Structural Equation Model in a Cross-Sectional Study. *International Journal of Mental Health and Addiction.* 2016;14(3):257-267.
57. Li C, Dang J, Zhang X, Zhang Q, Guo J. Internet addiction among Chinese adolescents: The effect of parental behaviour and self-control. *Computers in Human Behaviour.* 2014;41:1-7.
58. Ho RC, Zhang MWB, Tsang TY, et al. The association between internet addiction and psychiatric co-morbidity: a meta-analysis. *BMC Psychiatry.* 2014;14:183-183.
59. American Society of Addiction Medicine (ASAM). Accessed on August 2, 2016 at: *http://wwwasamorg/quality-practice/definition-of-addiction*.
60. Shaw M, Black DW. Internet addiction: definition, assessment, epidemiology and clinical management. *CNS Drugs.* 2008;22(5):353-365.
61. Caplan SE, High AC. Online social interaction, psychosocial well-being, and problematic Internet use. *Internet addiction: A handbook and guide to evaluation and treatment.* 2011:35-53.
62. Pontes HM, Kuss D, Griffiths M. Clinical psychology of Internet addiction: a review of its conceptualization, prevalence, neuronal processes, and implications for treatment. *Neuroscience and Neuroeconomics.* 2015;4(11):e23.
63. Li W, O'Brien JE, Snyder SM, Howard MO. Diagnostic Criteria for Problematic Internet Use among U.S. University Students: A Mixed-Methods Evaluation. *PLoS One.* 2016;11(1).
64. Holden C. Psychiatry. Behavioural addictions debut in proposed DSM-V. *Science.* 2010;327(5968):935.
65. Potenza MN, Kosten TR, Rounsaville BJ. Pathological gambling. *Jama.* 2001;286(2):141-144.
66. Blanco C, Moreyra P, Nunes EV, Saiz-Ruiz J, Ibanez A. Pathological gambling: addiction or compulsion? *Semin Clin Neuropsychiatry.* 2001;6(3):167-176.
67. Blanco C, Myers J, Kendler KS. Gambling, disordered gambling and their association with major depression and substance use: a web-based cohort and twin-sibling study. *Psychol Med.* 2012;42(3):497-508.
68. Leeman RF, Potenza MN. A targeted review of the neurobiology and genetics of behavioural addictions: an emerging area of research. *Can J Psychiatry.* 2013;58(5):260-273.
69. Han DH, Bolo N, Daniels MA, Arenella L, Lyoo IK, Renshaw PF. Brain activity and desire for Internet video game play. *Compr Psychiatry.* 2011;52(1):88-95.

70. Sung J, Lee J, Noh HM, Park YS, Ahn EJ. Associations between the Risk of Internet Addiction and Problem Behaviours among Korean Adolescents. *Korean J Fam Med.* 2013;34(2):115-122.
71. Koo HJ, Kwon J-H. Risk and Protective Factors of Internet Addiction: A Meta-Analysis of Empirical Studies in Korea. *Yonsei Med J.* 2014;55(6):1691-1711.
72. Lee YS, Han DH, Kim SM, Renshaw PF. Substance abuse precedes internet addiction. *Addict Behav.* 2013;38(4):2022-2025.
73. Petry NM. Should the scope of addictive behaviours be broadened to include pathological gambling? *Addiction.* 2006;101 Suppl 1:152-160.
74. Nalpas B, Yguel J, Fleury B, Martin S, Jarraud D, Craplet M. Pathological gambling in treatment-seeking alcoholics: a national survey in France. *Alcohol Alcohol.* 2011;46(2):156-160.
75. Hasin DS, O'Brien CP, Auriacombe M, et al. DSM-5 Criteria for Substance Use Disorders: Recommendations and Rationale. *Am J Psychiatry.* 2013;170(8):834-851.
76. Hodgins DC, Currie SR, Currie G, Fick GH. Randomised trial of brief motivational treatments for pathological gamblers: More is not necessarily better. *J Consult Clin Psychol.* 2009;77(5):950-960.
77. Phillips JG, Ogeil RP, Blaszczynski A. Electronic interests and behaviours associated with gambling problems. *International Journal of Mental Health and Addiction.* 2012;10(4):585-596.
78. Martin RJ, Usdan S, Cremeens J, Vail-Smith K. Disordered gambling and co-morbidity of psychiatric disorders among college students: An examination of problem drinking, anxiety and depression. *Journal of Gambling Studies.* 2014;30(2):321-333.
79. Pietrzak RH, Morasco BJ, Blanco C, Grant BF, Petry NM. Gambling level and psychiatric and medical disorders in older adults: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *The American journal of geriatric psychiatry.* 2007;15(4):301-313.
80. Retz W, Ringling J, Retz-Junginger P, Vogelgesang M, Rösler M. Association of attention-deficit/hyperactivity disorder with gambling disorder. *J Neural Transm.* 2016:1-7.
81. Studer J, Baggio S, Mohler-Kuo M, Simon O, Daeppen J-B, Gmel G. Latent Class Analysis of Gambling Activities in a Sample of Young Swiss Men: Association with Gambling Problems, Substance Use Outcomes, Personality Traits and Coping Strategies. *Journal of Gambling Studies.* 2016;32(2):421-440.
82. Ko CH, Yen JY, Yen CF, Chen CS, Chen CC. The association between Internet addiction and psychiatric disorder: A review of the literature. *European Psychiatry.* 2012;27(1):1-8.
83. Yau YHC, Pilver CE, Steinberg MA, et al. Relationships between problematic Internet use and problem-gambling severity: Findings from a high-school survey. *Addict Behav.* 2014;39(1):13-21.
84. Petry NM, O'Brien CP. Internet gaming disorder and the DSM-5. *Addiction.* 2013.
85. King DL, Delfabbro PH. The Cognitive Psychopathology of Internet Gaming Disorder in Adolescence. *J Abnorm Child Psychol.* 2016;44(8):1635-1645.
86. AJ VANR, Kuss DJ, Griffiths MD, Shorter GW, Schoenmakers MT, D VDM. The (co-)occurrence of problematic video gaming, substance use, and psychosocial problems in adolescents. *J Behav Addict.* 2014;3(3):157-165.
87. Grant JE, Schreiber LR, Odlaug BL. Phenomenology and treatment of behavioural addictions. *Can J Psychiatry.* 2013;58(5):252-259.
88. Weinstein A, Feder LC, Rosenberg KP, Dannon P. Internet addiction disorder: overview and controversies. *Behavioural addictions Criteria, evidence, and treatment.* 2014:99-118.
89. Bernardi S, Pallanti S. Internet addiction: a descriptive clinical study focusing on comorbidities and dissociative symptoms. *Compr Psychiatry.* 2009;50(6):510-516.
90. Weinstein A, Lejoyeux M. Internet addiction or excessive internet use. *Am J Drug Alcohol Abuse.* 2010;36(5):277-283.
91. Young KS. Internet Addiction: the emergence of a new clinical disorder. Poster presentation at the annual meeting of the American Psychological Association; 1996; Toronto, Canada.
92. Beard KW. Internet addiction: a review of current assessment techniques and potential assessment questions. *Cyberpsychol Behav.* 2005;8(1):7-14.
93. Young KS. Psychology of computer use: XL. Addictive use of the Internet: a case that breaks the stereotype. *Psychol Rep.* 1996;79(3 Pt 1):899-902.

94. Alavi SS, Jannatifard F, Eslami M, Rezapour H. Survey on validity and reliability of diagnostic questionnaire of internet addiction disorder in students users. *Zahedan Journal of Medical Sciences.*13(7):34-38.
95. Boysan M, Kuss DJ, Barut Y, Aykose N, Gulec M, Ozdemir O. Psychometric properties of the Turkish version of the Internet Addiction Test (IAT). *Addict Behav.* 2015.
96. Li Y, Zhong B, Liu X, Zhang Y, Zhu J, Hao W. Reliability and validity of the Chinese version of self-rating Young's diagnostic questionnaire of internet addiction: a preliminary study. *Zhongguo Yao Wu Yi Lai Xing Za Zhi.* 2012;21(5):390-394.
97. Siomos KE, Dafouli ED, Braimiotis DA, Mouzas OD, Angelopoulos NV. Internet addiction among Greek adolescent students. *Cyberpsychol Behav.* 2008;11(6):653-657.
98. Young KS. *Caught in the net: How to recognize the signs of internet addiction--and a winning strategy for recovery.* John Wiley & Sons; 1998.
99. Tsimtsiou Z, Haidich AB, Kokkali S, Dardavesis T, Young KS, Arvanitidou M. Greek version of the Internet Addiction Test: a validation study. *Psychiatr Q.* 2014;85(2):187-195.
100. Young K. Assessment of Internet addiction. *The Center for Internet Addiction Recovery Retrieved April.* 2008;12:2012.
101. Widyanto L, McMurran M. The psychometric properties of the internet addiction test. *Cyberpsychol Behav.* 2004;7(4):443-450.
102. Jelenchick LA, Becker T, Moreno MA. Assessing the psychometric properties of the Internet Addiction Test (IAT) in US college students. *Psychiatry Res.* 2012;196(2-3):296-301.
103. Khazaal Y, Billieux J, Thorens G, et al. French validation of the internet addiction test. *Cyberpsychol Behav.* 2008;11(6):703-706.
104. Nichols LA, Nicki R. Development of a psychometrically sound internet addiction scale: a preliminary step. *Psychol Addict Behav.* 2004;18(4):381-384.
105. Laconi S, Rodgers RF, Chabrol H. The measurement of Internet addiction: A critical review of existing scales and their psychometric properties. *Computers in Human Behaviour.* 2014;41:190-202.
106. Caplan SE. Problematic Internet use and psychosocial well-being: development of a theory-based cognitive–behavioural measurement instrument. *Computers in human behaviour.* 2002;18(5):553-575.
107. Freedland A. *The Mediating Effects of Problematic Internet Usage on Social Phobia and Psychosocial Well-being*, Thesis for a Master's Degree, University of Florida; 2012, pp 1-61.
108. Meerkerk GJ, Van Den Eijnden RJ, Vermulst AA, Garretsen HF. The Compulsive Internet Use Scale (CIUS): some psychometric properties. *Cyberpsychol Behav.* 2009;12(1):1-6.
109. Guertler D, Rumpf HJ, Bischof A, et al. Assessment of problematic internet use by the Compulsive Internet Use Scale and the Internet Addiction Test: a sample of problematic and pathological gamblers. *Eur Addict Res.* 2014;20(2):75-81.
110. Davis RA, Flett GL, Besser A. Validation of a new scale for measuring problematic internet use: implications for pre-employment screening. *Cyberpsychol Behav.* 2002;5(4):331-345.
111. Caplan SE. Theory and measurement of generalized problematic Internet use: A two-step approach. *Computers in Human Behaviour.* 2010;26(5):1089-1097.
112. Barke A, Nyenhuis N, Kroner-Herwig B. The German version of the Generalized Pathological Internet Use Scale 2: a validation study. *Cyberpsychol Behav Soc Netw.* 2014;17(7):474-482.
113. Demetrovics Z, Szeredi B, Rozsa S. The three-factor model of Internet addiction: the development of the Problematic Internet Use Questionnaire. *Behav Res Methods.* 2008;40(2):563-574.
114. Lesieur HR, Blume SB. The South Oaks Gambling Screen (SOGS): a new instrument for the identification of pathological gamblers. *Am J Psychiatry.* 1987;144(9):1184-1188.
115. Koronczai B, Urban R, Kokonyei G, et al. Confirmation of the Three-Factor Model of Problematic Internet Use on Off-Line Adolescent and Adult Samples. *Cyberpsychol Behav Soc Netw.* 2011.
116. Chen S, Weng L, Su Y, Wu H, Yang P. Development of Chinese Internet addiction scale and its psychometric study. *Chin J Psychol* 2003;45(3):279-294.

117. Ko CH, Yen JY, Yen CF, Chen CC, Yen CN, Chen SH. Screening for Internet addiction: an empirical study on cut-off points for the Chen Internet Addiction Scale. *Kaohsiung J Med Sci.* 2005;21(12):545-551.
118. Ceyhan E, Ceyhan AA, Gurcan A. The validity and reliability of the Problematic Internet Usage Scale. *Kuram Ve Uygulamada Egitim Bilimleri.* 2007;7(1):387-416.
119. Rial Boubeta A, Gomez Salgado P, Isorna Folgar M, Araujo Gallego M, Varela Mallou J. PIUS-a: Problematic Internet Use Scale in adolescents. Development and psychometric validation. *Adicciones.* 2015;27(1):47-63.
120. Cicchetti DV. The precision of reliability and validity estimates re-visited: distinguishing between clinical and statistical significance of sample size requirements. *J Clin Exp Neuropsychol.* 2001;23(5):695-700.
121. Nunnally JC, Bernstein IH, Berge JMt. *Psychometric theory.* Vol 226: JSTOR; 1967.
122. Schmitt DB. *Advances in Accounting Behavioural Research.* Vol 16: Emerald Group Publishing; 2013.
123. Suhr D, Shay M. Guidelines for reliability, confirmatory and exploratory factor analysis. Paper presented at: Proc. 2009 Western Users of SAS Conf. San Jose, CA2009.
124. LaRose R, Eastin MS. A social cognitive theory of Internet uses and gratifications: Toward a new model of media attendance. *Journal of Broadcasting & Electronic Media.* 2004;48(3):358-377.
125. LaRose R, Mastro D, Eastin MS. Understanding internet usage - A social-cognitive approach to uses and gratifications. *Social Science Computer Review.* 2001;19(4):395-413.
126. Kuss DJ, Shorter GW, van Rooij AJ, Griffiths MD, Schoenmakers TM. Assessing Internet Addiction Using the Parsimonious Internet Addiction Components Model—A Preliminary Study. *International Journal of Mental Health and Addiction.* 2013:1-16.
127. Brezing C, Derevensky JL, Potenza MN. Non-substance-addictive behaviours in youth: pathological gambling and problematic Internet use. *Child Adolesc Psychiatr Clin N Am.* 2010;19(3):625-641.
128. Goldstein RZ, Volkow ND. Dysfunction of the prefrontal cortex in addiction: neuroimaging findings and clinical implications. *Nature Reviews Neuroscience.* 2011;12(11):652-669.
129. Montag C, Kirsch P, Sauer C, Markett S, Reuter M. The role of the CHRNA4 gene in Internet addiction: a case-control study. *J Addict Med.* 2012;6(3):191-195.
130. Kormas G, Critselis E, Janikian M, Kafetzis D, Tsitsika A. Risk factors and psychosocial characteristics of potential problematic and problematic internet use among adolescents: a cross-sectional study. *BMC public health.* 2011;11:595.
131. Zhou Y, Lin FC, Du YS, et al. Gray matter abnormalities in Internet addiction: a voxel-based morphometry study. *Eur J Radiol.* 2011;79(1):92-95.
132. Grant JE, Potenza MN, Weinstein A, Gorelick DA. Introduction to behavioural addictions. *The American journal of drug and alcohol abuse.* 2010;36(5):233-241.
133. Liu M, Luo J. Relationship between peripheral blood dopamine level and internet addiction disorder in adolescents: a pilot study. *International journal of clinical and experimental medicine.* 2015;8(6):9943-9948.
134. Vink JM, Beijsterveldt TC, Huppertz C, Bartels M, Boomsma DI. Heritability of compulsive Internet use in adolescents. *Addiction biology.* 2015.
135. Kim J, LaRose R, Peng W. Loneliness as the Cause and the Effect of Problematic Internet Use: The Relationship between Internet Use and Psychological Well-Being. *Cyberpsychology & Behaviour.* 2009;12(4):451-455.
136. Ayas T, Horzum M. Relation between depression, loneliness, self-esteem and internet addiction. *Education.* 2013;133(3):283-290.
137. Müller KW, Koch A, Dickenhorst U, Beutel ME, Duven E, Wölfling K. Addressing the question of disorder-specific risk factors of internet addiction: a comparison of personality traits in patients with addictive behaviours and comorbid internet addiction. *BioMed research international.* 2013;2013.
138. Kuss DJ, Shorter GW, Van Rooij AJ, van de Mheen D, Griffiths MD. The Internet addiction components model and personality: establishing construct validity via a nomological network. *Computers in human behaviour.* 2014;39:312-321.

139. Yen J-Y, Yen C-F, Chen C-C, Chen S-H, Ko C-H. Family factors of internet addiction and substance use experience in Taiwanese adolescents. *CyberPsychology & Behaviour.* 2007;10(3):323-329.
140. Wu CST, Wong HT, Yu KF, et al. Parenting approaches, family functionality, and internet addiction among Hong Kong adolescents. *BMC Pediatr.* 2016;16(1):130.
141. Ko CH, Wang PW, Liu TL, Yen CF, Chen CS, Yen JY. Bidirectional associations between family factors and Internet addiction among adolescents in a prospective investigation. *Psychiatry Clin Neurosci.* 2015;69(4):192-200.
142. Floros G, Siomos K, Dafouli E, Fisoun V, Geroukalis D. Influence of parental attitudes towards internet use on the employment of online safety measures at home. *Studies in health technology and informatics.* 2012;181:64-70.
143. Yen CF, Ko CH, Yen JY, Chang YP, Cheng CP. Multi-dimensional discriminative factors for Internet addiction among adolescents regarding gender and age. *Psychiatry Clin Neurosci.* 2009;63(3):357-364.
144. Mei S, Yau YHC, Chai J, Guo J, Potenza MN. Problematic Internet use, well-being, self-esteem and self-control: Data from a high-school survey in China. *Addictive Behaviours.* 2016;61:74-79.
145. Li Y, Zhang X, Lu F, Zhang Q, Wang Y. Internet Addiction Among Elementary and Middle School Students in China: A Nationally Representative Sample Study. *Cyberpsychology, Behaviour, and Social Networking.* 2014;17(2):111-116.
146. Wang L, Luo J, Bai Y, et al. Internet addiction of adolescents in China: Prevalence, predictors, and association with well-being. *Addiction Research & Theory.* 2013;21(1):62-69.
147. Guo J, Chen L, Wang X, et al. The relationship between Internet addiction and depression among migrant children and left-behind children in China. *Cyberpsychology, Behaviour, and Social Networking.* 2012;15(11):585-590.
148. Gong J, Chen X, Zeng J, Li F, Zhou D, Wang Z. Adolescent addictive Internet use and drug abuse in Wuhan, China. *Addiction Research & Theory.* 2009;17(3):291-305.
149. Huang R, Lu Z, Liu J, et al. Features and predictors of problematic internet use in Chinese college students. *Behaviour & Information Technology.* 2009;28(5):485-490.
150. Lin CH, Lin SL, Wu CP. The effects of parental monitoring and leisure boredom on adolescents' Internet addiction. *Adolescence.* 2009;44(176):993-1004.
151. Yang SC, Tung C-J. Comparison of Internet addicts and non-addicts in Taiwanese high school. *Computers in Human Behaviour.* 2007;23(1):79-96.
152. Chou C, Hsiao M-C. Internet addiction, usage, gratification, and pleasure experience: the Taiwan college students' case. *Computers & Education.* 2000;35(1):65-80.
153. Siomos K, Floros G, Fisoun V, et al. Evolution of Internet addiction in Greek adolescent students over a two-year period: the impact of parental bonding. *Eur Child Adolesc Psychiatry.* 2012;21(4):211-219.
154. Fisoun V, Floros G, Siomos K, Geroukalis D, Navridis K. Internet addiction as an important predictor in early detection of adolescent drug use experience—implications for research and practice. *Journal of addiction medicine.* 2012;6(1):77-84.
155. Bakken IJ, Wenzel HG, Gotestam KG, Johansson A, Oren A. Internet addiction among Norwegian adults: a stratified probability sample study. *Scand J Psychol.* 2009;50(2):121-127.
156. Johansson A, Gotestam KG. Internet addiction: characteristics of a questionnaire and prevalence in Norwegian youth (12-18 years). *Scand J Psychol.* 2004;45(3):223-229.
157. Thomas NJ, Martin FH. Video-arcade game, computer game and Internet activities of Australian students: Participation habits and prevalence of addiction. *Australian Journal of Psychology.* 2010;62(2):59-66.
158. Parkash V, Basu D, Grover S. Internet addiction: Do two diagnostic criteria measure the same thing? *Indian Journal of Social Psychiatry.* 2015;31(1):47.
159. Kheirkhah F, Gouran A. Internet Addiction, Prevalence and Epidemiological Fea-tures in Mazandaran Province, Northern Iran. *Iran Red Crescent Med J.* 2010;2010(2):133-137.
160. Ac-Nikolic E, Zaric D, Niciforovic-Surkovic O. Prevalence of Internet Addiction among Schoolchildren in Novi Sad. *Srp Arh Celok Lek.* 2015;143(11-12):719-725.
161. Beard KW, Wolf EM. Modification in the proposed diagnostic criteria for Internet addiction. *Cyberpsychol Behav.* 2001;4(3):377-383.

162. Ho RC, Zhang MW, Tsang TY, et al. The association between internet addiction and psychiatric co-morbidity: a meta-analysis. *BMC Psychiatry.* 2014;14(1):183.
163. Ha JH, Kim SY, Bae SC, et al. Depression and Internet addiction in adolescents. *Psychopathology.* 2007;40(6):424-430.
164. Scimeca G, Bruno A, Cava L, Pandolfo G, Muscatello MRA, Zoccali R. The Relationship between Alexithymia, Anxiety, Depression, and Internet Addiction Severity in a Sample of Italian High School Students. *The Scientific World Journal.* 2014;2014:504376.
165. Yen JY, Yen CF, Chen CS, Tang TC, Ko CH. The association between adult ADHD symptoms and internet addiction among college students: the gender difference. *Cyberpsychol Behav.* 2009;12(2):187-191.
166. Park S, Hong KE, Park EJ, Ha KS, Yoo HJ. The association between problematic internet use and depression, suicidal ideation and bipolar disorder symptoms in Korean adolescents. *The Australian and New Zealand journal of psychiatry.* 2012.
167. Lin IH, Ko CH, Chang YP, et al. The association between suicidality and Internet addiction and activities in Taiwanese adolescents. *Compr Psychiatry.* 2014;55(3):504-510.
168. Moreno MA, Jelenchick L, Cox E, Young H, Christakis DA. Problematic internet use among US youth: a systematic review. *Arch Pediatr Adolesc Med.* 2011;165(9):797-805.
169. Carli V, Durkee T, Wasserman D, et al. The association between pathological internet use and comorbid psychopathology: a systematic review. *Psychopathology.* 2013;46(1):1-13.
170. Wasserman D, Carli V, Wasserman C, et al. Saving and empowering young lives in Europe (SEYLE): a randomised controlled trial. *BMC public health.* 2010;10:192.
171. Carli V, Wasserman C, Wasserman D, et al. The saving and empowering young lives in Europe (SEYLE) randomised controlled trial (RCT): methodological issues and participant characteristics. *BMC public health.* 2013;13:479.
172. Beck A, Steer R, Brown G. Beck Depression Inventory II: manual. In: Assessments DLP, ed. USA1996.
173. Zung WW. A rating instrument for anxiety disorders. *Psychosomatics.* 1971;12(6):371-379.
174. Becker A. Strengths and Difficulties Questionnaire (SDQ). 2008.
175. WHO. Global School-Based Student Health Survey. 2010.
176. Gratz KL. Measurement of deliberate self-harm: Preliminary data on the Deliberate Self-Harm Inventory. *Journal of psychopathology and behavioural assessment.* 2001;23(4):253-263.
177. Paykel E, Myers J, Lindenthal J, Tanner J. Suicidal feelings in the general population: a prevalence study. *The British Journal of Psychiatry.* 1974;124(582):460-469.
178. Sasmaz T, Oner S, Kurt AO, et al. Prevalence and risk factors of Internet addiction in high school students. *Eur J Public Health.* 2014;24(1):15-20.
179. Shek DT, Yu L. Internet addiction phenomenon in early adolescents in Hong Kong. *Thescientificworldjournal.* 2012;2012:104304.
180. Caron J, Fleury MJ, Perreault M, et al. Prevalence of psychological distress and mental disorders, and use of mental health services in the epidemiological catchment area of Montreal South-West. *BMC Psychiatry.* 2012;12(1):183.
181. Charlton JP, Danforth ID. Distinguishing addiction and high engagement in the context of online game playing. *Computers in Human Behaviour.* 2007;23(3):1531-1548.
182. Kuss DJ, Griffiths MD. Online social networking and addiction—a review of the psychological literature. *Int J Environ Res Public Health.* 2011;8(9):3528-3552.
183. Kraut R, Patterson M, Lundmark V, Kiesler S, Mukopadhyay T, Scherlis W. Internet paradox. A social technology that reduces social involvement and psychological well-being? *Am Psychol.* 1998;53(9):1017-1031.
184. Kraut R, Kiesler S, Boneva B, Cummings J, Helgeson V, Crawford A. Internet paradox revisited. *Journal of social issues.* 2002;58(1):49-74.
185. Peltzer K, Pengpid S, Apidechkul T. Heavy Internet use and its associations with health risk and health-promoting behaviours among Thai university students. *Int J Adolesc Med Health.* 2014;26(2):187-194.
186. Gür K, Yurt S, Bulduk S, Atagöz S. Internet addiction and physical and psychosocial behaviour problems among rural secondary school students. *Nurs Health Sci.* 2015:n/a-n/a.

187. Akhter N. Relationship between Internet Addiction and Academic Performance among University Undergraduates. *Educational Research and Reviews.* 2013;8(19):1793.
188. Punamaki RL, Wallenius M, Nygard CH, Saarni L, Rimpela A. Use of information and communication technology (ICT) and perceived health in adolescence: the role of sleeping habits and waking-time tiredness. *J Adolesc.* 2007;30(4):569-585.
189. Straker L, Pollock C, Maslen B. Principles for the wise use of computers by children. *Ergonomics.* 2009;52(11):1386-1401.
190. Cao F, Su L, Liu T, Gao X. The relationship between impulsivity and Internet addiction in a sample of Chinese adolescents. *European Psychiatry.* 2007;22(7):466-471.
191. Slater MD. Alienation, Aggression, and Sensation Seeking as Predictors of Adolescent Use of Violent Film, Computer, and Website Content. *Journal of Communication.* 2003;53(1):105-121.
192. Kim HK, Davis KE. Toward a comprehensive theory of problematic Internet use: Evaluating the role of self-esteem, anxiety, flow, and the self-rated importance of Internet activities. *Computers in Human Behaviour.* 2009;25(2):490-500.
193. Durkee T, Kaess M, Carli V, et al. Prevalence of pathological internet use among adolescents in Europe: demographic and social factors. *Addiction.* 2012;107(12):2210-2222.
194. Eaton DK, Kann L, Kinchen S, et al. Youth risk behaviour surveillance - United States, 2009. *MMWR Surveill Summ.* 2010;59(5):1-142.
195. Ekwutosi OC, Moses OS. Internalization of Organizational Culture: A Theoretical Perspective.
196. Baligh HH. Components of culture: nature, interconnections, and relevance to the decisions on the organization structure. *Management Science.* 1994;40(1):14-27.
197. Jessor R. Problem-Behaviour Theory, Psychosocial Development, and Adolescent Problem Drinking. *Br J Addict.* 1987;82(4):331-342.
198. Jessor R. Risk behaviour in adolescence: a psychosocial framework for understanding and action. *J Adolesc Health.* 1991;12(8):597-605.
199. McGorry PD, Hickie IB, Yung AR, Pantelis C, Jackson HJ. Clinical staging of psychiatric disorders: a heuristic framework for choosing earlier, safer and more effective interventions. *Aust N Z J Psychiatry.* 2006;40(8):616-622.
200. Perren S, Alsaker FD. Social behaviour and peer relationships of victims, bully-victims, and bullies in kindergarten. *Journal of Child Psychology and Psychiatry.* 2006;47(1):45-57.
201. Veenstra R, Lindenberg S, Oldehinkel AJ, De Winter AF, Verhulst FC, Ormel J. Bullying and victimization in elementary schools: a comparison of bullies, victims, bully/victims, and uninvolved preadolescents. *Dev Psychol.* 2005;41(4):672.
202. Kowalski RM, Limber SP. Psychological, physical, and academic correlates of cyberbullying and traditional bullying. *Journal of Adolescent Health.* 2013;53(1):S13-S20.
203. LaRose R, Lin CA, Eastin MS. Unregulated Internet usage: Addiction, habit, or deficient self-regulation? *Media Psychology.* 2003;5(3):225-253.
204. Thorens G, Wullschleger A, Khan R, Achab S, Zullino DF. What is Addictive in Internet? *Open Addiction Journal.* 2012;5(1):14-19.
205. O'Malley G, McHugh L, Mac Giollabhui N, Bramham J. Characterizing adult attention-deficit/hyperactivity-disorder and comorbid borderline personality disorder: ADHD symptoms, psychopathology, cognitive functioning and psychosocial factors. *European Psychiatry.* 2016;31:29-36.
206. Eurostat. Causes of death. Accessed on March 25, 2016 at: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/.
207. McElhaney KB, Allen JP. Sociocultural perspectives on adolescent autonomy. *Adolescence and beyond: Family processes and development.* 2012:161-176.
208. Lopez SR, Guarnaccia PJ. Cultural psychopathology: uncovering the social world of mental illness. *Annual review of psychology.* 2000;51:571-598.
209. King DL, Delfabbro PH. Video-gaming disorder and the DSM-5: some further thoughts. *Australian and New Zealand Journal of Psychiatry.* 2013;47(9):875-876.
210. Starcevic V. Video-gaming disorder and behavioural addictions. *The Australian and New Zealand journal of psychiatry.* 2013;47(3):285-286.