PROBLEMATIC GAMING BEHAVIOR AMONG ADOLESCENTS AND YOUNG ADULTS

RELATIONSHIP BETWEEN GAMING BEHAVIOR AND HEALTH

Niko Männikkö
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Relationship between gaming behavior and health

Academic dissertation to be presented with the assent of the Doctoral Training Committee of Health and Biosciences of the University of Oulu for public defence in Auditorium F202 of the Faculty of Medicine (Aapistie 5 B), on 13 October 2017, at 12 noon

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**Abstract**

The aim of the study was to describe and explain the problematic gaming behavior and the relationship between the digital gaming behavior (gaming time, medium, genres and motives), health (psychological, social and physical) and problematic gaming behavior among young people aged from 13 to 24 years. Information received can be used for developing practices to identify individuals with problematic gaming behavior, promote their lifestyle change and subsequently to increase knowledge of the nature of the condition within healthcare education. In this study, digital games means electronic games that can be played through console, computer, network and mobile devices.

In the first sub-study, a systematic literature review with synthesis from previous empirical studies (n = 50) about the health outcomes related to problematic gaming behavior was conducted. In the second sub-study, cross-sectional and national survey design with a randomly selected sample (N = 3 000) was used to identify problematic gaming behavior and to examine its associations with the digital gaming behavior (gaming time, genres and motives) and health (psychological, social and physical) among Finnish adolescents and young adults (n = 293). In the third sub-study, a descriptive, regional cross-sectional study was conducted to examine adolescents’ (n = 560) digital gaming behavior and its relationship to problematic gaming behavior symptoms. The data from empirical studies two and three were collected by using an internet-based survey. Statistical methods were used to analyse the data.

The findings of the systematic review and empirical study showed that problematic gaming behavior was especially related to adverse psychosocial health outcomes, namely, anxiety, depression and a preference for online social interaction. Problematic gaming behavior was also linked to the use of a cluster of games-characterized features of role playing, action, progression and strategy. Moreover, the gaming motives, such as entertainment achievement, social and escapism, correlated significantly to problematic gaming behavior. Among the sample of adolescents, the blended family structure might predict problematic gaming behavior symptoms. The study significantly added understanding of gaming and health characteristics in the role of problematic gaming behavior among young people. The findings may help to advance in the areas of screening and counselling for PGB.

**Keywords:** addictive behavior, adolescents, digital games, health, internet gaming disorder, prevalence, young adults
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**Tiivistelmä**
Tutkimuksen tarkoituksena oli kuvata ja selittää 13–24-vuotiaiden nuorten ongelmallisen digipelaamiskäyttäytymisen yhteyksiä psyykkiseen, sosiaaliseen ja fyysiseen terveyteen. Tutkimuksen tavoitteena oli tuottaa uutta tietoa ongelmallisesta digipelaamisesta, helpottaa ilmiön tunnistamista ja edistää terveyskasvatusta. Digipeleillä tarkoitetaan tässä tutkimuksessa tietokone-, konso-, verkko- ja mobiililaitteilla pelattavia pelejä.

Ensimmäisessä osatutkimuksessa arvioitiin ja tiivistettiin systemaattisen kirjallisuuskatsauksen avulla tämän hetkinen tutkimustieto (n = 50) ongelmallisen digipelaamisen ja terveyden välisistä yhteyksistä. Toisessa osatutkimuksessa tutkittiin osittain satunnaisotantana (N = 3 000) kerätyn aineiston avulla suomalaisten nuorten (n = 293) digipelaamista, ongelmallisen digipelaamisen esiintyvyyttä sekä ongelmallisen digipelaamisen yhteyksiä nuorten pelaamiskäyttäytymiseen ja terveyteen. Kolmannessa osatutkimuksessa kuvattiin alueellisen poikkileikkaustutkimuksen avulla nuorten (n = 560) digipelaamiskäyttäytymistä ja sen yhteyksiä ongelmalliseen digipelaamiseen. Empiriisten osatutkimusten aineisto kerättiin verkkopohjaisen kyselyn avulla, ja saatu aineisto analysoitiin tilastollisilla menetelmillä.


Tutkimus lisäsi tietoperustaa nuorten ongelmallisesta digipelaamisesta, pelaamiskäyttäytymisestä ja terveysomaisuuksien merkityksestä. Tuloksia voidaan hyödyntää ongelmallisen digipelaamisen selvonnan ja ilmiöön liittyvän ohjauksen kehittämisessä.

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addiktivinen käyttäytyminen, esiintyvyys, nuoret, nuoret aikuiset, ongelmapelaaminen, terveys
To my family
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with whom I had the chance to work together during my research work. I am also grateful to Dr. Zsolt Demetrovics for his advice and contribution during the last article of this work. I wish to acknowledge Louise Morgan for performing the English language proofreading of this dissertation. In addition, the help of Outi Ervasti in editing the Finnish abstract is gratefully acknowledged. I would also like to extend my gratitude to Mari Pajula A-Clinic Foundation and Inka Silvennoinen Finnish Association for Substance Abuse Prevention for their cooperation and positive support. Throughout this dissertation work period, many people from University of Oulu and Oulu University of Applied Sciences have supported my efforts. It has been privilege to work with them.

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Oulu, 24th of August 2017

Niko Männikkö
Abbreviations

ADD Attention deficit disorder
ADHD Attention deficit hyperactivity disorder
AICA-S Assessment of Internet and Computer game Addiction scale
APA American Psychiatric Association
BMI Body Mass Index
CBT Cognitive-Behavioral Therapy
CET Cognitive evaluation theory
CI Confidence interval
CRD Centre for Reviews and Dissemination
DSM-V Diagnostic and Statistical Manual of Mental Disorders, 5th edition
ESA Entertainment Software Association
FPS First-Person Shooter
GAS Gaming Addiction Scale for Adolescents
IA Internet Addiction
ICD-10 International Classification of Diseases
ICT Information and Communication Technology
IGD Internet Gaming Disorder
ISFE Interactive Software Federation of Europe
JBI Joanna Briggs Institute
MMOFPS Massively Multiplayer Online First Person Shooters
MMOG Massively Multiplayer Online Games
MMORPG Massively Multiplayer Online Role-Playing Games
MMORTS Massively Multiplayer Online Real-Time Strategy Games
MOBA Multiplayer Online Battle Arena
MOG Multiplayer Online Games
MUD Multiuser Dungeons
OCD Obsessive-Compulsive Disorder
PC Personal Computer
PCA Principal component analysis
PGB Problematic Gaming Behavior
POGQ Problematic Online Gaming Questionnaire
PVP Problem Videogame Playing
RPG Role-playing game
RSA Respiratory Sinus Arrhythmia
SC Galvanic Skin Conductance
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<td>SDT</td>
<td>Self-determination theory</td>
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<tr>
<td>SHP</td>
<td>The School Health Promotion</td>
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<td>SWLS</td>
<td>Satisfaction With Life Scale</td>
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<tr>
<td>YIAT</td>
<td>Young Internet Addiction Test</td>
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<tr>
<td>VIF</td>
<td>Variance Inflation Factor</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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List of original publications

This thesis is based on the following publications, which are referred to throughout the text by their Roman numerals:


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1 Introduction

Over the last decade digital games have become a highly popular leisure activity among adolescents and adults. Development of technology and the internet have contributed to digital games’ functionality, allowing players to use them easily on a variety platforms. Complex, realistic and social features of digital games have increased and many of them have the option of being played as interactive persistent online virtual worlds (for example, World of Warcraft) or competitive team-based strategy (for example, StarCraft) with other players (Kuss & Griffiths 2012, Adams 2014). Gaming mediums cover consoles, portable hand-held screens, mobile phones, tablets and personal computers.

According to the latest reports, digital game-playing is a highly prevalent activity among young people worldwide. The data from Interactive Software Federation of Europe (ISFE 2012) has shown that 25% of the European online population aged from 16 to 64 years have played digital games at least once per week. According to this data, digital gaming is also increasingly prevalent among both genders, with 45% of gamers being female. The average age of the gamer is 35 years. Networked games have become a larger part of everyday life, with an average 81% of European players playing games online. The data from Finland (ISFE 2012) has revealed that 60% of the online population aged from 16 to 64 years have played digital games in past 12 months. Further, according to this data, online is the most popular form of gaming; 79% of gamers play games online in Finland. This study has also revealed that 25% of respondents have played games weekly, and laptops and computers are the most used devices for gaming. ISFE’s report has also noted that, among gamers, 86% have a high interest in using the internet. The proportional number of gamers is equally distributed across age and gender. Gaming is perceived as entertaining to 58% of gamers (ISFE 2012).

Digital game-playing is not only used for entertainment purposes, research has also paid significant attention to advantages of digital game-playing in learning and training. These, known as educational or serious games, have been utilized for a variety of purposes, and they have provided encouraging outcomes in terms of perceptual, behavioral, affective, motivational and cognitive functions (Connolly et al. 2012). Research has also noted potentials or advantages of digital game-playing on areas such as socialization (for example, encouraged cooperation), cognition (for example, improved problem solving), and emotion (for example, improved mood and promote relaxation) (Granic et al. 2014). Some review reports have also shown that digital games provide a useful tool for promoting health, for
example, mental health (Lau et al. 2017), childhood obesity (Lu et al. 2013) and physical health in the elderly (Larsen et al. 2013).

Adolescents mostly play digital games for entertainment purposes. Even if digital game-playing is a major and enjoyable recreation activity, growing evidence suggests that some players have experienced problems in controlling their gaming behavior, which has further led to negative consequences (Young 2009, Rehbein et al. 2010, Kuss et al. 2014, Kuss & Billieux 2017). Digital gaming may become a preference, act as a compensation habit of activity or a motivation that they do not obtain in real life (Wan & Chiou 2006). The length of time they engage in gaming directly affects their self-concept, i.e., the longer the duration spent on the game, the lower the self-concept (Lee et al. 2012), and the higher the likelihood of gaming addiction (Haagsma et al. 2012b). This can negatively impact on daily living, with signs or symptoms such as concern with the accumulated gaming, social omission, dishonesty about gaming behavior, deficit of inclination in alternative recreational activities, social and psychological withdrawal, escape responses, defensive and anger reactions (Young 2009), as well as social and psychological stress, diminished school achievement, sleep problems and suicidal thoughts (Rehbein et al. 2010).

The first studies of problematic gaming habits and their addictive potential were published in the 1980s and 1990s (Soper & Miller 1983, Shotton 1991, Griffiths 1996). Increased research in the area has led to Internet Gaming Disorder (IGD) being included for the Appendix of the American Psychiatric Association’s (APA) Diagnostic and Statistical Manual V (2013) as a condition requiring more examination. There is also consideration about inclusion of this potential disorder in the 11th revision of the International Classification of Diseases (ICD-10) (Grant et al. 2014).

Based on the incompleteness of IGD and a lack of a formal definition of the phenomenon, a term Problematic Gaming Behavior (PGB) is used throughout this study, referring to the situation where individuals experience addictive features or symptoms mainly relating to their gaming behavior with an inability to reduce or stop this behavior despite its adverse life effects.

Although PGB has shown to be related to the co-occurrence of a variety of health problems, in Finland the existence of PGB and its associations with health and health-related behavior are still largely unexplored. In addition, in the field there is still uncertainty about possible negative health implications due to mixed effect sizes and significances yielded across the studies (Kuss & Griffiths 2012, King et al. 2013), and thus literature on the topic in terms of prevention and
treatment methods is scarce. A better understanding of the connections and consequences of PGB can be helpful in a variety of health educational domains.

With a view of the aforementioned facts, there is a justification to examine the emerging gaming behavior lifestyle and what this will mean for individuals’ health characteristics. The aim of the study is to describe and explain PGB and the relationship between digital gaming behavior (gaming time, mediums, genres and motives), health (psychological, social and physical) and PGB among adolescents and young adults. This study focus on adolescents (aged 13–17 years) and young adults (aged 18–24 years) because they have shown to be most populous groups of gamers in Finland (Mäyrä et al. 2016) and further, these young people in their psychological and physical development age period are very susceptible to behavioral risk factors (Schwartz et al. 2015). The results of this study can be utilized for developing health promotion practices (for example, counselling) and for facilitating further research and education in the field of healthcare and nursing science. This is the first comprehensive study that examines PGB in Finland and thus this gives an insight into the existence and nature of the problem in the country.
2 Problematic gaming behavior and health in adolescents and young adults

2.1 Adolescents’ and young adults’ health

Adolescence is a development phase ranging from the ages of 10 to 19 years, when youth go through psychological, social, physical and neurobiological alterations (Fatusi & Hindin 2010, UNICEF 2016). Emerging adulthood has typically been considered the years of 18 until 25 (Arnett 2015). During this development period, most of the body and mind changes have already happened, but identity is still maturing (Arnett 2015).

Health is a multidimensional concept. The most well-known definition of health is the World Health Organization’s (WHO) description where health is a state of complete physical, social and mental well-being (WHO 1946). Later, definition of health has been expanded to include the social and cultural issues surrounding the concept. Within this context, health has been seen as “a resource of everyday life in which emphasizes social and personal resources as well as physical capabilities” (WHO 1986). In turn, well-being or positive mental health are able to be seen in the context of “including elements of emotional (affect/feeling), psychological (positive functioning), social (relationship with others), physical and spiritual (sense of meaning and purpose in life)” (Barry & Friedli 2008).

Many factors affect the health of youths, including, for instance, home and school conditions, social relationships between friends and parents, physical activity, mental strain and stress levels (Kuntsche & Ravens-Sieberer 2015). In addition, adolescents and young adults engage in risky behaviors, such as substance use and high engagement to digital gaming that, in turn, may cause them to become more susceptible to short-term and long-term health problems (Raphael 2013, Schwartz et al. 2015). In terms of digital gaming, several neurobiological studies have shown structural and functional brain alterations among young people in response to high consumption of digital gaming (Kühn et al. 2011, Meng et al. 2015) although full maturity of the brain will not be reached until the late 20s (Giedd et al. 1999).

To reduce adverse health risks, special attention could be paid to behavioral (for example, adequate physical activity and nutrition), emotional or psychological (for example, positive mental health) and societal (for example, good relationships with peers and families) determinants (Denny et al. 2011). In this study, by
reproducing these aforementioned definitions, health-related outcomes can be conceptualized as a comprehensive functional state whereby psychological, social and physical aspects are in harmony within the individual.

2.2 Digital gaming behavior

This study refers to many conceptual terms, mostly drawn from the theory, but also the forming of the research. Key concepts of digital gaming behavior are explained in Table 1. A digital game is an electronic and dynamic system, “a state machine” (Juul 2005, Adams & Dormans 2012) that reacts to the players’ activity. Digital games also include elements such as moving images, vibrant colors, sophisticated graphics and sound stimulus (Adams & Dormans 2012, Adams 2014). Game play refers to the interaction occurring between the player and the game in a pretended reality (Landay 2014). Digital gaming is based on rules, challenges, player performances and dynamics in which players try to achieve a goal or several goals by executing quests and beating opponents (Adams & Dormans 2012, Adams 2014). Digital games can be played through consoles, portable hand-held screens, mobile phones, tablets and personal computers (Salen & Zimmerman 2004).

Digital games can be divided into offline and online forms (for example, Griffiths et al. 2012, Adams 2014). Offline games refer to the games that don’t incorporate real-time online functionality and multiplayer gaming through the internet. Online games enable players to play, communicate and create common strategies with each other through the internet or online in the real-time settings (Kuss 2013, Adams 2014). Offline games are mostly played alone or with two or more people at the same screen (Adams 2014). They also have a clear start and ending point and in-game tasks and challenges can be completed by the players themselves. Internet connection allow the game developers to add new features (new virtual spaces, functions and other structural characteristics) repeatedly that keep the players’ interested. Most of the players spend more time with online than offline games; players typically prefer to play more online games (Prato et al. 2010).

Massively Multiplayer Online Games (MMOGs) refers a category of the most complex online games where hundreds or thousands of players may simultaneously participate in the same virtual environment (Barnett & Coulson 2010). Multiplayer Online Games (MOGs) is a simpler version of this world where a limited number of players are present at any given moment. MMOG can be categorized into three main groups: Massively Multiplayer Online Role-Playing Games (MMORPGs), Massively Multiplayer Online First Person Shooters (MMOFPSs) and Massively
Multiplayer Online Real-Time Strategy games (MMORTSs) (Rice 2006). There are other kinds of online games that typically interest fewer users, such as on Facebook, racing, sport and music games (Nagygyörgy et al. 2013). Both offline and online digital games can be applied categories of first person shooters, role playing games and real-time strategy. Also, recently, a very popular game type named Multiplayer Online Battle Arena (MOBA) includes the structural features of real-time strategy and role playing games (Grubb 2015).

People play digital games for many reasons. Motivation can include external and intrinsic aspects (Deci & Ryan 1985, 1991). External motivation can mean purposful activity to gain external or material reward, whereas with intrinsic motivation the situation or activity itself is rewarding (Deci & Ryan 1985, 1991). With digital gaming behavior, intrinsic motivation can be seen as “the drive to play digital games that produces to the gamer the emotion of fulfillment” (Sin et al. 2014). Early studies of gaming motivations have revealed such intrinsic motivations as fantasy, challenge and curiosity (Malone 1981). Later, Hainey et al. (2011) considered that a challenge may be one of the strongest motivations for playing digital games. More recently, Sin et al. (2014) listed in their findings motivation factors that can influence why young people persistently play digital games including, for instance, game content and type, challenge and entertainment.

Over the last two decades digital games, like other technology-based activities (i.e., social media websites, chat rooms and virtual reality environments), have become a crucial as a leisure time activity among adolescents and young adults (Ofcom 2015). An official game website (MobyGames.com) has listed more than 114 000 different games. In addition, there are about 202 platforms. New digital gaming genres or types (for example, puzzle, simulation, strategy, shooter, sports) and mediums (for example, consoles, computers, mobile devices other hand-held screens), and sophisticated technologies have recently evolved and are now easily available. Recently mobile games and applications have shown strong growth (Deloitte 2014, Mäyrä et al. 2016). In this study video game-playing or digital game-playing refers to the games that are played through personal computers, consoles, mobile phones or tablets.

Digital games are predominantly designed to appeal to children and adolescents. A recent report by EU Kids Online (2014) has revealed that online gaming among children and adolescents aged between 9 and 16 years in seven European countries has significantly increased from 16% in 2010 to 28% in 2014. Digital game-playing is also on the increase in the USA. According to the latest reported by the Entertainment Software Association (ESA 2016), 63% of
households in the USA have at least one person who plays video games regularly while 65% of USA households now own a device used to play video games (ESA 2016). In Finland, around 60% of the population aged between 10 and 75 years play digital games at least monthly (Mäyrä et al. 2016). This data has also indicated that mobile gaming has increased popularity, 37.2% play mobile games actively (i.e., at least monthly) (Mäyrä et al. 2016). Most-often-played video games were puzzle games in all age groups, whereas adventure games were most popular among players aged below 30 years (Mäyrä et al. 2016). The most frequently-used gaming devices were mobile phones (37.2%), personal computers (32.4%) and game consoles (22%) (Mäyrä et al. 2016). The average age of digital players was 38 years, and their mean weekly gaming time was 5.6 hours (Mäyrä et al. 2016).

Table 1. Key concepts of digital gaming behavior. The term digital gaming behavior in this study refers to gaming activity or this kind of way of life itself in terms of how and why people play these games. It includes also players’ intrinsic (for example, motives) and extrinsic (for example, game genres) factors that can affect and drive people’s continued game play habit.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Source</th>
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<tr>
<td>A digital game</td>
<td>An electronic and dynamic system, “a state of machine” that reacts according to the players’ actions.</td>
<td>Juul 2005</td>
</tr>
<tr>
<td>Game play</td>
<td>The interaction occurring between the player and the game in a pretended reality. It includes elements of player performances and game mechanics.</td>
<td>Landay 2014</td>
</tr>
<tr>
<td>Gaming medium or platform</td>
<td>In this study the term gaming medium refers to different “computer platforms” that digital games appear on, such as personal computers, game consoles, hand-held game devices and games for tablets and mobile phones.</td>
<td>Salen &amp; Zimmerman 2004</td>
</tr>
<tr>
<td>Game genre</td>
<td>Digital games are classified into genres based on the style of game play and certain set of challenges irrespective of game-world content. Games can include factors of more than one genre.</td>
<td>Adams 2014</td>
</tr>
<tr>
<td>Offline game</td>
<td>Game types where game play does not require an internet connection. It refers to a particular pattern of gameplay</td>
<td>Adams 2014</td>
</tr>
<tr>
<td>Online game</td>
<td>Game types that are played through a network, especially the internet, which allows players to communicate, cooperate and compete with other players. “Online gaming is technology rather than a genre”.</td>
<td>Adams 2014</td>
</tr>
<tr>
<td>Motives for game play</td>
<td>A reason or reasons for playing digital games. It includes external (reward) and intrinsic (purposefulness) aspects.</td>
<td>Deci &amp; Ryan 1985, 1991</td>
</tr>
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</table>
2.3 PGB among adolescents and young adults

2.3.1 Conceptualization and assessment of PGB

Scientific findings have indicated that some digital game players experience dysfunctional, dependency-like features that share similarities with traditional addictive behaviors (Griffiths 2000, Grüsser *et al.* 2007, Kuss *et al.* 2014). In these extreme situations high engagement for video games may lead to cognitive behavioral symptoms, such as increased tolerance, withdrawal, relapse, salience, conflict and mood modification, which are considered to be core components of behavioral addiction (Griffiths 2005). Early-stage empirical research on the negative outcomes of digital gaming theoretically based on phenomenon in the framework of impulse-control disorder or behavioral addiction (Grüsser & Thalemann 2006, Király *et al.* 2015), and the criteria from the pathological gambling or substance dependence or generalized internet addiction, were used in parallel by researchers to define and assess the negative outcomes of digital gaming (Kuss & Griffiths 2012, King *et al.* 2013, Pontes & Griffiths 2014, Kuss *et al.* 2016). These criteria approaches have mainly been used by researchers and clinicians because it was considered that the means to ascertain whether behavioral addictions were comparable to traditional addiction was to scrutinize them against clinical criteria for other certified drug-ingested addictions (Griffiths 1996, 1998, 1999, Pontes & Griffiths 2014). Most of the previous research relied on inconsistent and non-standardized theoretical frameworks to define problematic gaming (King *et al.* 2013).

Among existent tests of PGB, the Gaming Addiction Scale for Adolescents (GAS) has been widely utilized and tested in Europe (for example, Mentzoni *et al.* 2011, Haagsma *et al.* 2012b). According to a comprehensive review that examined the criteria of 18 PGB instruments, GAS and Young Internet Addiction Test (YIAT) provided the most appropriate properties for clinical purposes (King *et al.* 2013). Moreover, based on the diagnostic components of this review, most of the assessment tools included features such as withdrawal, loss of control and conflict related to the interpersonal relationships, work or school responsibility (King *et al.* 2013). It is also considered that the severity of PGB may vary along a continuum from a mild to harmful condition (Griffiths *et al.* 2015b), and to date no valid cutoffs or criteria constructs exist to distinguish high involvement from problematic involvement for digital game-playing (Charlton & Danforth 2007, Kuss & Griffiths 2011).
IGD has been incorporated in the Diagnostic and Statistical Manual of Mental Disorders (5th edition; DSM-5) by the American Psychiatric Association (APA 2013) as a potential disorder that warrants more research (Petry & O’Brien 2013). According to this statement, IGD refers to a behavioral pattern with regards to both online and offline game-playing (even if the name of the criteria is misleading), causing significant impairment or distress over a 12-month period. This latest DSM-5 instruction of IGD encompasses in total nine criteria, where IGD may be indicated when a person encompasses persistent and recurrent activities with five or more out of the nine following criteria: (1) preoccupation with games; (2) withdrawal symptoms when gaming is taken away; (3) increased tolerance, resulting in the need to spend higher duration engaged in games; (4) unsuccessful attempts to control participation in games; (5) loss of interest in previous hobbies and entertainment as a result of, and with the exception of, games; (6) continued excessive use of games despite knowledge of psychosocial problems; (7) deceiving family members, counselors, or others concerning the duration of gaming; (8) use of games to escape or relieve negative moods; and (9) endangering or risking a meaningful relationship, job, or education or career change because of participation in games (APA 2013).

IGD criteria based on the theoretical approach refers to online gaming as a sub-type of internet activities. Some scholars have developed an integrative model where they have taken into account both the problem behavior itself and special features of online games as a type of PGB criteria (Kim & Kim 2010, Demetrovics et al. 2012). Demetrovics et al. (2012) created a model that supported a view that all types of online games need to be incorporated in PGB criteria (named Problematic Online Gaming Questionnaire (POGQ)) to make distinctions possible between different digital games and players. Their model included six problematic online gaming components: preoccupation, overuse, immersion, social isolation, interpersonal conflicts and withdrawal. The model of POGQ with its components outlined by Demetrovics et al. (2012) is very much like the criteria for IGD in the DSM-5.

Following emergence of IGD criteria, Petry et al. (2014) published a debate paper where they provided an initiative definition of a common tool for assessing IGD according to the latest outline, and they further argued about explanation behind components of IGD criteria in the DSM-5. Petry et al. (2014) also critiqued that these presented diagnostic criteria based on earlier study samples that used diagnostic criteria of internet addiction (IA) (Tao et al. 2010). This debate paper fostered further critical discussion. Recently, Petry et al.’s findings have been
questioned by leading researchers in the field and it has been showed that there is not a consensus reached about official disorder status and criteria of the phenomenon (Griffiths et al. 2015b). Because of conceptual ambiguity and discrepancies around the IGD as a bona fide addiction, the term problematic gaming behavior (PGB) was adapted throughout the present study.

Figure 1 provides an overview of the main theoretical approaches of PGB. PGB has been viewed as an independent condition that reflects common behavioral addiction characteristics (Griffiths 2005). Alternatively, internet has been considered the main platform that connects various, distinct, problematic online activities (for example, online games, gambling, shopping) (for example, van Rooij et al. 2011). Consequently, problematic online gaming has been seen as a specific form of PGB, as part of internet addiction, or as a separate condition. There are also approaches that have integrated these theoretical views (for example, Demetrovics et al. 2012). In this study, PGB has been considered an independent condition that can include both online and offline gaming characteristics.

Fig. 1. Conceptual approaches of PGB.
2.3.2 Prevalence of PGB

The prevalence of PGB has been reported to be between 1.2% and 8.5% among digital game players (Griffiths et al. 2012, Griffiths et al. 2016). The majority of the national representative studies of PGB prevalences have targeted adolescents; some surveys have been conducted on the samples encompassing both adolescents and adults using a variety assessment tools (Table 2). It is remarkable that although a notable number of adolescents is highly exposed to gaming behavior, a relatively low number experiences harm or detrimental consequences comparable to PGB. Some of the most recent studies that examined the prevalence of the condition have adapted the assessment tool based on the latest theoretical criteria of IGD (for example, Pontes et al. 2014, Lemmens et al. 2015, Pontes & Griffiths 2015a, Rehbein et al. 2015, van Rooij et al. 2015, Király et al. 2016). The variety in prevalence assessments may be partly due to discrepancies in classification and measurement of PGB (King et al. 2013, Petry et al. 2014). The populations studied were often not representative (for example, self-selected samples) (Pontes & Griffiths 2015b) and the studies varied a lot in terms of sample size, participants age range and participant type (i.e., general population vs. gamers) (Griffiths et al. 2015a). Despite availability statistics about game-playing in Europe and Finland (ISFE 2012, Mäyrä et al. 2016), relatively little is known about PGB and its related propensities in Finland. Therefore, it is important to gain more knowledge of the existence of PGB in Finland.

Table 2. Studies of prevalence of PGB.

<table>
<thead>
<tr>
<th>Country, scale title</th>
<th>Sample (size, age [age range/mean, M])</th>
<th>Prevalence</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany, WHO ICD-10</td>
<td>7 069 (M = 21.1)</td>
<td>11.9% of the participants classified as addicted</td>
<td>Grüsser et al. 2007</td>
</tr>
<tr>
<td>Netherlands: Game Addiction Scale</td>
<td>644 (12–18 years)</td>
<td>Approximately 2% fulfilled diagnostic criteria of addiction</td>
<td>Lemmens et al. 2009</td>
</tr>
<tr>
<td></td>
<td>573 (12–18 years)</td>
<td>9% classified as problematic game use</td>
<td></td>
</tr>
<tr>
<td>Germany, Video Game Dependency Scale</td>
<td>10 060 (M = 15.3)</td>
<td>2.8% dependent on video games</td>
<td>Rehbein et al. 2010</td>
</tr>
<tr>
<td>Singapore: Pathological video-gaming (adapted criteria for Pathological Gambling)</td>
<td>2 998 (M = 11.2)</td>
<td>8.7% were classified as pathological players</td>
<td>Choo et al. 2010</td>
</tr>
<tr>
<td>Country, scale title</td>
<td>Sample (size, age [age range/mean, M])</td>
<td>Prevalence</td>
<td>Reference</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Norway: Gaming Addiction Scale</td>
<td>816 (16–40)</td>
<td>0.6% classified as addicted, 4.1% classified as problematic video game use</td>
<td>Mentzoni et al. 2011</td>
</tr>
<tr>
<td>USA: Problem Videogame Playing (PVP) Scale</td>
<td>2 885 (M = 40.4)</td>
<td>1.6% were classified as problematic video game use according to the PVP scale</td>
<td>Ream et al. 2011</td>
</tr>
<tr>
<td>Netherlands: Compulsive Internet Use Scale and Gaming Frequency</td>
<td>4 074 (13–16 years)</td>
<td>3% online gamers fulfill criteria of addiction</td>
<td>Van Rooij et al. 2011</td>
</tr>
<tr>
<td>Hungary: the 12-item Problematic Online Gaming Questionnaire Short-Form (POGQ-SF)</td>
<td>4 875 (M = 16.4)</td>
<td>Rate of problematic gamers was 4.3%</td>
<td>Király et al. 2014a</td>
</tr>
<tr>
<td>From 57 different countries. Internet Gaming Disorder test (IGD-20)</td>
<td>1 003 (M = 26)</td>
<td>5.3% of the gamers were classified as disordered gamers</td>
<td>Pontes et al. 2014</td>
</tr>
<tr>
<td>Netherlands: IGD (a long 27-item and short 9-item version). Seven European countries: The Scale for the Assessment of Internet and Computer game Addiction—Gaming Module (AICA-S-gaming)</td>
<td>2 444 (13–40 years)</td>
<td>Prevalence of IGD was 5.4% (adults), 5.5% among adolescents aged 13–20 IGD prevalence rate was 1.6%</td>
<td>Lemmens et al. 2015</td>
</tr>
<tr>
<td>Germany: Video Game Dependency Scale, DSM-5 adapted version (criteria of IGD)</td>
<td>12 938 (14–17 years)</td>
<td>1.16% were classified IGD according to DSM-5 recommendations</td>
<td>Rehbein et al. 2015</td>
</tr>
<tr>
<td>Norway: The 7-item version of the Game Addiction Scale for Adolescents (GAS)</td>
<td>11 003 (13–18 years)</td>
<td>Prevalence of addicted gamers was 1.4%</td>
<td>Wittek et al. 2015</td>
</tr>
<tr>
<td>Country, scale title</td>
<td>Sample (size, age [age range/mean, M])</td>
<td>Prevalence</td>
<td>Reference</td>
</tr>
<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>Hungary: 10-item Internet Gaming Disorder Test (IGDT-10)</td>
<td>4 487 (14–64 years)</td>
<td>IGD prevalence rate was 2.9%.</td>
<td>Király et al. 2016</td>
</tr>
<tr>
<td>Portugal: IGD, short form (IGDS9-SF)</td>
<td>509 (10–18 years)</td>
<td>IGD players 5.3%.</td>
<td>Pontes &amp; Griffiths 2016</td>
</tr>
</tbody>
</table>

**2.3.3 Self-awareness of PGB**

Although extreme engagement in digital games is not necessarily to be associated with the harmful outcomes, and thus has to be discriminated from detrimental or problematic behavior (Charlton & Danforth 2007), it seems that some gamers have difficulties in recognizing themselves when their engagement in video games becomes problematic (King et al. 2009). However, to date, there are scarcely any studies that have sought whether excessively or detrimentally played gamers recognise or admit the problematic nature of their gaming habit. An exception is a study by Haagsma et al. (2012b), which showed that only 16.7% of excessive gamers were aware of their problematic behavior. Another study by Oggins and Sammis (2012) examined World of Warcraft players’ own notions about behaviors they considered characteristics of PGB. The authors of this study also examined the interrelations of players’ self-reports of being addicted to games and participants’ PGB scores. According to this study, players considered addiction characteristics to include such things as excessive playing time and its feature to disturb other activities (for example, socializing or work). Further, data from this study showed that 44% of the players considered themselves addicted (i.e., a single item question) to video games but only 6% endorsed being at increased risk on PGB according to the test scores.

It is still an open question as to why some players have difficulty admitting their PGB. Accordingly, it is worth conducting studies that further explore the association between PGB and self-awareness of problematic gaming. The term self-awareness of PGB in this study refers to the digital game players’ self-perception when considering the problematic nature of their game-playing, consumption of game-playing and need of external help because of their playing behavior.
2.4 PGB and its associations with digital gaming behavior

2.4.1 PGB and gaming motives

Even though experienced fun is one generally acknowledged essential reason to play digital games (Przybylski et al. 2010), more clarified understanding of motives that thrive for problematic behavior still requires studying. Indeed, with digital gaming behavior, only a few players may achieve any external rewards by playing. Instead, the attraction of this activity is based on attributes of the experiences possible to get from pursuing this behavior.

In research of players’ motivations theory principles have been applied, such as self-determination theory (SDT; Ryan et al. 2006) and its sub theory, cognitive evaluation theory (CET; Przybylski et al. 2010). This research based on SDT predicts that players’ motivations are concerned with digital gaming contexts that satisfies their psychological human needs (Ryan et al. 2006). CET-based research proposes that players’ intrinsic motivation, such autonomy (sense of volition or control), competence (sense of capability to achieve desired outcomes) and relatedness (need to feel social connectedness) are relevant to explain the engagement with digital games (Przybylski et al. 2010). These theory approaches consider continued digital game-playing as a purpose of use in relation to psychological needs that digital gaming behavior possibly measures up to.

In a fundamental work regarding player differences in game preferences and motivations, Richard Bartle defined a theory that Multi-User Dungeon (MUD) players could be divided into four main types: killers, achievers, explorers and socialisers (Bartle 1996). Later a study by Nick Yee (2006) reported that an individual’s motivations for playing MMORPGs have a notable influence on real online gaming adhesion. Yee categorized this model into three main types of motives: achievement, social activity and immersion in a virtual environment. Each category included specific subcomponents (for example, immersion can be divided into subcomponents of role-playing, exploration or escapism). This study indicated that achievement and escapism motives were predictors of problematic online game use. The validity of Yee’s model of players’ motives has recently been verified in the framework of a study that evidenced through longitudinal avatar monitoring meaningful relationships between self-reported motives and actual in-game behaviors (Billieux et al. 2013). Another study by Billieux et al. (2014) reported that motives for playing MMORPG are a significant function of problematic online gaming.
To date, research has reported associations between specific motivations for playing and the number of hours played per week and problematic use of online games (Yee 2006, Kuss & Griffiths 2012). Other recent studies have shown connections between PGB and game motives such as escapism (Billieux et al. 2011, Hellström et al. 2012, Billieux et al. 2015,) and immersion (Kneer & Glock 2013, Billieux et al. 2015, Kneer & Rieger 2015). Consequently, a study by Kneer & Riegel (2015) found that immersion was the only motive that significantly predicted PGB and, controversially, social interaction and achievement were not significantly related to the risk of PGB. On the whole, existing studies showed that achievement and escapism are the best predictors of PGB. The exact relationship between different gaming motives and PGB has not been reached, especially now as the gaming-behavior-related technological features matures.

2.4.2 PGB and gaming genres

Certain types of games are more likely to be associated with problematic game behaviors than others. Among the meagre existing data, a study by Elliott et al. (2012) showed that gamers who exhibited PGB symptoms preferred game genres such as first-person shooter (FPS), action adventure, role playing and online gambling (i.e., simulations of Poker, Black Jack and slot machine gambling). It has been highlighted that online gaming more likely relates to the continuous problematic engagement than offline gaming (for example, Király et al. 2014b).

Among existing games, MMORPGs are the ones for which evidence has linked strongly to problematic use (for example, Kuss et al. 2012b). In these games there can be hundreds or even thousands of gamers playing concurrently. In MMORPGs, both collaborative (Players versus Environment (PVE)) and competitive (Players versus Players (PVP)) activities can be performed (Achterbosch et al. 2008). The addictive qualities of MMORPGs appear to relate to its socializing, anonymous and reinforcing features, as well as the consideration that the games exist in perpetual virtual worlds (worlds that exist even when the player is not connected) and they encompass an advancement component, i.e., the player creates an avatar that is continuously evolving (Cole & Griffiths 2007, Kuss & Griffiths 2012). These described features have been suggested as structural characteristics adding to the problematic nature of this specific type of video game (for example, King et al. 2010, Billieux et al. 2014).

A recently published study revealed that gaming versatility (for example, a greater number of video game genres played) can be seen as one of the behavior-
predicting features associated with PGB (Donati et al. 2015). However, the recognition of a sub-class of game types with certain game characteristics and reward features related to the problematic game behavior are still somewhat open for further scientific debate (Elliott et al. 2012, Rehbein & Mößle 2013, Donati et al. 2015).

2.5 PGB and health-related outcomes

2.5.1 PGB and psychosocial health

Psychosocial symptoms related to PGB typically overlap, therefore, these are discussed together in this section. Studies have indicated that PGB is negatively linked to psychological and social features, including low self-efficacy (Jeong & Kim 2011, Festl et al. 2013), low self-esteem (Caplan 2007, Walther et al. 2012, Billieux et al. 2015), increased anxiety (Caplan 2007, Wenzel et al. 2009, Wei et al. 2012), impulsivity traits (Gentile et al. 2011, Billieux et al. 2015), decreased offline social support (Kaczmarek & Drążkowski 2014), reduced decision-making ability (Pawlikowski & Brand 2011), greater attentional bias (Jeromin et al. 2016), lower psychosocial wellbeing (Lemmens et al. 2011), decreased happiness (Hull et al. 2013) and greater levels of depression (Li et al. 2011, Wei et al. 2012).

PGB can also contribute to the occurrence of loneliness along with social self-efficacy problems (Walther et al. 2012). In addition, players with PGB have displayed signs or symptoms such as social omission, deficit of interest in other recreational hobbies, social and psychological withdrawal (Young 2009, Jeong & Kim 2011), escape problems (Young 2009, Billieux et al. 2015), aggressive behavior or thoughts (Anderson 2004, Anderson et al. 2010, Rehbein et al. 2010, Walther et al. 2012), low sociability and satisfaction with life (Festl et al. 2013).

In some cases, PGB may have acted as a control mechanism for imperfections or problems in the player’s life, such as a shortage of friends, relationship troubles or dissatisfaction with physical looks (Griffiths & Beranuy 2009). Furthermore, PGB is indicated by symptoms that may have evolved as a result of other disorders, such as depression, anxiety and social phobia (Gentile et al. 2011) but it is not clear whether PGB is a discrete problem or symptom of these underlying comorbidities (Pies 2009).
2.5.2 PGB and physical health

It has been suggested that adolescents who spend an accumulated amount of time on computer activities, such as game-playing, may experience difficulties with absorption of health-related determinants, such as life appreciation, health responsibility, social support and exercise behavior (Chen et al. 2008). Adolescents engaging in an increasing amount of time in sedentary pursuits (for example, watching television, working at a desk, playing digital games, etc.) are more likely to experience an effect on their psychosocial health as well as reducing the time available for being physically active and thus to be at risk of lifestyle diseases (Tremblay et al. 2010, Carson et al. 2016). Consequently, a connection has been found between excessive digital game play and sedentary behavior among children and adolescents (Tremblay et al. 2010, Carson et al. 2016). Some authors have suggested that the prevalence of sedentary behaviors increases through adolescence (Hardy et al. 2007, Biddle et al. 2010).

Prolonged exposure to digital games or PGB has been shown to be associated with physical health problems, such as musculoskeletal symptoms (Lui et al. 2011), increased occurrence of sleeping problems (Dworak et al. 2007, Achab et al. 2011, Lam 2014) and obesity (Vandewater et al. 2004). Furthermore, a study by Ballard et al. (2009) indicated that the length of time spent playing online video games is negatively associated with physical activity. Similarly, a previous study by Ma and Jones (2003) found an association between computer use with wrist and forearm failure risk in both genders. A study by Turel et al. (2016) found that PGB was associated with shorter sleep and further, in turn, to poorer cardiometabolic health, namely, higher blood pressure, low high-density lipoprotein cholesterol, high triglycerides and high insulin resistance (Turel et al. 2016). It is important to note that excessive gaming/PGB is not consistently linked to many of the physical health outcomes (i.e., physical activity or fitness, cardiovascular disease risk factors and body composition, Carson et al. 2016).

2.6 Summary of the literature

Figure 2 depicts the central theoretical concepts and their interrelations with the present study. Digital game-playing may impact the players in many ways – either positive or negative – depending upon the personal tendencies and motives of the players, their life situation, preferred game genres and the allocated time used for
this activity (Kuss 2013). Consequently, PGB and health outcomes are combined as the main theoretical framework of the study.

This study focuses on adolescents and young adults and special attention is paid to these individuals’ digital gaming behavior, including gaming preferences, game-related structural and motivation characteristics and adverse health outcomes. Specifically, this viewpoint includes the idea that game mediums and genres are associated with PGB and the reasons people with PGB play these games.

Throughout this study, the concept of “problematic gaming behavior” will be used where a degree of PGB can vary upon a continuum perspective from less severe cases to extreme situations (Griffiths et al. 2015b). The term “problematic gaming behavior” was chosen instead of, for instance, “Internet Gaming Disorder” to avoid assumption that this problem behavior only occurs under influences relating to an internet-based context.

This study focuses on both online and offline gaming with different game genres but not gambling or other forms of gaming activities related to betting money. Based on scientific fact, PGB can be related to any kind of digital games (i.e., online and offline) (Griffiths et al. 2012) and as the popularity of cross-platform gaming is increasing (ESA 2016) it is reasonable to examine the role of distinct gaming mediums (i.e., context) associated with it.

Because of the concerns surrounding the conceptualization and assessment criteria of the PGB, in this study the selection of assessment tools is based on conceptual approaches of the problem behavior itself (for example, GAS, one of the most appropriate tools according to the reviews (King et al. 2013)) and special demands towards different game types (POGQ, which takes account of the context of digital gaming comprehensively (Demetrovics et al. 2012)). For instance, the assessment criteria of IGD has led to more confusion than common understanding (Griffiths et al. 2015b).

In this study, the operational definition adopted to define health was the one suggested by the World Health Organization (WHO), in which health is defined as a state of complete physical, social and mental well-being (WHO, 1946). High engagement for digital gaming has been seen as a risky behavior that may negatively affect health and subsequently may harm the development of adolescents (Raphael 2013). Based on these theoretical views, the health-related outcomes will be defined as a functional state whereby psychological, social and biological aspects are in harmony within the individual. Despite many of beneficial effects of moderate gaming, this study concentrates on harmful outcomes of PGB.
Fig. 2. Theoretical background of the study.

Adolescents and young adults

- Digital Gaming Behavior
  - Time used
  - Frequency
  - Game genres
  - Mediums
  - Motives

- PGB
  - Symptoms
  - Self-awareness

- Health
  - Psychological
    - Social
    - Physical
3 The aim, research questions and hypotheses of the study

The aim of the study was to describe and explain the problematic gaming behavior (PGB) and the relationships between the digital gaming behavior (game-playing time, game mediums, genres and motives), health (psychological, social and physical) and PGB among adolescents and young adults. Knowledge received can be utilized for developing health counselling methods to support PGB individuals in their adherence to behavior change. This study was conducted as three sub-studies (publications I–IV) and the study will be answered following research questions and hypotheses:

Sub-study 1:
1. What is the relationship between PGB and psychological, social and physical health outcomes based on the existing literature? (publication I)

Sub-study 2:
1. What is the size of the PGB group in Finnish adolescents and young adults based on self-reports? (publication II)
2. What is the relationship between digital gaming behavior (i.e., game-playing time, game genre preferences (content), and motives for game-playing) and PGB (i.e., PGB symptoms and self-awareness of PGB) among Finnish adolescents and young adults? (publication II)

Hypothesis 1: High involvement for game types including characteristics of role-playing and shooting (for example, MMORPG, RPG, FPS) was positively related to the elevated PGB symptoms.

Hypothesis 2: Escapism- and achievement-related gaming motives were positively associated with elevated PGB symptoms.

3. What is the relationship between PGB and psychological, social and physical health outcomes among Finnish adolescents and young adults? (publication III)

Sub-study 3:
1. What is the relationship between socio-demographics, digital gaming behavior characteristics (for example, gaming mediums (context) and game genres (content)) and PGB in the sample of adolescents? (publication IV)
4 Material and methods

The study was carried out as three sub-studies, which comprised four publications (I–IV). A theoretical approach was more present in the study phase based on systematic review and meta-analysis. This phase provided the basis for the empirical study phases, which were visible in the two cross-sectional study designs. Study samples, data collection, procedures and analysis with ethical considerations are described in this chapter. Purpose, study designs, participants and methods are summarized in Table 3.

Table 3. The sub-study procedures.

<table>
<thead>
<tr>
<th>Sub-study</th>
<th>Sub-study I</th>
<th>Sub-study II</th>
<th>Sub-study III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>To determine associations of PGB with health outcomes in adolescents and young adults. To identify PGB among Finnish adolescents and young adults and examine its relationship with gaming genres, gaming motives, self-awareness of PGB and a variety of psychological, social and physical health outcomes. To explore the relationship between socio-demographics, digital gaming behavior characteristics and PGB.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>Adolescents and young adults.</td>
<td>National sample of the Finnish adolescents and young adults aged 13–24 years (N = 3 000).</td>
<td>Regional sample of adolescents, aged 12–16 years (N = 846).</td>
</tr>
<tr>
<td>Data collection</td>
<td>Scopus, Medline Ovid, PsycARTICLES, and CINAHL databases.</td>
<td>Self-administered online survey.</td>
<td>Administered online survey.</td>
</tr>
<tr>
<td>Investigated outcomes</td>
<td>Psychological, social and physical health outcomes.</td>
<td>Digital gaming behavior.</td>
<td>Associations between PGB and health.</td>
</tr>
<tr>
<td>Publication</td>
<td>I</td>
<td>II</td>
<td>III</td>
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</table>
4.1 Sub-study I: Systematic review (I)

4.1.1 Procedure

The aim of a systematic review was to synthesize existing research on health-related outcomes of PGB based on the comprehensive health concept framework that addressed the following contexts: psychological, social and physical levels. The systematic review process followed the current guidelines of Centre for Reviews and Dissemination (CRD 2009).

A systematic literature search was conducted for peer-reviewed articles on the databases, including Scopus, Ovid Medline®, PsycARTICLES and Cinahl in May–June 2016. Search strategies were developed with the assistance of professional research librarians. Both MeSH (Medline Ovid and Cinahl) and free search terms (Scopus and PsycARTICLES) were applied as a search strategy (Table 4). Table 4 presents search terms.

Table 4. Search terms.

<table>
<thead>
<tr>
<th>Database</th>
<th>Search terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus</td>
<td>(&quot;computer gam*&quot; OR &quot;video gam*&quot; OR &quot;internet gam*&quot;) AND (problem* OR compulsive OR &quot;addict*&quot; OR patholog* OR dependen) AND (health OR &quot;well-being&quot; OR wellbeing OR welfare OR &quot;quality of life&quot; OR &quot;life satisfaction&quot; OR effect OR impact OR outcome OR physical OR psychological OR mental OR social OR eating OR &quot;food consumption&quot; OR diet OR sleep OR activity OR fitness OR exercise OR cardiorespiratory OR obesity OR overweight OR pain OR musculoskeletal OR body OR discomfort OR loneliness OR friendship OR relationship OR communication OR fatigue OR stress OR ailment OR depression OR anxiety OR mood OR somatic OR psychosomatic OR symptom OR disorder)</td>
</tr>
<tr>
<td>PsycARTICLES</td>
<td>(&quot;computer gam*&quot; OR &quot;video gam*&quot; OR &quot;internet gam*&quot;) AND (problem* OR compulsive OR &quot;addict*&quot; OR patholog* OR dependen) AND (health OR &quot;well-being&quot; OR wellbeing OR welfare OR &quot;quality of life&quot; OR &quot;life satisfaction&quot; OR effect OR impact OR outcome OR physical OR psychological OR mental OR social OR eating OR &quot;food consumption&quot; OR diet OR sleep OR activity OR fitness OR exercise OR cardiorespiratory OR obesity OR overweight OR pain OR musculoskeletal OR body OR discomfort OR loneliness OR friendship OR relationship OR communication OR fatigue OR stress OR ailment OR depression OR anxiety OR mood OR somatic OR psychosomatic OR symptom OR disorder)</td>
</tr>
<tr>
<td>Ovid Medline®</td>
<td>MeSH video games, MeSH behaviors addictive</td>
</tr>
<tr>
<td>Cinahl</td>
<td>MeSH video games, MeSH behaviors addictive</td>
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</tbody>
</table>
Several inclusion and exclusion criteria were tailored in order to evaluate the eligibility of the empirical studies for the review (Table 5). The data gathering was limited to peer-reviewed studies, in English, and published between January 2005 and June 2016.

Table 5. Inclusion and exclusion criteria for studies.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inclusion criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Participants types</td>
<td>The mean age of the study participants older than 12.5 years.</td>
</tr>
<tr>
<td>Study design</td>
<td>Quantitative, prospective, cross-sectional and retrospective longitudinal studies.</td>
</tr>
<tr>
<td>Context of PGB assessment</td>
<td>Core criteria of PGB assessment (King et al. 2013): withdrawal, loss of control, problems relating to personal relationships and school or work difficulties.</td>
</tr>
<tr>
<td>Outcome types</td>
<td>Associations between PGB and at least one health related outcome (psychological, social or/and physical) provided.</td>
</tr>
<tr>
<td><strong>Exclusion criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Participants type</td>
<td>The mean age of the study participants under 12.5 years.</td>
</tr>
<tr>
<td>Study design</td>
<td>Experimental study design (for example, randomized controlled trials) or single case reports. Unpublished dissertations, thesis studies, conference papers.</td>
</tr>
<tr>
<td>Content of the study</td>
<td>Concentrated on the therapeutic games (i.e., educational or serious games interventions) or gambling behavior. Had a focus on other technological behaviors. Evaluation of impact or interactions of video gaming focused on the players' neurobiological or cognitive functioning or aggression effects.</td>
</tr>
</tbody>
</table>

The database search produced 2,203 studies in total. Before the selection process of studies, the duplicates ($n = 30$) from four databases were eliminated to reduce publication bias (CRD 2009). Then two researchers individually screened the titles and abstracts ($n = 2,173$) retrieved studies, and after screening resulted in 2,057 studies were excluded in accordance with inclusion and exclusion criteria. In order to determine the final list of suitable studies, the full texts of potential studies ($n = 116$) were retrieved for further examination. Following this phase, 50 eligible studies were chosen for the final analysis.

A critical appraisal tool (for case series and cohort studies) created by the Joanna Briggs Institute (JBI 2014) was adopted as an approach to assess the quality and risk of biases of the retrieved studies. Quality assessment criteria for the studies are presented in the Table 6. This method was adequate for examining both
descriptive cross-sectional and longitudinal studies, and it included a list of nine objective criteria that allowed the researchers to ensure the quality of study being reviewed. Seven items assessing the quality of the studies were retained in the analysis of cross-sectional studies. All nine criteria were utilized in the evaluation of longitudinal studies. Two independent reviewers individually evaluated the quality of all studies that were eligible for review. None of the selected studies were rejected after the quality appraisal. The quality of each included original study was evaluated with scores that ranged from 2 to 7 for cross-sectional (Mean 4.9) and from 5 to 7 for longitudinal (Mean 5.8) studies.

Table 6. Quality assessment criteria for the studies.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomization (sampling bias).</td>
<td>Nonprobability, probability or consecutive sampling.</td>
</tr>
<tr>
<td>Eligibility (sampling bias).</td>
<td>Certain selection criteria provided when sample recruited.</td>
</tr>
<tr>
<td>Confounding factor (bias in analysis).</td>
<td>Identified and took account.</td>
</tr>
<tr>
<td>Outcomes (measurement bias).</td>
<td>Standardized measures used (health related outcomes).</td>
</tr>
<tr>
<td>Participants’ characteristics (reporting bias).</td>
<td>Adequate description.</td>
</tr>
<tr>
<td>Follow up (longitudinal studies).</td>
<td>Longer than 1 year.</td>
</tr>
<tr>
<td>Withdrawals (longitudinal studies).</td>
<td>Described individuals who withdrew.</td>
</tr>
<tr>
<td>Measurement (measurement bias).</td>
<td>Used dimensional approach.</td>
</tr>
<tr>
<td>Analysis (bias in analysis).</td>
<td>Health-related outcomes determined based on at least two analysis.</td>
</tr>
</tbody>
</table>

4.1.2 Data extraction and analysis

Data was extracted from the studies on the relationship between PGB and health-related connections and collected for further analysis. All included studies were analyzed and processed so that information related to health associations could be extracted. The following information was extracted from each included study: year the study was published, study design, sample (country in which data was gathered, sample size, gender distribution), assessment tools utilized to investigate PGB and health-related associations and other remarks relevant to the study. Additionally, analysis findings were summarized and presented by narrative synthesis divided for psychological, social and physical outcome associations of PGB.

A meta-analysis was performed using STATA 11.2 (StataCorp LP, College Station, TX). The findings on thematic factors were produced with the data that was available, sufficient and at least three independent effect size estimates. The correlation coefficient \( r \) was used as a primary effect size estimate. For the
purpose of meta-analysis, widely employed formulas were used to convert all other effects size statistics to the correlations (Borenstein et al. 2009). The effect ratio differences within participants’ developmental age subgroups were also examined by using random effect models. Sub-group analysis with random effect model analysis included the following age groups: 13–18 years (adolescence), 18–28 years (young adults) and over 18 years (young adults to older adults). Given the assumed heterogeneity between samples, random effect model with the weighted mean effects and their 95% confidence intervals was performed. Mean correlational effect sizes were interpreted according to Cohen’s (1992) guidelines, whereby effect size can be low (0.1), medium (0.3) or large (0.5). The degree of heterogeneity was determined by using $I^2$-statistic. $I^2$-values varied between 0% and 100%, whereby 25% to 50% was denoted as low, 50% to 75% moderate and 75% or greater as high heterogeneity (Higgins et al. 2003). Visual inspection of funnel plots and Egger’s test ($p < 0.05$) were used to estimate publication bias (Sterne et al. 2001).

4.2 Sub-study II: Cross-sectional, national survey (II, III)

4.2.1 Participants and procedure

A cross-sectional sampling method was used to identify the prevalence of the PGB group and examine the relationships between PGB, digital gaming behavior (i.e., game-playing duration, game genre preferences and motives for game-playing) and health (i.e., includes psychological, social and physical outcomes) in Finnish adolescents and young adults.

The survey population of the study was comprised of 3 000 individuals aged 13–24 years who were randomly selected from the Population Register Center of Finland. Inclusion criteria was that the participants needed to be Finnish-speaking and aged 13–24 years. A stratified sampling method was applied to obtain study participants from all the age group and from both genders. The study population was stratified and balanced for age: 13–16, 17–20 and 21–24 years old.

The study invitations were distributed to these individuals by post, but data was collected online. The online survey was answered anonymously (no personal data was collected, including individual Internet Protocol (IP) addresses).

A total of 293 participants (the response rate of the study was 9.8%), 150 males and 143 females, were included in the sample. The average age of the participants
was 18.76 ($SD = 3.45$) and their ages ranged from 13–24 years. The sample consisted of mostly students (77.1%). The rest of the sample who completed the survey represented following occupational statuses: full-time job 8.8%, unemployed 5.5%, part-time job 3.1% and other 5.5%.

### 4.2.2 Measures

The online survey consisted of six sections that depicted the following topics: socio-demographics, digital gaming behavior, PGB and psychological, social and physical health. The summary information of the assessment variables are presented in Table 7. These adapted measures had been modified for the purpose of this study.

Socio-demographics and general digital gaming-related data was assessed using questions about gender, age, education and occupation status, game use, playing time (i.e., estimated mean time per day and week), game genres and gaming motives.

The frequency of playing in different game genres was assessed on a five-point Likert scale: (1) never, (2) every now and then, (3) monthly, (4) every week, (5) every day. Two game examples were given for each category to ensure that each of the genres proposed were clear to the respondents. The game genres were given based on previous literature (for example, Elliott et al. 2012, Kuss & Griffiths 2012). Game genres were arranged in 17 categories included following: massively multiplayer online role-playing games (MMORPG) (for example, World of Warcraft), massively multiplayer online games (MMOGs) (for example, World of Tanks), role-playing games (RPGs) (for example, Skyrim), other forms of strategy games (for example, real-time strategy such as StarCraft), platform games (for example, Sonic), action-adventure games (for example, Tomb Raider, Hitman), adventure games (for example, Full Throttle or Indiana Jones), first person shooter games (FPS) (for example, Battlefield, Counter Strike), fighting games (for example, Street Fighter, Mortal Kombat), sports games (for example, FIFA, NHL), music and party (for example, SingStar, Rocksmith), driving simulation (for example, World Rally Championship, F1), puzzle games (for example, Candy Crush Saga), other simulation games (for example, FlightGear), classic games (for example, card games (patience)), mobile games (games such as Angry Birds played on a mobile device such as a smartphone or PDA) and Facebook games (games played on Facebook such as Farmville).
The role of game-related motives were defined using 14 variables consisting of items adapted from previous studies and items designed for the purpose of the current study (Choi et al. 2004, Haagsma 2012a, LaRose & Eastin 2004). Items were scored on a five-point Likert scale (1 = totally disagree, 3 = neutral, 5 = totally agree).

Self-perceived PGB symptoms were measured with the seven-item version of the Gaming Addiction Scale for Adolescents (GAS) and additional items measuring a self-awareness of problematic gaming behavior. GAS is a short version of Gaming Addiction Scale and is generated to assess problematic gaming behavior among the adolescent population. The validity of the scale was achieved in a previous study (Lemmens et al. 2009). GAS was adapted from English to Finnish by a back-translation procedure. The scale includes one item for each of the seven criteria designed to detect PGB symptoms (for example, cognitive and behavioral symptoms, mood modification, conflicts). Each item comprised of a problematic-type statement, and respondents reported how often this had taken place over the past six months on a five-point Likert scale (never, rarely, sometimes, often or very often). The internal consistency of the GAS was high in the current study (Cronbach’s alpha = 0.79).

To identify PGB cases the monothetic and polythetic approaches proposed by Lemmens et al. (2009) were utilized. Based on the monothetic approach (score > 2 on all seven symptom items), no case of PGB was detected. When applying the polythetic approach (score > 2 at least four items), 24 participants with PGB were detected.

Self-awareness of PGB was assessed by using three statements: (1) I think I spend too much time on gaming, (2) I think my gaming behavior is problematic and (3) I think I’m going to seek help. Items were scored on a five-point Likert scale varying from 1 (certainly not) to 5 (certainly). These items were originally created by Haagsma et al. (2012b).

Psychological health measures assessed responders’ psychological symptoms and satisfaction with life. Psychological symptoms such as the ability to concentrate, depression and anxiety were assessed using three items adapted from The School Health Promotion (SHP) study (Kunttu & Pesonen 2013). Each of the items was scored on a four-point Likert scale ranging from 1 (not at all) to 4 (daily or almost daily). The Satisfaction With Life Scale (SWLS) was utilized to define respondents’ general satisfaction with life (Diener et al. 1985). The SWLS included five statements, with respondents being requested to choose their degree of agreement.
to each item on a seven-point Likert scale (ranging from strongly disagree to strongly agree). Cronbach’s alpha was 0.89 for the SWLS in the current study.

Social health was assessed by using the preferences for online social interaction scale based on a cognitive behavioral model of problematic internet use (Caplan 2010, Haagsma et al. 2013). Elements of the model included a preference for online social interaction, mood regulation and deficient self-regulation. Two items determining preference for online social interaction were kept in the current study: “I prefer communication with other people online rather than face-to-face” and “Online social interaction is more comfortable for me than face-to-face interaction”. Each statement was appraised on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Other items (4) were generated by the authors to appraise preferences for online interaction.

In terms of physical health, respondents were asked to report their general health, adapted from the scale originally used in The School Health Promotion study in Finland (Kunttu & Pesonen 2013). This was rated on a five-point Likert scale ranging from good to bad. Body Mass Index (BMI) was determined from self-reports of weight and height. A BMI score of 25.1–29.9 was categorized as overweight and BMI > 30 as obese in accordance with WHO criteria (WHO 1995).

Respondents were also asked to report their bodily discomfort by using seven items that were originally utilized in The School Health Promotion study in Finland (Kunttu & Pesonen 2013). This measure included assertions about headache, weakness/fatigue, dizziness, sleep problems, upper back/neck ailments, lower back ailments and limbs or joint pain. Each of the assertions was rated on a four-point Likert scale ranging from 1 (not at all) to 4 (daily or almost daily).

In terms of the assessment of physical activity, two dimensions were adapted (Kunttu & Pesonen 2013). Respondents were requested to report their frequency of engagement in moderate-to-vigorous intense sports or exercise lasting at least 30 minutes in one go; responses ranged from never, less than once per month, 1–3 days per month, 1 day per week, 2–3 days per week, 4–6 days per week to daily. Respondents also reported the duration of time engagement they spent in incidental exercise daily with responses ranging from less than 15 minutes, 15–29 minutes, 30–60 minutes, to over an hour.
Table 7. Assessments in the study.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Items</th>
<th>Question type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>2</td>
<td>MC(^2)</td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>OS(^1)</td>
</tr>
<tr>
<td>Education level</td>
<td>7</td>
<td>MC(^2)</td>
</tr>
<tr>
<td>Occupation status</td>
<td>6</td>
<td>MC(^2)</td>
</tr>
<tr>
<td>Digital gaming behavior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital game use</td>
<td>1</td>
<td>MC(^2)</td>
</tr>
<tr>
<td>Playing duration</td>
<td>2</td>
<td>OS(^3)</td>
</tr>
<tr>
<td>Game types</td>
<td>17</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Gaming motives</td>
<td>12</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Problematic gaming behavior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaming Addiction Scale (GAS)</td>
<td>7</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Self-awareness of PGB</td>
<td>3</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Psychological health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptoms</td>
<td>3</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Satisfaction with life</td>
<td>5</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Social health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preference for online social interaction</td>
<td>2</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Preference for online interaction (general)</td>
<td>4</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Physical health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General health</td>
<td>1</td>
<td>MC(^2)</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>2</td>
<td>OS(^3)</td>
</tr>
<tr>
<td>Bodily discomfort</td>
<td>7</td>
<td>LS(^1)</td>
</tr>
<tr>
<td>Physical activity</td>
<td>2</td>
<td>MC(^2)</td>
</tr>
</tbody>
</table>

\(^1\) Likert scale, \(^2\) multiple choice, \(^3\) open space in questionnaire.

4.2.3 Data analysis

Descriptive statistics were collected for the participants’ socio-demographics and gaming behavior variables (for example, gaming time, GAS scores, gaming type use, gaming motives). Non-parametric tests – the Mann-Whitney and Kruskal-Wallis tests – were computed to determine the relationship between game-playing time and demographics (gender and age groups). The Kruskal-Wallis test was also conducted to determine differences in problematic gaming scores and weekly gaming times at different self-awareness levels of problematic gaming. These nonparametric tests were conducted due to the skewed distribution of the data (Breakwell et al. 2012). The Pearson correlation coefficients were computed to estimate intercorrelations between total GAS scores and health outcomes variables.
A chi-square analysis was conducted to determine differences among the presence of PGB and psychological and physical symptom outcomes.

Principal component analysis (PCA) was conducted to examine the structure of the gaming genres and motives for data compacting purposes (Pett et al. 2003). The aim was to find common categories and related gaming genres (17 types of genres) and motives (14 types of motives) types. Oblimin rotation was conducted due to an expectation of the genres and motives not to be independent (Pett et al. 2003).

The associations of PGB (GAS scores) and the strongest determinants with socio-demographics, gaming behavior and health-related parameters were explored and tested for statistical significance with the multiple linear regression analysis. Regression analysis was favoured instead of correlation analysis, as the regression method takes into consideration the intercorrelations between the independent variables (Pett et al. 2003). Distings regression analysis were preferred to avoid including too many variables in the same group (Breakwell et al. 2012). The assumptions regarding normality, multicollinerarity and homoscedasticity were verified to be suitable before the interpretation of the analysis (Pett et al. 2003). Statistical analysis was performed by using the SPSS (version 22.0) statistical software package. The level of significance was set at $p < 0.05$.

### 4.3 Sub-study III: Cross-sectional, regional sample (IV)

#### 4.3.1 Participants and procedure

A cross-sectional, regional sample was collected from two purposefully-selected public junior high schools in northern Finland in the autumn of 2015. Participants comprised 846 junior high school students from the 7th to 9th grades.

The study was approved by the school authorities. Parents were informed about the study by school authorities. An anonymous self-completion online questionnaire was administered to adolescents by school teachers and researchers during class time. Once students entered the survey website they had an access to instructions on the questionnaire that guided the completion of the survey.

A total of 560 adolescent respondents were analyzed (the response rate of the study was 66.2%). Of the participants, 257 were girls and 303 boys and mean age of the sample was 14 years. The majority of the respondents described living in a
nuclear family (72.9%) whereas 11.8% lived in shared physical custody, 9.1% lived in a single-parent household and 4.6% lived in blended family structure.

### 4.3.2 Measures

The survey consisted of two sections: (1) socio-demographics, and media behavior (i.e. background variables) and (3) gaming behavior patterns. A summary of information about the assessment variables is presented in Table 8.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Items</th>
<th>Question type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio demographic</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>2</td>
<td>MC²</td>
</tr>
<tr>
<td>Age</td>
<td>5</td>
<td>MC²</td>
</tr>
<tr>
<td>Family type</td>
<td>6</td>
<td>MC²</td>
</tr>
<tr>
<td>Media behavior</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Internet connection at home</td>
<td>1</td>
<td>DQ¹</td>
</tr>
<tr>
<td>Computer ownership</td>
<td>1</td>
<td>DQ¹</td>
</tr>
<tr>
<td>Tablet ownership</td>
<td>1</td>
<td>DQ¹</td>
</tr>
<tr>
<td>Table/phone ownership</td>
<td>1</td>
<td>DQ¹</td>
</tr>
<tr>
<td>Possession of mobile phone/tablet with internet access or without internet access</td>
<td>1</td>
<td>DQ²</td>
</tr>
<tr>
<td>Possession of tablet and personal computer</td>
<td>1</td>
<td>DQ¹</td>
</tr>
<tr>
<td>Average duration used for different media (week day and weekend day separately)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal computer/laptop</td>
<td>2</td>
<td>OS³</td>
</tr>
<tr>
<td>Tablet</td>
<td>2</td>
<td>OS³</td>
</tr>
<tr>
<td>Table/phone</td>
<td>2</td>
<td>OS³</td>
</tr>
<tr>
<td>Gaming behavior</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Average time spent on gaming (typical day)</td>
<td>1</td>
<td>OS³</td>
</tr>
<tr>
<td>Problematic gaming behavior</td>
<td>18</td>
<td>LS⁴</td>
</tr>
<tr>
<td>Most frequently used game category</td>
<td>9</td>
<td>MC²</td>
</tr>
<tr>
<td>Preference for online gaming</td>
<td>3</td>
<td>MC²</td>
</tr>
</tbody>
</table>

¹ Dichotomous questions, ² multiple choice, ³ open space in questionnaire, ⁴ five-point Likert scale ranging from 1 “never” to 5 “always”.

Socio-demographics included questions about gender, age, grades and family type. Measurements of media and gaming behavior patterns were initially developed for the large international Tech Use Disorders (TUD) project (http://uclep.be/tud/). The
question part was adapted to this study based on discussion in the research group and it had been modified for the purpose of this study. These questions helped us to understand the gaming behavior characteristics including gaming consumption (duration), gaming content (game genres) and context (mediums) of PGB among adolescents.

The Problematic Online Gaming Questionnaire (POGQ) comprised 18 items detecting symptoms of PGB. Although the POGQ was initially designed to assess symptoms of problematic online gaming, it is also suitable for detecting problem behavior related to offline gaming (Smohai et al. 2017). The validity and reliability of the scale was achieved in a previous study (Demetrovics et al. 2012). POGQ was adapted into Finnish by the back-translation process supported by researchers and a linguistic expert translator from this respective language to English. All sub-items are answered on a five-point Likert scale ranging from 1 (never) to 5 (always). In the current study, Cronbach’s alpha of the scale was 0.93.

4.3.3 Data analysis

Statistical analysis was performed using IBM SPSS statistics Version 22 for Windows. Descriptive statistics of the socio-demographics, media ownerships, media use and gaming behavior characteristics were conducted. Non-parametric tests such as the Mann-Whitney’s U and Kruskal Wallis test were used to test statistical differences between socio-demographics (Breakwell et al. 2012). Summated variable was formed as the PGB data included several sub-variables that could be linked to the dependent variable. This summated PGB data based on factor structure performed in an earlier study on problematic online gaming behavior (Demetrovics et al. 2012). In addition, a multiple regression analysis (a step-forward method) was conducted with the PGB scores as the dependent variable and demographics and school grades, average duration spent on different media and gaming on typical day and gaming genres related as the independent variables. Again, the assumptions regarding normality, multicollinearity and homoscedasticity were verified as suitable before the interpretation of the analysis (Pett et al. 2003). The level of significance was concluded at $p < 0.05$.

4.4 Ethical considerations

Regarding the systematic review and meta-analysis, the review process was followed and reported according to the recommended methodology guidelines
Ethical procedures of all original studies were identified in the review process and there was no reason to exclude certain findings due to concern about the ethics of research (RCR 2012). Findings of the review data was reported with the respect of the primary source (RCR 2012).

Sub-studies did not involve an intervention in the physical integrity of subject and thus the ethical guidelines for medical research was not applied (Statutes of Finland: Medical Research Act No. 488/1999). The research aspect was meaningful for increasing base knowledge of the PGB and related health outcomes in Finnish society. The study was consistent with the ethical standards for research involving human participants (National Advisory Board on Research Ethics 2009) and it was carried out in accordance with the Declaration of Helsinki (World Medical Association 2013) guidelines of Responsible Conduct of Research and Procedure for Handling Allegations of Misconduct in Finland (RCR 2012).

Before the actual data gathering, a pilot study was conducted to verify the feasibility of the online survey (Breakwell et al. 2012, Everitt 2006). Study participants (sub-studies II and III) were fully informed of the necessary information of the study including the following details: a short description of the purpose (intention) and aim of the study, who was conducting the survey, how they had been selected for the survey, to whom they were able to turn with their questions and concerns, that participation was voluntary and anonymous, who had access to data and how it had used (i.e., process of the data handling) (National Advisory Board on Research Ethics 2009). Participants were made aware of the voluntary nature of the study and that they had also right to withdraw from the study at any time. Participation was able to be interrupted at any time in case the adolescent showed signs of discomfort and wanted to leave. In sub-study two, the younger participants aged 13–14 years were given a study invitation letter addressed to the parents or guardians, who were able to make a decision as to whether they gave their child the information and link to take part to the online survey (i.e., a passive informed consent). Participants accepted participation in the survey in both empirical studies by passing the first information page. To verify the participants’ confidentiality, respondents’ identification data were not gathered. Participants’ responses were stored on a research organization’s protected server and it will be destroyed when there is no more use.

Regarding the data from adolescents, the study was approved by the school authorities. Given the nature of the study, passive consent was obtained from the parents. Students’ parents were informed (with written information) about the intention and nature of the study and they could inform the school’s contact person
if they wanted to their child to be excluded from the study participation. The online questionnaire was administered within the class and participants were guided in completing the survey by a teacher and researchers.
5 Results

5.1 Problematic gaming behavior and health outcomes among adolescents and young adults (I)

The systematic review of 50 studies identified several, health-related outcomes for which evidence showed significant associations with increased PGB symptoms. These included psychological (for example, depression, anxiety and obsessive-compulsive disorder (OCD)) social (for example, family functioning, social capabilities and loneliness) and physical (for example, somatization and sleep problems) factors.

A total of 33 effect size ($r$) were also used in the meta-analysis to examine the overall relationship between prominent PGB and OCD, somatization, depression and anxiety symptoms. Based on the random effect size model these associations yielded an average small to medium effect size, of which correlates 0.26 for depression (95% CI 0.20–0.30), 0.28 for anxiety (95% CI 0.19–0.37), 0.40 for OCD (95% CI 0.22–0.59) and 0.40 for somatization (95% CI 0.22–0.59) were measured respectively. Effect sizes of across factors were also heterogeneous ($Q$ test, $p < 0.05; I^2 > 75$%). A subsequent analysis of depression and anxiety symptoms in PGB in different age-related sub-groups identified correlates that varied between a small to medium effect size in groups of adolescents and young adults or adults respectively. More detailed information on the synthesis of the meta-analysis and health-related outcomes in PGB can be found in publication I.

This review identified 30 studies with health-related outcomes that specifically targeted adolescents and young adults. These significant health-related associations with PGB among adolescents and young adults were described as narrative synthesis.

An overview of the most reported health-related associations with PGB among adolescents and young adults is presented in Figure 3. The most commonly reported psychological health factors associated with PGB were depression and anxiety. Fourteen studies found a significant relationship between PGB and symptoms of depression (Desai et al. 2010, Kwon et al. 2011, Li et al. 2011, Starcevic et al. 2011, Van Rooij et al. 2011, Van Rooij et al. 2012, Papay et al. 2013, Son et al. 2013, Brunborg et al. 2014, Király et al. 2014b, Müller et al. 2015, Strittmatter et al. 2015, Lemos et al. 2016, Vukosavljevic-Gvozden et al. 2016). In eight studies, participants reported anxiety symptoms related to increased PGB symptoms.
(Mehroof & Griffiths 2010, Starcevic et al. 2011, Van Rooij et al. 2012, Walther et al. 2012, Müller et al. 2015, Kim NH et al. 2016, Lemos et al. 2016, Vukosavljevic-Gvozden et al. 2016). The study by Li et al. (2011) found that gamers experienced higher levels of actual-ideal discrepancy and depression, and were more likely to exhibit escapism and PGB symptoms. Additionally, the experienced level of PGB symptoms was also found to be positively related to the following psychological conditions: psychoticism (Starcevic et al. 2011), obsession-compulsion (Starcevic et al. 2011, Vukosavljevic-Gvozden et al. 2016) and general psychiatric distress (Rikkers et al. 2016).

Overall, this review also identified several thematic factors closely related to psychosocial outcomes that associated with the presence of PGB symptoms, including impulsivity (Walther et al. 2012) or poor self-control (Kim et al. 2008), attention deficit (Gentile 2009, Walther et al. 2012, Müller et al. 2015), hyperactivity (Baer et al. 2012, Strittmatter et al. 2015, Rikkers et al. 2016), self-discrepancy (Kwon et al. 2011), low self-esteem (Walther et al. 2012, Van Rooij et al. 2012, Papay et al. 2013, Király et al. 2014b), impaired life skills (Baer et al. 2012), low school well-being (Rehbein & Baier 2013) and obsessive passion (Lafreniere et al. 2009).

A study by Wu et al. (2013) found that a need for autonomy, competence and relatedness can be both directly or indirectly influenced having experienced symptoms of PGB. Moreover, a study by Montag et al. (2011) found that PGB correlated positively with levels of neuroticism personality and negatively to self-reported agreeableness and conscientiousness. A study by Wan and Chiou (2006) examined the connections between increased PGB symptoms and psychological needs, and according to their findings a dissatisfaction for psychological needs such as safety, love, belonging, self-esteem and self-actualization related to the risk of PGB.

A number of social health outcomes were found to be associated with PGB. Studies indicated that PGB was related to problems in family harmony (Rikkers et al. 2016), social integration in class (Rehbein & Baier 2013), social self-efficacy or social competence (Rehbein et al. 2010, Jeong & Kim 2011, Müller et al. 2015). Moreover, interpersonal difficulties (i.e., with peers) (Kim et al. 2008, Baer et al. 2012, Müller et al. 2015, Strittmatter et al. 2015, Rikkers et al. 2016) were positively associated with the experienced symptoms of PGB. Conversely, social self-efficacy in the virtual world or otherwise gamers’ strong preference for online interaction correlated positively with PGB symptoms (Jeong & Kim 2011). Finally,
PGB was found to be associated with increased levels of loneliness (Van Rooij et al. 2012, Walther et al. 2012).

Various physical health outcomes have been found to be associated with PGB. Accordingly, PGB was related to the physiological alterations in the somatic (Starcevic et al. 2011, Müller et al. 2015, Vukosavljevic-Gvozden et al. 2016), autonomic nervous (Coyne et al. 2015), and plasma catecholamine domains (Kim NH et al. 2016). PGB was found to be connected to decreased levels of sport or exercise activity (Montag et al. 2011, Henchoz et al. 2016) and hand and wrist pain (Gentile 2009). A one-year longitudinal study by Coyne et al. (2015) reported that the changes of certain physiological indicators (i.e., sympathetic and parasympathetic nervous system activities) measured by Respiratory Sinus Arrhythmia (RSA) and Galvanic Skin Conductance (SC) were connected to PGB where decreased RSA withdrawal alterations in response specific tasks was associated with greater severity of PGB. Two studies showed that prominent PGB was related to the sleep problems (Rehbein et al. 2010, Kim NH et al. 2016).

Fig. 3. The most reported health-related connections in PGB (i.e., at least two studies reported statistically significant connections).
5.2 Digital gaming behavior and PGB among Finnish adolescents and young adults: prevalence and relationships (II, III)

5.2.1 Digital gaming behavior characteristics

Most of the participants (92.5%, \( n = 271 \)) reported that they had played digital games at least sometime within the previous three months. Additionally, results revealed that participants had played an average of 1.8 hours per day (\( SD = 2.3 \)) and 11.5 hours (\( SD = 14.9 \)) weekly. Respondents’ self-reported weekly gaming time ranged from less than 3 minutes to around 100 hours.

Table 9 describes the prevalence of each type of gaming genre on both the non-PGB and PGB participants. The most played gaming genres were “mobile” (74%), “puzzle” (72%) and “platform” (68%) among the non-PGB group. Prevalence proportions were determined on the basis of gaming frequency in which the respondent reported at least sometimes during the past three months.

<table>
<thead>
<tr>
<th>Gaming genres</th>
<th>Non-PGB(^1)</th>
<th>PGB(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile</td>
<td>73.6</td>
<td>54.2</td>
</tr>
<tr>
<td>Puzzle</td>
<td>72</td>
<td>79.1</td>
</tr>
<tr>
<td>Platform</td>
<td>68.4</td>
<td>70.8</td>
</tr>
<tr>
<td>Driving</td>
<td>58.8</td>
<td>41.6</td>
</tr>
<tr>
<td>Classic</td>
<td>58.3</td>
<td>62.5</td>
</tr>
<tr>
<td>FPS</td>
<td>53.6</td>
<td>75</td>
</tr>
<tr>
<td>Strategy</td>
<td>53</td>
<td>62.5</td>
</tr>
<tr>
<td>Action-adventure</td>
<td>49.9</td>
<td>75.1</td>
</tr>
<tr>
<td>RPG</td>
<td>49</td>
<td>91.6</td>
</tr>
<tr>
<td>Adventure</td>
<td>47.9</td>
<td>66.7</td>
</tr>
<tr>
<td>Music</td>
<td>47.4</td>
<td>50</td>
</tr>
<tr>
<td>Sport</td>
<td>46.4</td>
<td>29.2</td>
</tr>
<tr>
<td>Fighting</td>
<td>33.9</td>
<td>54.2</td>
</tr>
<tr>
<td>Facebook</td>
<td>33</td>
<td>12.5</td>
</tr>
<tr>
<td>MMOG</td>
<td>32.1</td>
<td>29.2</td>
</tr>
<tr>
<td>Simulation</td>
<td>32</td>
<td>41.7</td>
</tr>
<tr>
<td>MMORPG</td>
<td>28.7</td>
<td>41.8</td>
</tr>
</tbody>
</table>

\(^1\) non-PGB \( n = 228 \) (in the category of Facebook games percentage of the valid response cases was 85.7%), \(^2\) PGB \( n = 24 \)
Further analysis revealed that high engagement among the non-PGB respondents (participants who endorsed frequency of weekly or daily gaming) was concerned with the genres such as mobile (37%), FPS (28%) and puzzle (28%). Players with identified PGB (n = 24) endorsed engagement in game types such as RPG (92%), puzzle (79%), action-adventure (75%), FPS (75%) and platform (71%), whereas the highest engagement in the PGB players was associated with RPG (42%), mobile (29%), action-adventure (29%), MMORPG (25%), strategy (25%) and puzzle (25%) (publication II).

Figure 4 displays the study participants’ motives for digital gaming on both non-PGB and PGB participants. Respondents of non-PGB endorsed the highest frequency for the following motives: “I enjoy doing it” (74%), “It is an easy way to pass the time” (74%) and “It is a way to relax” (61%). Respondents with PGB reported the highest frequency, for instance, for the following questions: “It is a way to relax” (95%), “It is an easy way to pass the time” (91%), “I enjoy doing it” (91%) and “I want to develop as a player” (87%) (publication II).

![Fig. 4. Motives for gaming (%; base non-PGB n = 238 (in the category of “I enjoy doing it” percentage of valid response cases was 89.1%), PGB, n = 24).](image-url)
5.2.2 PGB

Among the study participants a proportion of 9.1% \((n = 24)\) of PGB was observed based on a polythetic approach. According to this criteria model, participants were categorized as displaying potential problematic gaming behavior (PGB) if they rated at least four of the seven symptom items with a score of 3 (sometimes), 4 (often) or 5 (very often). In the present study, the total PGB scores ranged from 7 and 31 \((M = 11.1, SD = 4.3)\).

As PGB is known to be a gendered issue, the PGB scores were compared by gender in this study. The findings indicated that boys (with a mean rank of 152.76/Median = 11) more than girls (with a mean rank of 111.20/Median = 9) showed higher PGB symptoms \((U = 6010, p < 0.001)\). As shown in Table 10, most PGB symptoms were reported by a small proportion of young gamers. Some of the symptoms, for example, “spending increasing amounts of time on games” was endorsed the most often among young gamers in Finland (almost 31%). The other problematic gaming behavior symptoms were exhibited by far fewer among these young gamers.

### Table 10. Percentages of endorsed subjective problematic gaming behavior for each GAS scale item.

<table>
<thead>
<tr>
<th>GAS item</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>n/%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you started spending increasing amounts of time on games?</td>
<td>269</td>
<td>2.00</td>
<td>0.98</td>
<td>83/30.8</td>
</tr>
<tr>
<td>Have you neglected other important activities (for example, school or</td>
<td>269</td>
<td>1.71</td>
<td>0.91</td>
<td>53/19.7</td>
</tr>
<tr>
<td>work) to play games?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have you played games to forget about real life?</td>
<td>271</td>
<td>1.63</td>
<td>1.02</td>
<td>53/19.5</td>
</tr>
<tr>
<td>Have you spent all day thinking about playing the game?</td>
<td>271</td>
<td>1.66</td>
<td>0.95</td>
<td>45/16.6</td>
</tr>
<tr>
<td>Have you had fights with others (for example, family, friends) over your</td>
<td>271</td>
<td>1.45</td>
<td>0.89</td>
<td>32/11.8</td>
</tr>
<tr>
<td>time spent on games?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have others unsuccessfully tried to reduce your game use?</td>
<td>268</td>
<td>1.40</td>
<td>0.88</td>
<td>29/10.8</td>
</tr>
<tr>
<td>Have you felt bad when you were unable to play?</td>
<td>271</td>
<td>1.32</td>
<td>0.71</td>
<td>19/7.0</td>
</tr>
</tbody>
</table>

\(^1\) Polythetic approaches proposed by Lemmens et al. (2009), proportion of participants who endorsed score > 2 on item.

Demographic characterization, weekly playing time and PGB scores of the gamers are shown in Table 11. Results indicated \((U = 3918, p < 0.001)\) that boys \((Median = 2 \text{ hours})\) played significantly more per day than girls \((Median = 0.50 \text{ hours})\). Regarding the different age group of the sample, respondents aged 16 to 18 years played the most (an average 146 minutes per day) but there was not a statistically significant difference compared to other age groups (average time per
day spent for gaming varied from 88 minutes to 115 minutes). Participants with PGB \((\text{Median} = 3 \text{ hours})\) spent significantly higher \((U = 982, p < 0.001)\) time per day playing digital games compared to the non-problematic players (non-PGB) \((\text{Median} = 0.88 \text{ hours})\). A significant positive relationship existed between total weekly playing time and PGB scores \((r = 0.49, p < 0.01)\).

Regarding the self-awareness of PGB, of all the participants, 16.5% \((n = 45)\) self-perceived spending too much time on digital gaming. Of the PGB group, 33% \((n = 8)\) experienced spending too much time on digital gaming. Of the total sample, only 3.6% \((n = 10)\) and 12.5% \((n = 3)\) from group of PGB, self-perceived their gaming behavior could be problematic. Of the total sample, 0.8 \((n = 2)\) experienced being in need of external help to manage their gaming (publication II).

There was a statistically significant difference in PGB scores and weekly playing time between the different levels of awareness of PGB. Results showed that the highest self-awareness level of PGB was associated with the highest scores on weekly duration of gaming and PGB symptoms (publication II).

Table 11. Prevalence of gaming, average weekly playing time and problematic gaming behavior scores by gender, age and occupation category.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n)</td>
<td>Playing time (h/week)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13–15</td>
<td>38</td>
<td>16.60</td>
</tr>
<tr>
<td>16–18</td>
<td>32</td>
<td>20.08</td>
</tr>
<tr>
<td>19–21</td>
<td>37</td>
<td>17.09</td>
</tr>
<tr>
<td>22–24</td>
<td>29</td>
<td>12.77</td>
</tr>
<tr>
<td>Total</td>
<td>136</td>
<td>16.73</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time job</td>
<td>7</td>
<td>10.15</td>
</tr>
<tr>
<td>Part-time job</td>
<td>3</td>
<td>13.66</td>
</tr>
<tr>
<td>Unemployed or temporarily laid-off</td>
<td>7</td>
<td>21.07</td>
</tr>
<tr>
<td>Student</td>
<td>115</td>
<td>16.70</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>19.22</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>16.61</td>
</tr>
</tbody>
</table>
5.2.3 Relationship between gaming genres, gaming motives and PGB

Two PCAs were performed to array the data of gaming types and motives and optimize them for following analyses. Game genres such as MMOG and Facebook were removed from the analysis due these genres only being reported by a small number of participants and thus these were not as representative as other types of gaming genres. The analysis indicated the extraction of four factors. The first included six types of games that corresponded to role-playing, progression (for example, character development), action and strategy features (for example, MMORPG, RPG, action-adventure, strategy, FPS and adventure). The second related to sports or simulation games (for example, sports, driving or simulation). The third corresponded to problem-solving/puzzles, logical thinking (for example, puzzle, classic and mobile phone). The fourth was related to short-term, on-screen character actions, which are typically competitive and entertainment features (for example, fighting and music). One game genre (platform) loaded similarly on two components (1 and 3), and thus it was removed based on this analysis (publication II).

The second PCA was performed to find categories of gaming-related motives. The analysis indicated four components: (1) experience-immersion (including of three items that corresponded to the importance of seeking experiences or excitement and trying different identities); (2) entertainment-achievement (including of four items demonstrating a way to relax or pass the time and to enjoy competitiveness); (3) social (including of three items that portrayed to feeling less lonely, preferences of social interaction and communication through gaming); and (4) escapism (including of two items that corresponded to using the game to escape from reality and worries). These categories were kept for future analyses and were formed by combining related sub-items into sum variables. Two motive items (“I want to develop as a player” and “by playing I can learn new things”) were counted out from the analysis because they loaded low (lower than 0.50) and similarly with two factors component (publication II).

Two distinct multiple linear regression models (i.e., Model 1: gaming genres; Model 2: gaming motives) indicating how self-reported PGB levels (i.e., GAS score) were related to the gaming genres and motives are described in Table 12 (publication II, Table 3). The PGB was significantly associated with the usage of the game categories of role-playing, progression (for example, character development), action and strategy. In addition, results for regression showed that
that entertainment-achievement, social and escapism motives significantly correlated with PGB. In contrast, the motive of experience-immersion was not significantly related to PGB. According to this analysis, a 10% increase in PGB is related to the 4.2% increase in role-action game-playing, 1.9% increase in entertainment-achievement, 2.3% social and 3.0% escapism motives. The results provided support for the set hypothesis 1 and 2.

Table 12. Multiple regression coefficients¹ of the associations between gaming genres and motive-related predictor variables with PGB.

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>n Valid</th>
<th>Beta</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaming Genres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role-Action-Adventure</td>
<td>0.420</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Sports-Simulation</td>
<td>-0.073</td>
<td>0.254</td>
<td></td>
</tr>
<tr>
<td>Puzzle-Classic</td>
<td>-0.018</td>
<td>0.753</td>
<td></td>
</tr>
<tr>
<td>Fighting-Music</td>
<td>0.108</td>
<td>0.074</td>
<td></td>
</tr>
<tr>
<td>Motives for playing games</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience-immersion</td>
<td>0.056</td>
<td>0.400</td>
<td></td>
</tr>
<tr>
<td>Entertainment and achievement</td>
<td>0.192</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>0.237</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Escapism</td>
<td>0.302</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

¹ Data showed as standardized regression coefficients with statistically significant associations shown in bold.

5.2.4 Relationship between PGB and health outcomes

Of all participants, 96% (n = 282) experienced their general health as either average or good. Of all physical symptoms, respondents had experienced headache and fatigue with the most reported prevalence (i.e., experienced at least occasionally) 73% and 77% respectively. Of all participants, 31% (n = 83), self-reported that the social meaning of the gaming is significant to them. In addition, 5.6% (n = 15) of the participants reported that they more likely have contacts in their gaming environment than in real life situations. Participants’ BMI varied from 14.5 to 58.8 and the average BMI of the sample was 22.62 (SD = 5.10). Overall, 53.2% (n = 156) of the participants performed at least 30 minutes of incidental physical activity daily. Daily very active exercise (i.e., at least 30 minutes of moderate-to-vigorous) was performed by 8.9% (n = 26) of the respondents (publication III).

Inspection of connections between elevated PGB symptoms and certain psychological, social and physical health variables showed that among individuals
with PGB there were a strong co-occurrence of poorer general health, sleep problems, fatigue, concentration difficulties, and symptoms of anxiety and depression (Table 13, more detailed information on the interrelations of the study variables can be found in publication III, pages 284–285). There was a moderate inverse connection between satisfaction with life level and the respondents’ PGB experiences. Regarding the physical activity context, there was an inverse relationship between physical activity (i.e., both incidental and more intense exercise) and experienced PGB symptoms. For the analyses of further psychological and physical symptom variables, comparison between non-PGB group and PGB gamers was taken into account. Significant differences were found for variables indicating young people with PGB were more likely to experience fatigue ($\chi^2 = 9.72, p < 0.05$), sleep ($\chi^2 = 9.72, p < 0.05$), concentration ($\chi^2 = 6.24, p < 0.05$) depression ($\chi^2 = 13.58, p = 0.05$) and anxiety ($\chi^2 = 8.42, p < 0.05$) problems than non-PGB participants (publication III).

Table 13. Correlations between indices of health factors and PGB (GAS scores).

<table>
<thead>
<tr>
<th>Variable</th>
<th>GAS Scores ($r$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological health</td>
<td></td>
</tr>
<tr>
<td>Inability to concentrate (no – almost daily/daily)</td>
<td>0.16$^2$</td>
</tr>
<tr>
<td>Depression (no – almost daily/daily)</td>
<td>0.17$^2$</td>
</tr>
<tr>
<td>Anxiety (no – almost daily/daily)</td>
<td>0.13$^2$</td>
</tr>
<tr>
<td>Satisfaction with life (extremely dissatisfied – extremely satisfied)</td>
<td>-0.23$^2$</td>
</tr>
<tr>
<td>Social health</td>
<td></td>
</tr>
<tr>
<td>Preference for online social interaction (irrelevant – relevant)</td>
<td>0.45$^2$</td>
</tr>
<tr>
<td>Physical health</td>
<td></td>
</tr>
<tr>
<td>General health (good – bad)</td>
<td>0.26$^2$</td>
</tr>
<tr>
<td>BMI (low-normal – intermediate-high)</td>
<td>0.05</td>
</tr>
<tr>
<td>Sleeping problems (no – almost daily/daily)</td>
<td>0.13$^1$</td>
</tr>
<tr>
<td>Headache (no – almost daily/daily)</td>
<td>0.03</td>
</tr>
<tr>
<td>Weakness/fatigue (no – almost daily/daily)</td>
<td>0.20$^2$</td>
</tr>
<tr>
<td>Dizziness (no – almost daily/daily)</td>
<td>0.10</td>
</tr>
<tr>
<td>Upper back/neck ailments (no – almost daily/daily)</td>
<td>0.09</td>
</tr>
<tr>
<td>Lower back ailments (no – almost daily/daily)</td>
<td>0.09</td>
</tr>
<tr>
<td>Limb or joint pain (no – almost daily/daily)</td>
<td>0.04</td>
</tr>
<tr>
<td>Incidental exercise (low – high)</td>
<td>-0.23$^2$</td>
</tr>
<tr>
<td>Moderate to vigorous intense physical activity (low – high)</td>
<td>-0.27$^2$</td>
</tr>
</tbody>
</table>

$^1p < 0.05$, $^2p < 0.01$. 

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To examine which of the health-related outcomes contributed to the development of PGB in a notable manner, a multiple linear regression analysis was conducted (Table 14, publication III, Table 4). In order to confirm a possible problem of multicollinearity degree, pre-analysis checks related to the intercorrelations (low to medium), variance inflation factor ($VIF < 5$) and the tolerance score ($tolerance > 0.20$) for the predictor variables were conducted.

### Table 14. Linear regression analysis predicting problematic gaming behavior symptoms (GAS scores).

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
</tr>
<tr>
<td>Full-time job</td>
<td>0.048</td>
</tr>
<tr>
<td>Part-time job</td>
<td>0.066</td>
</tr>
<tr>
<td>Unemployed or temporarily laid off</td>
<td>0.115</td>
</tr>
<tr>
<td>Student</td>
<td>0.219$^1$</td>
</tr>
<tr>
<td><strong>Education level</strong></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>-0.163</td>
</tr>
<tr>
<td>Secondary education</td>
<td>-0.059</td>
</tr>
<tr>
<td>Other vocational education</td>
<td>-0.031</td>
</tr>
<tr>
<td>Higher professional education</td>
<td>-0.005</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>-0.052</td>
</tr>
<tr>
<td><strong>Playing time (hours/week)</strong></td>
<td>0.310$^3$</td>
</tr>
<tr>
<td><strong>Depression (no – almost daily)</strong></td>
<td>0.188$^2$</td>
</tr>
<tr>
<td><strong>Satisfaction with life (extremely dissatisfied – extremely satisfied)</strong></td>
<td>0.016</td>
</tr>
<tr>
<td><strong>Preference for online interaction (irrelevant – relevant)</strong></td>
<td>0.309$^3$</td>
</tr>
<tr>
<td><strong>General health (good to bad)</strong></td>
<td>0.099</td>
</tr>
<tr>
<td><strong>Physical activity (incidental; low – much)</strong></td>
<td>0.020</td>
</tr>
<tr>
<td><strong>Physical activity (moderate to vigorous; never – daily)</strong></td>
<td>-0.109</td>
</tr>
</tbody>
</table>

Standardized betas are shown. $^1 p < 0.05$, $^2 p < 0.01$, $^3 p < 0.001$, base $n = 250$.

Due to depression correlating strongly ($r = 0.69$, $p < 0.01$) with the anxiety symptoms, it was decided to exclude anxiety from the model. Predictors (i.e., independent variables) of the model (enter method) were the dimensions of occupational status and educational level, age, digital gaming time, general health, incidental exercise, physical activity, depression, the total score on the life satisfaction and the total score on the preference for online social interaction. A dependent variable was used for the total score on the GAS (i.e., the highest PGB level). The total variance in PGB levels is explained by this model 42.4% ($p < 0.001$). Four predictor variables were significantly associated with total PGB
symptoms, namely, being a student, weekly playing time, depression and a preference for online interaction. Weekly playing time ($\beta = 0.31$) and preference for online interaction ($\beta = 0.30$) were the strongest predictors. In addition, attempting a high level of moderate-to-vigorous physical activity would predict decrease in problematic gaming symptoms.

5.3 Relationship between socio-demographics, digital gaming behavior characteristics and PGB among adolescents (IV)

5.3.1 Descriptive characteristics of the sample

The analytical sample comprised 465 participants (i.e., exclusion of 95 non-gamers) who ranged in age from 12 to 16 years. In terms of gender of the respondents, 37.2% were female ($n = 173$) and 62.8% male ($n = 292$). Average daily dosage for personal computer was around 1 hour (i.e., on minutes, $M = 72.07$, $SD = 111.33$) and for cell or smartphones around 2 hours (i.e., on minutes, $M = 123.15$, $SD = 117.27$). On average, respondents spent around 0.27 hours ($SD = 65.93$) on a typical day using a tablet. Boys ($Median = 38$) spent significantly more times ($U = 16588$, $p < 0.001$) on personal computers than girls ($Median = 16$) on typical day. On the contrary, girls ($Median = 120$) spent significantly more time using mobile or smartphones than boys ($Median = 77$) on typical day ($U = 20301$, $p < 0.01$).

Respondents spent an average of 74 minutes ($SD = 96.71$) gaming on typical day. Average daily gaming consumption was 63.92 ($SD = 82.57$) for seventh grade, 86.14 ($SD = 110.54$) minutes for eighth grade and 80.84 ($SD = 101.95$) for ninth grade respectively.

Boys daily gaming dosage ($Median = 60$ minutes) was notably higher ($U = 9950$, $p < 0.001$) compared to girls ($Median = 15$ minutes). Also, PGB scores were significantly higher ($U = 16453$, $p < 0.001$) among boys ($Median = 29$) than girls ($Median = 24$). The average PGB scores across different family structures did not vary significantly. A comparison of average daily gaming dosage (i.e., minutes) across different family structures showed that the students who lived in joint physical custody played the most ($\chi^2 (4) = 15.32$, $p = 0.004$) with a mean rank of 220 for nuclear family, 289 for joint physical custody, 261 for single parent household, 222 for blended family and 216 for other family structure.
Gamers’ most favored game types were Casual Games 23.9%, followed by Shooting Games 19.8%, Sport games (for example, Pro Evolution Soccer, Virtual Tennis) 12.9%, Multiplayer Online Battle Arena (MOBA) (for example, Heroes of Order & Chaos, Vainglory) games 5.8%, Solo Video Games 5.2%, Vehicle Simulation Games 4.5%, Massively Multiplayer Online Role-Playing Game 3.9%, Strategy and Management Games 3% and other games 13.8% respectively.

### 5.3.2 Relationship between socio-demographics, digital gaming behavior and PGB

Multiple linear regression analyses were conducted to estimate which independent factors contribute to PGB. The results of the regression analysis are displayed in Table 15. Blended family structure, daily gaming time and certain game genres (e.g. MMORPG, solo and strategy-management) were positively associated with the total PGB scores. In contrast, the ninth grade of school was negatively associated with the total PGB scores. Taken together, blended family structure, preference for certain strategy-action-role-playing game genres and daily digital gaming consumption contributed significantly to the variance in problematic use of digital gaming (27.7%, \( p < 0.001 \)).

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Beta</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.2773</td>
<td></td>
</tr>
<tr>
<td>Daily gaming time consumption</td>
<td>0.4493</td>
<td>0.2773</td>
</tr>
<tr>
<td>School grade nine</td>
<td>-0.1723</td>
<td></td>
</tr>
<tr>
<td>Blended family structure</td>
<td>0.1081</td>
<td></td>
</tr>
<tr>
<td>MMORPG preference</td>
<td>0.1202</td>
<td></td>
</tr>
<tr>
<td>Solo game preference</td>
<td>0.1242</td>
<td></td>
</tr>
<tr>
<td>Strategy-management game preference</td>
<td>0.1071</td>
<td></td>
</tr>
</tbody>
</table>

Note: Standardized regression coefficients. Statistically significant associations shown in \( ^1 p < 0.05, ^2 p < 0.01, ^3 p < 0.001 \).

### 5.4 Summary of the main results

The results indicated that multidimensional outcomes were related to the PGB in adolescents and young adults (Figure 5). A systematic review showed that several health outcomes were prevalent in PGB including depression, anxiety, attention...
deficit, low social competence, problems in social relationships and somatization. The meta-analysis verified small-to-medium health outcome effect sizes for anxiety and depression associated with PGB. In summary, the majority of these thematic outcomes were categorized in the psychological health domain (depression, anxiety, attention deficit), with fewer outcomes identified in the social (low social competence, problems in social relationships) and physical (somatization) dimensions. The effect sizes of PGB on health-related factors were heterogeneous.

Fig. 5. Multidimensional outcomes for PGB in adolescents and young adults.

Even though most of the adolescents and young adults regularly play digital games, the number of gamers who identified having PGB symptoms were low. Finnish males showed higher rates on digital gaming consumption and PGB symptoms than females. Findings from this cross-sectional, national study showed that specific digital gaming behavior (i.e., gaming duration, game types of role-action-adventure, gaming motives of entertainment-achievement, social and escapism), psychological (i.e., depression, anxiety, sleep problems, fatigue and in-ability to concentrate) and social (i.e., preferences for online social interaction) outcomes related to a higher level of PGB symptoms.

Findings from a regional, cross-sectional study suggested that certain socio-demographics (i.e., male, blended family structure) and digital gaming behavior characteristics (for example, gaming time and certain game content) are associated with PGB. In this sample, levels of PGB was positively related to being male and
in a blended family structure, with daily gaming consumption. A preference for game characteristics encompassing solo, strategy, multiplayer and role-playing features related to elevated self-experienced PGB symptoms.

When examining the overall effect sizes of depression and anxiety symptoms in PGB found from both the present review and national study sample, it can be seen that the effect sizes of the present cross-sectional sample approached lower in magnitude in relation to the combined total effect estimation. Details of these combined effect sizes are presented in Figure 6. Current results concurred with previous studies and showed a low-to-moderate overall association between PGB and depression and anxiety symptoms.

![Fig. 6. Studies and effect sizes of relationship between PGB and depression and anxiety among adolescents and young adults.](image-url)
6 Discussion

This chapter begins with a discussion and integration of theoretical views and the specific findings arising from the study. Next, the discussion of the validity and reliability of the study are provided. Finally, the practical implications and a general conclusion are addressed.

6.1 Discussion of the results

6.1.1 Relationship between PGB and health outcomes among adolescents and young adults (I)

As a whole, various health-related outcomes had been statistically specified to be related to PGB, namely, psychosocial, physical and comorbid symptoms. This systematic review and meta-analysis established small-to-medium effect sizes for a range of health-related factors in relation to PGB.

Overall, the findings of this review supported the previous conclusions (for example, King et al. 2013), and showed that the assessment practices of PGB had varied a lot across studies in the field. Moreover, results from the present review analysis that a wide variability of diagnostic methods were used to assess health-related outcomes that might have accounted for the variation in PGB related health outcomes. In order to get more reliable research, further robust updated and validated assessment instruments should be used. This review also highlighted the fact that no standard diagnosis and assessment methods exist for PGB.

The most common psychological variables connected to PGB were depression and anxiety (for example, Starcevic et al. 2011, Lemos et al. 2016), which align with the previous evidence base (for example, King et al. 2013, Kuss 2013). Consistent with the meta-analyses, the present study revealed significant small-to-medium effect sizes for depression and anxiety associated with PGB. These findings suggest that these symptoms and PGB may co-exist. Supposedly, in some cases the gaming has been used as purpose to cope with real life problems (for example, stressful situations), which again may contribute to the potential for PGB symptoms (Billieux et al. 2011). However, on the contrary, it is also possible that gaming could be used as a way to cope with the primary disorder (Gentile et al. 2011, Li et al. 2011). Because cross-sectional data mainly used a lack of temporal scope, potential progression of the condition and its related causative links could
not be provided. Future studies should pay attention to the direct and indirect symptom connections of PGB and its related comorbid disorders, which as yet seems to be somewhat limited due to emphasis on cross-sectional study design.

This review also showed that certain social problems were connected to PGB symptoms. Some studies reported that problems and conflicts in family interactions may be linked to the increased PGB symptoms (for example, Baer et al. 2012, Rikkers et al. 2016). It appeared that lack of supportive family relationships increased the risk for PGB. In addition, the results suggested the importance of the role of the social self-efficacy concerning the protection of PGB (for example, Rehbein et al. 2010, Jeong & Kim 2011). In sum, specific individuals' social features and relationships may partly contribute to the susceptibility for PGB symptoms, which in turn, when combined with different stressful situations may further increase detrimental immersion in gaming and its social functions instead of a real life social situations.

Evidence also showed that specific physical factors statistically related to PGB symptoms, namely, somatization (for example, Starcevic et al. 2011, Müller et al. 2015) and sleep problems (for example, Rehbein et al. 2010, Kim NH et al. 2016). However, according to the studies reviewed the psychosocial factors associated with PGB were more often emphasized and reported than studies addressing underlying physical determinants. Based on the analysis of the reviewed studies, the relationship between PGB and physical health problems is not unambiguous, especially concerning the factors of physical activity or fitness and body composition. Moreover, only a few studies addressed the musculoskeletal and obesity issues in PGB. Findings from the review highlight the need for future research efforts to take into account health-related physical factors.

6.1.2 PGB among adolescents and young adults and its relationship to self-awareness of PGB, game genre preferences, gaming motives and health outcomes (II, III)

Results from current study showed that for the large majority of adolescents and young adults gaming seemed to be a harmless recreational activity. A relatively small proportion of gamers displayed elevated PGB symptoms. In the present study, 9.1% of the respondents showed characteristics of PGB according to the polythetic approach (Lemmens et al. 2009). These results must be interpreted with caution, as a less-strict approach was used in evaluation. Previous studies have shown diverse
prevalence rates of PGB due to a variety of sampling and assessment practices used (Griffiths et al. 2012).

This was the first study investigating the existence of PGB in Finland so there was no comparison material available from this area. However, our estimation of existence of PGB differed from some points reported by other European studies. Representative studies from Dutch and Norwegian samples estimated the prevalence of problematic gaming were 1.3 (monothetic format, 3.3 percent among adolescents and young adults) and 4.1 (polythetic) respectively (Mentzoni et al. 2011, Haagsma et al. 2012b). The difference between the results from present study and those mentioned to above can be partly rationalized by the incorporation of older age groups in compared studies. It is also essential to be noted that the polythetic method measuring video game addiction may give a higher estimated prevalence. Representatives studies using a monothetic approach have reported relatively lower prevalence rates (Mentzoni et al. 2011, Haagsma et al. 2012b, Festl et al. 2013).

This study also showed that gamers who displayed PGB self-perceived it only in the situation where they engaged more severely (i.e., relatively high PGB scores and gaming dosage) on gaming. Presumably, it could be argued that people do not see excessive gaming as a risky habit compared to, for instance, generally accepted harmful behavior such as substance abuse.

As hypothesized (hypothesis 1), the study results were consistent with previous evidence showing structural characteristics of games, namely, role playing, action and strategy elements (for example, RPG and MMORPG) to be related to experienced symptoms of PGB (Lee et al. 2007, Smyth 2007, Kuss et al. 2012b, Lemmens & Hendriks 2016). These game types are characterized by particular features including, for instance, role-play immersion, in-game induced reward, complex progress and “never-ending” nature, which may further contribute to an uncontrolled way of playing (King et al. 2010, Billieux et al. 2014). On the contrary, a recent study by Lee and Kim (2017) found that game genres such as RPG, simulation and casual were positively linked to PGB among adolescents. In another study, it appeared that game genre might induce a greater time consumption used for playing (Johnson et al. 2016). Findings from this study showed that the duration spent on game genres such as MMORPG, role-playing, MOBA and strategy games in particular increased significantly (Johnson et al. 2016). Consequently, these findings also aligned with results showed that consumption of many game genres might add susceptibility to PGB among adolescents (Donati et al. 2015). Taken together, the present study verified the current knowledge of attributable of game
genres in PGB symptoms. In light of this evidence, it seems feasible that digital game players favor a certain cluster of game genres. In terms of an educational view, these findings implicate that counselling processes could also take account of young people’s preferences and engagement to the certain game genres.

In the current study PGB was significantly related to the escapism and achievement motives, which was also in line with previous data and an expected hypothesis (hypothesis 2) of the present study (Billieux et al. 2011, Hellström et al. 2012, Billieux et al. 2013, Hull et al. 2013, Billieux et al. 2015). It can be argued that in some cases escape problems in PGB may reflect the symptoms of other underlying issues (for example, anxiety, depression). Consequently, achievement motive may reflect player’s constant interest to solve time-consuming in-game items or tasks (i.e., rewards).

In the present, certain social motives (i.e., “it makes me feel less lonely, I can meet new people and it offers a way to participate in different social communities and discussions”) were related to the PGB. The present study showed that individuals with PGB were more likely to prefer to be in social interaction through online gaming than face to face. This finding is consistent with a recent study that showed association between attractions in the social points with time consumption for playing (Johnson et al. 2016). It was also found that PGB, depression and anxiety strongly co-occurred and these factors together may result in gamers’ social withdrawal. This could partly explain anxiety symptoms that had been previously been linked to the difficulties in interacting with peers in person and a preference for online social interaction (Caplan 2007, Yen et al. 2012). Accordingly, it can be supposed that this online social preference had partly built up by peer pressure that is the result of the involvement in the gaming communities. Consequently, some previous studies have found gaming environment-related social motives is a part of the risk of PGB development (Zanetta Dauriat et al. 2011, Hull et al. 2013). In summary, players who predominantly play games with a social motive may be more likely to develop a problematic manner for gaming.

Regarding the health outcomes, the current study found unfavorable connections of PGB on psychological and social health outcomes, namely, self-reported mood (i.e., depression and anxiety symptoms), sleep quality, vitality and concentration ability among adolescents and young adults. Moreover, life satisfaction inversely related to PGB symptoms. The current findings were consistent with previous evidence showing PGB related to the experienced symptoms of depression and anxiety (for example, Mentzoni et al. 2011, Vukosavljevic-Gvozden et al. 2016) and similarly to about the evidence of the
relationship between PGB and life satisfaction (for example, Montag et al. 2011, Festl et al. 2013). Further, it should be noted that PGB in specific cases, may incite proneness to depression and anxiety (Gentile et al. 2011). Since a cross-sectional design was used in the present study, it was not possible to indicate whether elevated psychopathological symptoms were triggers for PGB or whether PGB was the cause for distress. Because there is evidence that PGB is associated with the co-occurrence of a variety psychological problems it implies that there is the possibility to address in counselling approaches in the comprehensive way.

In the present study no connection was found between PGB and BMI or musculoskeletal ailments. However, it found that a high level of moderate-to-vigorous physical activity could protect from PGB symptoms, which was consistent with a previous study by Serrano-Sanchez et al. (2011), which showed that individuals who engaged regularly in organized physical activity were less likely to show signs of excessive gaming. A study by Mentzoni et al. (2011) showed that PGB was not related to the level of physical activity. Some previous studies had indicated associations between high involvement with gaming and certain physical health problems, namely, hand, wrist (for example, Gentile 2009, Choo et al. 2010), neck and shoulder impairments (Lui et al. 2011). Despite the increased amount of research examining the impact PGB has on the gamers psychosocial health, less research has targeted the physical factors. Future research should address this imbalance by addressing more efforts on this issue.

6.1.3 Relationship between socio-demographics, gaming mediums, gaming genres and PGB among adolescents (IV)

As gaming technology and the internet develops, it becomes crucial to distinguish the role of different digital gaming mediums in PGB. In the present study, PGB potential was addressed in the context of various technology medium that enabled gaming, including personal computers, tablets and smartphones. The study targeted adolescents aged 12 to 16 years and encompassed the age groups (adolescents aged 10 to 19 years), who recently reported to having played the most digital games in Finland (Mäyrä et al. 2016). Taken together, the present study showed that specific socio-demographic and digital gaming behavior patterns were associated with perceived PGB.

In this study adolescents reported to use their free time by spending on average 2 hours using cell or smartphones, more than 1 hour on a computer and almost half an hour on a tablet. These young people reported having played digital games on
average for about one hour on typical day. Involvement in computer and smartphone use appeared to increase towards upper grades, which is in accordance with the fact that mobile phones have become one of the main information and communication technology (ICT) used worldwide (ITU World Telecommunication/ICT indicators Database, 2015).

In the present sample, adolescents reported to spend on around five hours with digital media per day. This result was in line with current statistics, which have reported total screen activities as around seven to eight hours per day (Hale & Guan 2015). Consequently, this is well above the recommendations by national authorities that advises to limit daily screen time with entertainment media to no more than 2 hours per day (Tammelin & Karvinen 2008). However, the appropriateness of these guidelines are not explicit with regards to the view of how screens have become highly integrated into everyday life.

In terms of digital gaming, the average daily gaming time ($M = 74$ minutes) was different compared to the recent study data from the country, which showed that adolescents aged 10 to 19 years played digital games on average 12 hours per week (Mäyrä et al. 2016). Based on self-report data of the present study, digital gaming comprised about 37% of total, daily free time digital media use.

In the present study, a significant difference in the self-report PGB symptoms between boys and girls was observed, which is in the line with previous data showing PGB has been reported more among male players (for example, Rehbein et al. 2010, Haagsma et al. 2012b). This result may indicate boys’ predisposition towards competitive activities (Kuss et al. 2014).

A meaningful result in this study relates to family functioning. Elevated gaming dosages and PGB rates were related to the adolescents living in joint physical custody and blended families compared to nuclear family structure. A possible explanation for this situation could be related to a maladaptive coping strategy, which means that high involvement in gaming in certain cases is a gamer’s handling strategy when young people are facing life changes and negative emotions (for example, to enter in the role of a fictional character to avoid real life problems) (Billieux et al. 2011). This argumentation supports the view of family harmony’s importance on the psychosocial development of adolescents.

Players’ gaming duration emerged as an important aspect in the elevated symptoms of PGB, which is consistent with the previous data (Haagsma et al. 2012b). The amount of gaming time reached the highest rates among adolescents in eighth grade and it slightly decreased across other grade groups. Adolescents in eighth grade also had the highest PGB scores. It is likely that these young people
in their late teens may shift to use mobile phones more for communication through functions such as social networks, emailing or texting (Allen et al. 2014).

Previous studies have not explicitly addressed the importance of different media devices use (as a channel for gaming content) in relation to PGB symptoms. Although adolescents use widely different media devices, in this study sample there was not a strong relationship between certain media form consumption and PGB symptoms. In the present study the most popular game type, Casual games (for example, Candy Crush Saga), as well as identified problematic behavior potential game types such as MMORPG, and strategy-management, are widely accessible through different devices like smartphones and tablets (Griffiths 2014) of which casual games use is characterized by high frequency, rather than long duration. Notwithstanding, social networking and digital gaming have both been found to be specific technology use activities that may contribute to the problematic behavior potential (Andreassen et al. 2016). It is plausible that adolescents increasingly use these activities side by side for entertainment purposes, also through portable devices (Ofcom 2015) with the multi-genre and multi-platform use (ESA 2016).

6.2 Validity and reliability of the study

6.2.1 Systematic review and meta-analysis (I)

In order to minimize subjective selection bias, the study selection process of the review was conducted in clearly district phases, which followed CRD (2009) guidelines. The selection phase of the review was designed with an information specialist and the standardized methodological quality and risk-of-bias check were included in the review process to elude possible misleading conclusions (CRD 2009, JBI 2014).

Two independent research experts carried out the study selection process (CRD 2009). The whole review process from the search strategy to analysis was documented rigorously to ensure their reproducibility (CRD 2009). The search strategy covered all relevant databases in order to reduce the risk of publication bias (CRD 2009). However, language restriction (i.e., only articles in English included) was applied at the study selection phase and thus there was risk in some extent for publication bias (CRD 2009).

To identify relevant studies for the review, well-specified inclusion and exclusion criteria were used. The focus of this review was broad and included a
considerable number of health outcomes and assessment tools. The mean age limit of 12.5 was used in the inclusion criteria in order to avoid rejecting many relevant studies where the age range also covers younger adolescents (for example, 10–15 years). We wanted to focus on such studies that addressed possible adverse health-related outcomes in PGB and thus studies that covered therapeutic games with related activities were excluded from the analysis. Further, the positive impact of gaming had been addressed and discussed in the previous systematic literature review (Connolly et al. 2012).

To determine age-specific associations on the relationship between PGB and health factors, sub-group analyses were conducted. The sub-group analyses provided information about health-related effect size differences on different age periods (Higgins & Green 2011).

There was a strong heterogeneity between studies in terms of assessment of PGB and health-related outcomes, and to synthesize these complex findings rigorously a narrative synthesis and meta-analysis were both utilized. The present narrative review clearly identified a relationship between anxiety, depression and PGB. Thus meta-analysis was conducted to highlight an association between these outcomes and PGB. However, some papers had missing information on sample characteristics making it unfeasible to resolve whether basic demographics posed confounder factors for the PGB and health outcomes.

In the studies included in the review, the degree of quality ranged from moderate to high, and in order to avoid selection bias no studies were excluded from the synthesis based on this quality appraisal (CRD 2009). In terms of the possibility of publication bias, the level of heterogeneity among the effect sizes (i.e., health outcome correlates in PGB) was determined through I²-rates, ranging from 0% to 100%. Results showed a significant level of heterogeneity among the outcomes (I² > 75%). However, results from Funnel plots inspection indicated that there was no significant risk of publication bias present.

The studies reviewed underwent critical appraisal concerning their methodological and qualitative aspects. In sum, appraisal weaknesses related broadly to the following things: (1) the majority of studies were cross-sectional designs, (2) a lack of a mixed-methods design (i.e., integrating quantitative and qualitative methods), (3) most of the studies used non-probability-sampling (i.e., convenience sampling technique), (4) the assessment of the exposure and outcome variables based on self-reporting and partly non-validated instruments (especially if a separate single question used to determine health outcomes). It was also found that most of the studies used online survey methods, the suitability of which, in
terms of reliability and validity, has been previously supported (for example, Gosling et al. 2004).

**6.2.2 Cross-sectional, national study (II, III)**

The validity of the study encompass quality, accuracy and relevance of study elements and conclusions (Heale & Twycross 2015). Reliability refers to adequate precision of the assessment tools (Heale & Twycross 2015). In the present cross-sectional study, validity and reliability of data gathering instruments have been considered. The internal and external validity of the results of the study are discussed. First, information is given about the validity components relating to data collection.

A national, cross-sectional study design was utilized to identify digital gaming behavior, PGB and health-related outcomes. A randomized, stratified sampling method was selected to avoid risk of sampling error (Breakwell et al. 2012). A pilot study was conducted for 30 adolescents who represented similar characteristics as a target group before the actual data gathering to confirm the feasibility (for example, applicability of the instructions and questions and how much time would be needed to complete the answering) of the online, self-completed questionnaire (Everitt 2006, Breakwell et al. 2012).

An online questionnaire was used, which is very popular in behavioral science and has been shown to be useful (i.e., valid and reliable) as a research tool (Gosling et al. 2004). A semi-structured questionnaire was applied in the study, which has been considered to be a useful form specifically for assessing respondents’ behavior and knowledge (Moule & Goodman 2009). Data collection based on self-reporting is also very common in this field and it has many benefits compared to, for instance, the interviews including following: (1) survey gives the possibility to gather data from bigger samples; (2) it minimizes bias from the interviewer; (3) it permits deeply deliberated answers rather than hasty responses; and (4) it is anonymous. Limitations of this method include restricted control and typically a somewhat low response rate (Frankfort-Nachmias & Nachmias 1996). However, because of the self-reported survey questions used in the study, there was the possibility for misestimation (i.e., social-desirability bias) especially relating to behaviors (for example, physical activity and digital game-playing time) that are hard to recall (Affuso et al. 2011, Kahn et al. 2014).

In terms of content validity, previously used and tested health-related measures were selected based on a theoretical concepts that thoroughly cover psychological,
social and physical construct of health (Heale & Twycross 2015). For selecting survey measures, an external expert’s (whose doctoral research was conducted in the same field) opinion was asked and taken into account to verify that the study cover all relevant components. Measures of Preference for Online Social Interaction (Haagsma et al. 2013) and The Satisfaction With Life scales (Diener et al. 1985) were previously utilized in a multicultural context. Measures that determined physical activity and psychological and physical symptoms were previously used in Finland (Kunttu & Pesonen 2013). These measures were also suitable for the target groups of adolescents and young adults. The current study used previously validated measures with the exception of gaming genre and motive assessments, which were planned for the structure of the current study due to a lack of previously developed suitable instruments (for example, taking into account both online and offline gaming).

When the study protocol was planned no consensus existed on theoretical definition of PGB. Eventually, the Gaming Addiction Scale (GAS) was used to determine symptoms of PGB. GAS had previously been successfully and trustfully utilized and tested in Europe (Lemmens et al. 2009, Mentzoni et al. 2011, Haagsma et al. 2012b). The seven item version of the Gaming Addiction Scale (GAS) for adolescents was adapted from English to Finnish through a procedure of back-translation. Even though the GAS scale was designed to assess adolescents’ PGB symptoms, this method has proved to be suitable to a wide age range (Festl et al. 2013).

For the purpose of criterion validity correlates were determined with theoretically related constructs between PGB, gaming time and depression symptoms. In this survey, any other alternative correspondence measures that determine the same PGB or health-related characteristics were not used (i.e., criterion related validity) (Heale & Twycross 2015).

Internal consistency evaluation for all such measures included a set of items to determine particular characteristics (for example, GAS, preference for online social interaction, satisfaction with life) was provided for validation purposes by using Cronbach’s alpha results. Internal consistency was verified by using Cronbach’s alpha where the score 0.70 or higher was considered to be sufficient (Nunnally 1978).

A couple of relevant issues needed to take into account the internal validity of the results. Because of a cross-sectional design, any conclusions about causality connections were not able to be provided. The sample of the study based on random
heterogeneity but a low response rate may restrict the statistical power to a certain extent.

Suitable and reliable measures and analysis procedures were used. Inadequate data was cleaned before conducting analysis. A possible relationship between confounding factors (i.e., gender, age and occupational status) and PGB related variables (i.e., gaming time, PGB scores) were also checked in the analyze phase by segmenting the data based on socio-demographic and gaming behavior characteristics. It was also verified that the statistical analysis was not violated by assumptions (i.e., normality test performed, parametric and non-parametric test used accordingly). General findings of the study were also consistent with the previous data.

In terms of the external validity, the results of the study concerned mainly adolescents and young adult students, which implies findings cannot reflect other age groups. Even if a randomly selected and national-scale study method could be seen a strength of the study, a relative low response rate (9.8%) might restrict the generalization of the study results. In addition, even if the study design was based on randomly selected sampling, the final population mainly included students and thus the results are not generalizing other occupational statuses (non-response bias) (Breakwell et al. 2012). This possibly reflects a fact: students are more likely to participate in this kind of study design. However, study participants were obtained within all ages of target groups and from both genders, showing balance of data in this side.

### 6.2.3 Cross-sectional, regional study (IV)

This cross-sectional study was purposively targeted towards the junior high school students in the region of northern Finland to provide answers to the research’s questions relating to gaming context in PGB among adolescents. A selection of the target group of this study based on findings and related assumptions of the first study phase and previous literature indicated the vulnerability of problem behavior (Griffiths & Wood 2000, Griffiths 2011, Schwartz et al. 2015) and certain digital gaming behavior (for example, popularity of mobile gaming, Mäyrä et al. 2016) are apparent in this age group.

Regarding the content validity, study variables (i.e., survey construct) were selected to cover all relevant content of the study phenomenon including socio-demographic, digital gaming behavior and PGB (Breakwell et al. 2012). Digital gaming behavior patterns were selected for the study content due to the lack of
previous studies that had evidenced the role of different gaming devices (i.e., hand-held gaming devices and personal computers) especially associated with PBG symptoms (Griffiths et al. 2015a). Selected measures of digital gaming behavior patterns had been previously used in the multicultural context and its development had participated a group of expert in the area.

The instrument Problematic Online Gaming Questionnaire (POGQ) was adapted to identify cases of PGB (Demetrovics et al. 2012). POGQ was considered to be relevant in terms of different gaming context (i.e., played through both internet- and non-internet-based platforms) and content (i.e., game genres) (Griffiths et al. 2015a) and its validity and reliability was established previously (Demetrovics et al. 2012). This is the only known assessment tool of PGB in which its operationalization of a construct has included a face-validity phase conducted in the collaboration with online game players (Demetrovics et al. 2012). To adapt the instrument in the Finnish version the back-translation process was conducted. However, there was a possibility of over or under reporting due to outcomes assessed by using self-reported rates.

To evaluate the appropriateness of the Finnish version of PGB instrument, internal consistency and convergent validity were assessed (Breakwell et al. 2012). In terms of inter-item association for instrument’s subscales, Cronbach’s alpha was determined for the POGQ. Convergent validity was verified for the measure of gaming time included in the current study, which correlated with PGB construct also showed in previous research.

Participants’ descriptive and gaming-behavior-related characteristics were described and gender differences in these values were determined. Two of the most appropriate statistical methods (i.e., correlation coefficients, linear regression) were used to examine relationships between dependent (PGB, POQO scale) and independent (i.e., socio-demographics, digital gaming behavior) variables.

The selection of sampling strategy was made based on the nature of the target population, survey design and structure and available resources (Breakwell et al. 2012). The data was administered to the adolescents by a trained researcher with teachers during class time. Because this study phase was based on a non-probability sample, there are limitations with regard to generalization of results. According to these findings and in terms of external validity, valid inferences about the other age groups they represented are not possible to make (Breakwell et al. 2012). However, this study gave valuable, exploratory data for further research of the phenomenon in the country.
6.3 Implications of the study

The scientific knowledge surrounding digital gaming behavior and PGB is maturing and it is very important to clarify this phenomenon and its related aspects. The present study gave valuable knowledge and integrated it to existing information, therefore the findings may help to advance in the areas of lifestyle counselling, screening and treatment for PGB and its related comorbid conditions. In addition, notice should be taken to these issues by the scientific, health professionals and wider societal level.

Most of the adolescents and young adults who regularly play digital games do not experience problems concerning the activity or being at risk of PGB. It is also possible that those who play for recreational purposes are unlikely to progress to a case of PGB. However, among those who experience severe PGB it may significantly interfere with their life in many ways. The importance of PGB for players’ health is affected strongly by individual characteristics, the digital gaming behavior and social relationships.

This is the first study that estimates the proportion of Finnish adolescents and young adults who could be categorized as displaying PGB. Around one out of ten people rated positive on the assessment and were categorised as risk players. Given the limitations of the survey (for example, response rate and number of participants), findings give an initial insight into the phenomenon in the country. Consequently, current survey tests used in this study can be utilized as an early detection tool. In the field, no officially accepted definition of the condition exists and the best methods to meet the needs for assessing the phenomenon are still debated. Indeed, it is important to establish a suitable screening and diagnostic test for scientific and practical purposes.

One important view that can be noted from this study is that PGB commonly co-occurs with other adverse health outcomes including, for instance, depression and anxiety. Given this fact, effective interventions for detecting PGB may be adapted to the early screening of other negative health occurrences. In addition, early screening of young people addressed to this risk profile could help to diminish more severe problems evolving over time. Consequently, although digital gaming has also been linked to positive features, the present study elucidates the associations between PGB symptoms with health-related outcomes that warrants taking this phenomenon into consideration as a public health issue.

Regardless, there is a small number of adolescents and young adults who experience digital gaming related problems, it is plausible that this number is
expected to grow in the coming years due to increased immersion on technology and digital gaming behavior. It is important that recent and valuable information about the phenomenon is available for health professionals and policy makers. Proper information about the phenomenon would remove an unnecessary misunderstanding on the area.

To date, there are scarcely any authoritative guidelines or actual health promotion practices established for PGB individuals’ counselling, largely due to the unofficial status of the disorder. However, there have been some treatment interventions reported recently (Pallesen et al. 2015, Poddar et al. 2015). In terms of treatment methods, cognitive-behavioral therapy (CBT), pharmacological treatments and other forms of individual and group therapy approaches have been applied in cases of PGB (Kuss & Lopez-Fernandez 2016).

To date, some initiatives have been made in Finland to prevent and treat PGB. Preventive and counselling efforts to decrease the harm linked to PGB are provided mostly by substance abuse and gambling rehabilitation organizations, for example, A-Clinic Foundation and The Finnish Blue Ribbon (http://www.peliklinikka.fi). These organizations deal with monitoring and preventing problems related to gambling and PGB. They offer information, advice and support (for example, professional and peer support) for individuals with gambling and gaming problems.

At present, there is the potential to increase knowledge of PGB among health professionals and other service providers who deal with PGB individuals in Finland. Current studies provide valuable information that give further possibilities to refine the current knowledge base of PGB individuals counselling in the country. In light of this, it is important that all health promotion developments are tightly grounded in research evidence (i.e., evidence-based) that has rigorously adapted and evaluated to be based on a standardized model.

Overall, practitioners could seek possibilities to minimize harm related to PGB with other lifestyle challenges by tailoring a strategic, multimodal prevention program in the community, including a mix of individual, school and family-based activities. In this framework, it is possible to address beyond individual behavioral change by taking into account the physical and social environment that helps people to improve personal, cognitive and social abilities for sustaining good health. In addition, control capabilities of PGB and comorbidities can be strengthened within healthcare education by adhering evidence-based knowledge in the curriculum (for example, vocational education).
7 Conclusions

7.1 Conclusions derived from the results

The following conclusions can be stated based on the central findings (publications I–IV) of the study:

– Certain psychological, social and physical health outcomes were related to PGB symptoms among adolescents and young adults. Findings indicate that some adolescents and young adults with PGB may confront an elevated health risk at some point in their life and thus need to be educated about healthy digital game and media use patterns.

– For the majority of digital game players, this activity seemed to be an innocuous habit. A small group of Finnish adolescents and young adults displayed symptoms of PGB. However, a minority of the individuals with PGB self-perceived their problematic engagement in gaming, indicating that this phenomenon has not been seen as risky behavior compared with other generally accepted forms of addiction.

– Certain game genres and playing motives were positively associated with PGB among adolescents and young adults. Thus, the preferred content of digital gaming behavior and reasons why adolescents and young adults play digital games can be an integral part of the clarification of PGB. From these perspectives, in-game related structural mechanisms (for example, achievement and social functions of the games) may to some extent substitute the real world objectives and have a role in the progress of PGB.

– Young adolescents are accustomed to play digital games using many gaming mediums and the usage patterns predictors for PGB among these young people may change over the course of time.

– It appeared that the individual (for example, gender, motives for gaming), game (for example, game genre, gaming behavior pattern) and social contexts (for example, family structure) can play an important role with the degree to which PGB develops as a result of excessive digital gaming behavior.

7.2 Suggestions for future research

It is a fact that there is dilemma in assessment of PGB. Petry and O’Brien (2013) have argued that to include internet gaming disorder as a new mental disorder in
the future releases of the DSM the following strategies needed to be addressed in research progresses: (1) the features of the condition should be verified (for example, which things cause serious impairment); (2) a threshold of the diagnosis criteria has to be well established and validated cross-culturally; (3) occurrence rates must have been determined in representative samples all over the world; and (4) its course and related biological characteristics must have been evaluated. An important issue that can facilitate the instrument development of PGB is clinical validation, which could give a deeper estimation of the sensitivity and specificity for the screening purposes of the tests. These aforementioned statements would pave the way for future research towards the standard set of assessment criteria and further about the phenomenon’s correlates and consequences.

With regards to digital gaming behavior and PGB, it is crucial to understand how certain activities may turn out to be a harmful habit in adolescents and young adults. Because it is not clear whether PGB is a chronic or periodic phenomenon, it is essential to explore the natural course of the condition. To verify this, longitudinal studies (lasting more than two years) including quantitative and qualitative elements could help to understand the pattern of PGB in adolescents and young adults.

At present, a range of health and risk-related factors have identified in PGB. A majority of these factors can be classified at the individual level (i.e., psychosocial traits, gaming motivations and comorbid psychopathology) and fewer factors can be seen in the community (school performance) or societal level (guidelines, policies). The present samples examined with PGB assessment tools were relatively small, and studies with bigger sample sizes will be needed to gain a higher accurate estimation of the existence with its health correlates of the condition among adolescents and young adults.

Future studies could incorporate multidimensional factors (for example, ecological perspective, including cultural and societal elements) of digital gaming behavior meaning to gain more depth understanding of the determinants that influence adolescents’ and young adults’ PGB. As noted in a study by Király et al. (2015) future intervention evaluation may focus on distinguishing information including aspects such as gaming behavior (i.e., frequency), PGB-related symptoms, the condition’s influences on work, school or college functioning, directed activities in other leisure time pursuits and hobbies, and features of interpersonal connections.

As the vast majority of previous studies in this field used a quantitative research, a qualitative research could help to gain better understanding about young gamers
and their parents’ perspectives about PGB and what determinants possibly cause PGB symptoms with other drawbacks. Research with a group of young people who are living in different socio-demographic backgrounds would be worthwhile to identify the associations to relations within the immediate settings. 

There are some common fundamental risk factors (for example, impulsivity, psychopathology) between different problematic technology behaviors (Grant et al. 2010, Robbins & Clark 2015) that elucidate a view that future research should seek and compare interrelations between different problematic behavior patterns and health related symptoms. Specifically, further longitudinal investigation is needed to get more evidence about the similarities and differences influencing the progress of technology-based behavioral problems.

To date, healthcare system responses for possible risks related to PGB have been implemented to a lower extent. However, special treatment or rehabilitation programmes for PGB and related conditions are being organized in many countries, either integrated with other services or provided as separate self-contained services. The documentation of the effectiveness of prevention and rehabilitation interventions are still maturing. An experimental study could be conducted to train peer support individuals to counsel gamers with PGB and determine the effect of the programme upon counselling practice.

Taken together, further research is needed to validate a standardized instrument of PGB assessment. Future research should emphasize the holistic approach to enhance understanding of broader health, social and cultural features related to PGB. Randomized controlled and follow-up studies are required to verify health-related influences of PGB. Additionally, a mixed research method with developmental design that includes both qualitative and quantitative approaches, also examining notions and experiences of healthcare workers who are working with the people showing with the symptoms of PGB, could give more appropriate outcomes concerning the identification of the condition, experiences related to the condition and the role of different risk factors in it. Initiatives of the implementation of evidence-based practices or behavioral interventions with diverse samples in this area would be beneficial for improving the healthy technology use patterns and general health of the community.

Finally, although this study highlights the negative effects of PGB, research on digital games’ positive effects should not be ignored. To date there are barely any studies conducted that investigate both the positive and negative influences of the gaming. Instead of concentrating studies merely on either “good” or “bad” factors
of gaming, more comprehensive models in the domains of health influences would be important.
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