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Problematic digital gaming behavior and its relation to the psychological, social and physical health of Finnish adolescents and young adults

NIKO MÄNNIKKÖ[1]*, JOËL BILLIEUX[2] and MARIA KÄÄRIÄINEN[3]

[1]Oulu University of Applied Sciences, Oulu, Finland
[2]Laboratory for Experimental Psychopathology, Psychological Sciences Research Institute, Catholic University of Louvain, Louvain-la-Neuve, Belgium
[3]Research Unit of Nursing Science and Health Management, University of Oulu, Oulu University Hospital, Medical Research Center, Finland

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Background and aims: The aim of this study was to identify problematic gaming behavior among Finnish adolescents and young adults, and evaluate its connection to a variety of psychological, social, and physical health symptoms. *Methods:* This cross-sectional study was conducted with a random sample of 293 respondents aged from 13 to 24 years. Participants completed an online survey. Problematic gaming behavior was measured with the Game Addiction Scale (GAS). Self-reports covered health measures such as psychological health (psychopathological symptoms, satisfaction with life), social health (preferences for social interaction), and physical health (general health, Body Mass Index [BMI], body discomfort, physical activity). *Results:* Problematic gaming behavior was found to relate to psychological and health problems, namely fatigue, sleep interference, depression and anxiety symptoms. Multiple linear regression indicated that the amount of weekly gaming, depression and a preference for online social interaction predicted increased problematic gaming symptoms. *Conclusions:* This research emphasized that problematic gaming behavior had a strong negative correlation to a variety of subjective health outcomes.

Keywords: problematic gaming, problematic game behavior, health

INTRODUCTION

Digital gaming is an increasingly conventional activity found among adolescents and youth in general. Scientific findings indicate that some digital game players display dysfunctional, dependency-like features which resemble addictive behaviors (Griffiths, 2000; Grüsser, Thalemann & Griffiths; 2007; Kuss, Griffiths, Karila & Billieux, 2014). Early stage empirical research on negative outcomes of digital gaming have conceptualized the phenomenon in the framework of impulse-control disorder or behavioral addiction (Grüsser & Thalemann, 2006; Király, Griffiths & Demetrovics, 2015), and the criteria from the pathological gambling or substance dependence were used to define and assess the negative outcomes of digital gaming (King, Haagsma, Delfabbro, Gradisar & Griffiths, 2013; Kuss & Griffiths, 2012). Researchers have since investigated the nature, prevalence and etiology of the disorder. To date, Internet Gaming Disorder (IGD) has been included in Section 3 of the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association [APA], 2013) (Petry & O'Brien, 2013). However, this disorder has not been accepted yet as an official condition, as evidence is lacking regarding its etiology and course. Moreover, the severity of online gaming addiction may vary along a continuum from a mild to destructive condition, and to date no valid cut-offs or criteria exist to distinguish high involvement from problematic involvement (Charlton & Danforth, 2007; Kuss & Griffiths, 2011).

Digital gaming is known to affect several aspects of individuals' psychological, social health, and physical health. Digital game addiction is characterized by features such as low self-efficacy (Jeong & Kim, 2011), anxiety (Caplan, 2007; Wei, Chen, Huang & Bai, 2012), low self-esteem (Billieux et al., 2015; Caplan, 2007) and impulsivity traits (Billieux et al., 2015; Gentile et al., 2011). Moreover, maladaptive cognitions, shyness and physical problems (Peng & Liu, 2010) were also seen as predictive characteristics of gaming addiction. Gaming addiction was accompanied by symptoms which might have developed as a consequence of other disorders such as depression, anxiety and social phobia (Gentile et al., 2011). Correspondingly, addictive players exhibited signs or symptoms such as social neglect, loss of interest in other leisure activities, social and psychological isolation (Jeong & Kim, 2011; Young, 2009), escape problems (Billieux et al., 2015; Young, 2009), aggressive behavior (Anderson, 2004; Anderson et al., 2010), psychological stress, reduced school performance, decreased sleep quality, suicidal ideation (Rehbein, Kleiman & Mössle, 2010), low sociability and self-efficacy and lower satisfaction with life (Festl, Scharkow & Quandt, 2013). In certain cases, digital game playing was allowed to act as a coping strategy for deficiencies or problems in the player's life such as a lack of friends, relationship troubles, or

* Corresponding author: Niko Männikkö; Oulu University of Applied Sciences, Kiviharjuntie 8, FI-90220 Oulu, Finland; Phone: +358 50 409 6318; Fax: +358 10 27 21300; E-mail: niko.mannikko@oamk.fi

dissatisfaction with physical looks (Griffiths & Beranuy, 2009). Furthermore, prolonged exposure to digital game was associated with physical health problems such as musculoskeletal symptoms (Lui, Szeto & Jones, 2011).

In Finland, the effects of problematic game playing on players' health are still largely unexplored. Considering the increased prevalence of online gaming, this study aimed to identify the problematic gaming behavior among Finnish adolescents and young adults, and evaluate its connection to a variety of psychological (psychopathological symptoms, satisfaction with life), social (preferences for online social interaction) and physical health (general health, BMI, body discomforts, physical activity) symptoms. In this paper we consider problematic gaming behavior in accordance with the recent framework that sees it as "a continuum state which can range from a normal to severe condition" (Griffiths et al., 2015).

METHODS

Participants and procedure

The study surveyed 3000 individuals aged 13 to 24 years who were randomly selected from the Finland National Registry. Study participants were stratified and balanced for age and gender. Covering letters were distributed by post and responses could be submitted online. The study data were collected in March 2014. In total, 294 respondents completed the survey via a website. One respondent's data was excluded because of suspicious data. A total of 293 respondents of adolescents and young adults (mean age 18.7 years, SD = 3.4) were analyzed. The response rate of the survey was 9.8%.

Measures

Demographics and digital game playing. The questionnaire included questions concerning demographic characteristics (age, gender, education and occupation status) and specific items regarding digital game playing (the amount of time adolescents and youths spend playing digital games). Participants were asked to indicate the estimated mean time (minutes) devoted to video games per day and week.

Problematic gaming behavior. To assess problematic game behavior, we used a Finnish version of the seven-item version of the Gaming Addiction Scale (GAS). The GAS (Lemmens, Valkenburg & Peter, 2009) was developed to measure pathological gaming in a sample of Dutch adolescents. Two versions of the scale exist (a 21-item scale and a 7-item scale), and items were generated based on the DSM-IV pathological gambling criteria. In the current study, the 7-item scale was adapted from English to Finnish using a classical translation-back-translation procedure. The internal consistency of the GAS was high in the current study (Cronbach's $\alpha = .79$). The short version of the GAS scale contained one item for each of the seven criteria verified as core factors of digital game addiction (salience, tolerance, mood modification, withdrawal, relapse, conflict and problems). The items were rated on a five-point Likert scale: "never" (1), "rarely", "sometimes", "often", or "very often" (5).

Psychological health

Respondents were asked to indicate their psychological and physical symptoms such as sleeping problems, headache, weakness/fatigue, dizziness, ability to concentrate, depression and anxiety. The items used were adapted from The School Health Promotion (SHP) study, which aimed to assess the health and well-being of Finnish 14-20-year-old adolescents (Kunttu & Pesonen, 2013). Each of the items was scored on a four-point Likert scale: (1) "not at all", (2) "sometimes", (3) "every week", and (4) "daily or almost daily".

The Satisfaction With Life Scale (SWLS) was used to measure respondents' general satisfaction with life (Diener, Emmons, Larsen & Griffin, 1985). The SWLS included five assertions, with respondents being asked to select their level 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

The preferences for online interaction scale, created by Haagsma, Caplan, Peters and Pieterse (2013), was originally developed based on a cognitive behavioral model of problematic Internet use inspired by the work of Caplan (2010). Components of the model include preference for online social interaction, mood regulation, and deficient self-regulation. Two items assessing preference for online social interaction were retained 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 assessed on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Other items were generated by the authors to assess preferences for online interaction, namely "The social relationships of digital game playing are important to me"; "Social communities of digital game players are important to me"; "I feel that social communities of digital game players produce pressure to play even when I feel tired or bored"; and "I meet the same people in real life whom I interact with in the game environment". Responses were assessed on a Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5).

Physical health

General health was measured by using a five-point Likert scale ranging from "good" to "bad" adapted from The School Health Promotion study conducted by Kunttu & Pesonen (2013) in Finland. Body Mass Index (BMI) was determined from self-reports of weight and height. According to the criteria set by WHO (1995), a BMI score of 25.1–29.9 is classified as overweight, and BMI > 30 as obese.

Respondents were asked to indicate their bodily discomfort through three items, which were also used in The School Health Promotion study in Finland (Kunttu & Pesonen, 2013). This measurement included statements about upper back/neck ailments, lower back ailments and limbs or joint pain. Each of the statements was scored on a four-point Likert scale thus: (1) "not at all", (2) "sometimes", (3) "every week", or (4) "daily or almost daily".

Regarding the measurement of physical activity, two different aspects were included (Kunttu & Pesonen, 2013). Respondents were asked to indicate their frequency of engagement in moderate-to-vigorous intense sports or exercise lasting at least 30 minutes at once; 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 were also asked to indicate the amount 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".

Analysis

Statistical analysis was performed by using the SPSS (version 22.0) statistical software package. Descriptive analyses were conducted on problematic gaming behavior, psychological, social and physical health variables. Spearman correlation coefficients were used to compare associations between psychological health, preference for online social interaction, physical health components, the amount of weekly gaming and problematic gaming behavior (GAS scores). The total GAS scores were also used in this analysis, but other variables' coding was not modified for the purpose of correlation analysis.

To assess the differences among independent (presence of problematic game behavior) and outcome variables (psychological and physical symptoms: fatigue, sleep, inability to concentrate, depression and anxiety), a chi-square test was performed. These items were coded as irrelevant or relevant problems according to the reported frequency of symptoms. Answers of "not at all" or "sometimes" were coded as irrelevant problems (code 0), and answers of "every week" or "daily or almost daily" were coded as relevant problems (code 1). In addition, a dichotomous variable of BMI was used (adapted from WHO, 1995) in the chi-square test by assigning a BMI score of 25.1 or more as potentially overweight and 25 or below as normal weight. Related to the independent variable respondents were categorized as non-problematic gamers (coded as 0) or potential problematic gamers (coded as 1) based on a polythetic approach (Lemmens et al., 2009). More precisely, participants were considered as potential problematic gamers (PGBs) if they endorsed at least four of the seven components score 3, ("sometime"), 4 ("often") or 5 ("very often").

Multiple linear multiple regression analysis was used to evaluate the relationship between problematic digital game playing (GAS scores) and current occupational status, educational level, age, time spent playing weekly, general health, level of incidental exercise, moderate-to-vigorous physical activity, depression, satisfaction with life and preference for online social interaction. Regression analysis allows for highlighting of the relative importance of each predictor, and determines the specific effect of each because it takes into account the relations between the various predictors. The level of significance was set at $p < 0.05$.

Ethics

The study was conducted in accordance with the Declaration of Helsinki. All participants were informed about the study. The consent of the parent or guardian was obtained for study participants aged 13–14 via a letter addressed to the parent or guardian. Participation was voluntary. The online survey was answered anonymously (no personal data were collected, including individual Internet Protocol [IP] addresses).

This study is consistent with the ethical standards for research involving human participants, under the Code of Ethics for research within the School of Health and Social Sciences at Oulu University of Applied Sciences. It has received approval from the Research and Development Committee of the Oulu University of Applied Sciences.

RESULTS

Table 1 reports socio-demographic characteristics of the sample, along with GAS scores. Most of the respondents (92.5% of the sample, $n = 271$) reported having played digital games at least some time during the previous three months; 22 (7.5%) of the respondents had not played digital games at all. The gamers spent an average of 110 minutes per day playing digital games. Respondents' playing time per day varied from less than three minutes to 600 minutes. The Mann-Whitney test ($U = 3918$, $p < .001$) revealed that boys ($Mdn = 2$ hours) played significantly more per day than girls ($Mdn = 0.50$ hours). The average daily playing time across different age groups varied: the age

Table 1. Overview of demographics, age, occupation status, education level, playing time per day and week, and GAS scores

Categorical Variables	Frequency	Percentage of Sample
Gender		
Female	144	49
Male	150	51
Total	294	100
Occupation		
a) Full-time job	26	8.8
b) Part-time job	9	3.1
c) Unemployed or temporary lay-off	16	5.5
d) Student	226	77.1
e) Other	16	5.5
Total	293	100
Education level		
a) Elementary school	137	46.7
b) Secondary education	50	17.1
c) Other vocational education	4	1.3
d) Higher professional education	16	5.5
e) University	36	12.3
f) Other	50	17.1
Total	293	100
Continuous Variables	**Mean**	**Standard Deviation**
Age	18.7	3.4
Playing time hours/week	11.5	14.9
Playing time hours/day	1.8	2.3
GAS* scores (min 7 – max 31)	11.1	4.3

*Based on total, summated GAS scores.

group 16–18 years played the most (an average of 146 minutes per day), whereas the average time per day for other age groups varied from 88 minutes to 115 minutes. The proportion of the respondents displayed characteristic of PBG was 9.1% ($n = 24$). The amount of playing time per day was significantly higher (Mann-Whitney test, $U = 982$, $p < .001$) among problematic players ($Mdn =$ 3 hours) compared to the non-problematic ($Mdn = .88$ hours) players.

A correlation analysis for certain psychological, social, and physical health variables and GAS scores was conducted (see Table 2). The results revealed a strong co-occurrence of variables such as low general health, satisfaction with life, a preference for online social interaction and problematic gaming scores. These variables were significantly correlated to one another ($p < .01$). Preference for online social interaction indicated the strongest correlation with problematic gaming scores ($r = .45, p < .01$). High levels of satisfaction with life ($r = –.23$, $p < .01$) appeared to indicate a decreased vulnerability to problematic gaming symptoms. Proceeding to address the association between psychological, physical health, and problematic gaming behavior, correlation analysis showed significant connections between fatigue, depression, anxiety, sleep and problems concentrating on the problematic gaming scores. From these variables fatigue had the strongest correlation with a problematic gaming level ($r = .20, p < .01$).

Regarding the social context of game playing, about 31% ($n = 83$) of the participants reported that the social meaning of game playing is important to them. Correspondingly, 46% ($n = 11$) of the problematic players saw the social aspects of gaming as important; 50% ($n = 12$) of them met other players out in the real world. Overall, 26% ($n = 71$) of the respondents reported that they had met the same people they played games with in the real world. Only 5.6% ($n =$ 15) of the respondents thought that they preferred contacts in their gaming life compared to the real world. However, of the problematic players, 29% ($n = 7$) preferred contacts in the game environment.

In total, 96% ($n = 282$) of respondents reported their general health as either average or good. Further analysis showed that poorer reported health was not associated with severity of problematic game behavior. Results indicated that the sample mean BMI was 22.62 (SD = 5.10), ranging from 14.5 to 58.8. Additionally, a BMI of more than 25 was reported by 19% ($n = 57$) of the respondents. There was no connection between being overweight and problematic game behavior. Further analysis from a one-sample chi-square test showed that participants who played digital games for more than 15 hours per week were no more likely to have a higher BMI compared to those who played digital games less than 15 hours per week ($\chi^2 = 1.72$, $p > .05$). Likewise, no association was found between musculoskeletal ailments (in the upper back/neck, lower back, limbs or joints) and problematic gaming behavior. Whereas the chi-square test (see Table 3) revealed significantly moderate associations between problematic game behavior and health complaints such as fatigue ($\chi^2 = 9.72$, $p < 0.05$), sleep problems ($\chi^2 = 9.72$, $p < 0.05$), concentration problems ($\chi^2 = 6.24$, $p < 0.05$), depression ($\chi^2 = 13.58, p < 0.05$) and anxiety ($\chi^2 = 8.42, p < 0.05$), these findings were in line with the correlation analysis. With regard to physical activity, 26% of the respondents ($n = 76$) reported performing at least 60 minutes of incidental exercise per day. In addition, 62% of the respondents ($n = 183$) undertook some form of moderate-to-vigorous physical activity at least two times per week for durations of 30 minutes or more. Problematic game behavior was not associated with decreased physical activity.

To determine which of the selected risk factors contributes to the development of problematic game behavior in the most notable manner, a multiple linear regression analysis was used. The possible problem of multicollinearity among independent variables was confirmed from the variance inflation factor ($VIF < 5$) and the tolerance score ($IQ\ Scores,\ Tolerance > .20$). The data also fulfilled the assumption of independent errors ($Durbin\text{-}Watson\ value =$ 1.82), and the scatterplot of standardized residuals indicated that the data fulfilled the suppositions of homogeneity of variance and linearity. Table 4 presents the descriptive variables of the predictors performed in this model. Sixteen independent variables were entered into the model using the "enter" method. The dependent variable was the total score on the GAS and the independent variables were the dimensions of occupational status and educational level, age, general health, incidental exercise, physical activity, depression, the total score on the SWLS and the total score on the preference for online social interaction. The depression scale indicated a strong correlation with anxiety symptoms ($r = .69, p < .01$). To avoid the presence of multicollinearity, the anxiety scale was removed from the analysis. A preference for online interaction, being a student and depression were significant predictors of GAS scores. In addition, undertaking a high level of moderate-to-vigorous physical activity might protect from vulnerability to problematic gaming symptoms. Together these variables in this model explained 42.4% of the variance in participants' GAS scores ($F(16,234) = 10.76$, $p < .05$, $R^2 = .42$, $R^2 Adjusted = .38$).

DISCUSSION

The primary aim of this study was to identify problematic gaming behavior among Finnish adolescents and young adults, and evaluate its connection to a variety of psychological, social, and physical health symptoms. The article specifically explored the issue with a view to developing our understanding of the implications of problematic game behavior for health.

Our findings support previous evidence (e.g. Mentzoni et al., 2011) that persons with psychological health problems – such as self-reported depression and anxiety – were more susceptible to strong engagement with the dysfunctional features of digital game behavior. In addition, our study found that problematic game behavior related negatively to self-reported psychophysical health dimensions such as fatigue, sleep or concentration problems. Customarily, night-time game playing had been found to be associated with a likelihood of depression (Lemola et al., 2011). Nevertheless, in some cases anxiety and depression had been reported as possible outcomes of problematic game

Table 2. Bivariate correlations among psychological, social and physical health and problematic gaming behavior

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 ILL HEALTH	–																
2 HEADACHE	.17**	–															
3 DIZZINESS	.13*	.38**	–														
4 FATIGUE	.31**	.28**	.38**	–													
5 UPPER BACK/NECK AILMENTS	.23**	.37**	.34**	.36**	–												
6 LOWER BACK AILMENTS	.21**	.25**	.30**	.30**	.55**	–											
7 LIMBS OR JOINT PAIN	.19**	.32**	.38**	.24**	.37**	.48**	–										
8 SLEEP PROBLEMS	.21**	.27**	.35**	.33**	.28**	.18**	.23**	–									
9 CONCENTRATION PROBLEMS	.31**	.19**	.38**	.44**	.37**	.30**	.24**	.49**	–								
10 DEPRESSION	.36**	.21**	.37**	.41**	.31**	.19**	.23**	.40**	.45**	–							
11 ANXIETY	.37**	.24**	.37**	.40**	.35**	.24**	.28**	.40**	.46**	.69**	–						
12 POSI	.19**	−.03	.03	.13*	−.01	−.01	.01	.03	.14*	.06	.08	–					
13 SWLS	−.39**	−.02	−.06	−.21**	−.12*	−.02	−.05	−.20**	−.22**	−.37**	−.33**	−.24**	–				
14 PAI	−.27**	−.04	−.09	−.23**	−.13*	−.00	−.01	−.14*	−.17**	−.21**	−.15**	−.09	.27**	–			
15 PAMV	−.40**	−.07	−.01	−.18**	−.12*	.00	−.02	−.13*	−.14*	−.25**	−.22**	−.12*	.10	.40**	–		
16 WG	.19**	−.09	−.09	.02	−.11	−.04	−.03	−.04	.01	−.01	−.02	.44**	−.18**	−.12*	−.20**	–	
17 GAS	.26**	.03	.10	.20**	.09	.09	.04	.13*	.16**	.17**	.13*	.45**	−.23**	−.18**	−.27**	.58**	–

** < .01, * < .05, POSI = Preference for online interaction; SWLS = Satisfaction With Life Scale; PAI = incidental physical activity, PAMV = moderate-to-vigorous intense physical activity, WG = the amount of weekly gaming; GAS = Gaming Addiction Scale scores

Table 3. The prevalence of psychophysical symptoms* among adolescents and youths with non-problematic game and problematic game behavior (PGB), n (%)

SYMPTOM	NON-PROBLEMATIC GAME BEHAVIOR (N = 239)	PROBLEMATIC GAME BEHAVIOR (N = 24)	χ^2	P
FATIGUE	11 (5.7)	13 (18.1)	9.72	< 0.01
SLEEP	15 (6.8)	9 (20.9)	8.63	< 0.01
CONCENTRATION	17 (7.4)	7 (20.6)	6.24	< 0.05
DEPRESSION	15 (6.5)	9 (25.7)	13.58	< 0.001
ANXIETY	16 (6.9)	7 (22.6)	8.42	< 0.01

*The participants who reported every week or almost daily/daily to the point in question.

behavior (e.g. Gentile et al. 2011). Gentile et al. (2011) found in their longitudinal research that pathological gamers indicated higher scores on scales measuring ADHD, anxiety and depression. Thus, depression and anxiety had appeared as a function of an incitement or consequence of problematic game use.

The current study also identified social health risk factors that predicted involvement in problematic game use. Our findings showed that lower sociability (such as preferred communication with other people online rather than face to face) predicted problematic game playing. Our results also showed that lower satisfaction with life correlated positively with a preference for online social interaction. In addition, the study found that adolescents with high GAS scores were more likely to report lower levels of satisfaction with life – a finding which was in agreement with previous studies (e.g. Festl et al., 2012; Mentzoni et al., 2011). One piece of prior research revealed that lower psychosocial well-being indicators such as social anxiety were associated with a preference for online social interaction (Caplan, 2007). Yen et al. (2012) found that online interactions formed more pleasant conversational channels for individuals with social anxieties. Similar to the study findings above, Lemmens, Valkenburg and Peter (2011) demonstrated that pathological gaming related to diminished social competence, increased loneliness and lower self-esteem. Correspondingly, previous research by Snodgrass et al. (2012) also suggested that gaming among college-aged men can to some extent be a healthy source of socialization and relaxation.

In the current study, we defined physical health based on indicators such as BMI, musculoskeletal ailments, and exercise habits. It transpired that there was no significant difference in physical activity levels, BMI and musculoskeletal ailments between the participants who indicated

Table 4. Predictors in the linear regression analysis predicting problematic game behavior (GAS scores)

PREDICTORS	MIN	MAX	B	SE	T	P–VALUE	B
OCCUPATION							
FULL-TIME JOB	0 (no)	1 (yes)	.75	1.25	.60	.54	.04
PART-TIME JOB	0 (no)	1 (yes)	1.69	1.63	1.03	.30	.06
UNEMPLOYED OR TEMPORARILY LAID OFF	0 (no)	1 (yes)	2.12	1.41	1.50	.13	.11
STUDENT	0 (no)	1 (yes)	2.28	1.04	2.18	.03*	.21
EDUCATION LEVEL							
ELEMENTARY SCHOOL	0 (no)	1 (yes)	−1.38	.86	−1.59	.11	−.16
SECONDARY EDUCATION	0 (no)	1 (yes)	−.67	.82	−.82	.41	−.05
OTHER VOCATIONAL EDUCATION	0 (no)	1 (yes)	−1.05	1.96	−.53	.59	−.03
HIGHER PROFESSIONAL EDUCATION	0 (no)	1 (yes)	−.05	.78	−.07	.94	−.00
AGE	13	24	−.06	.11	−.56	.57	−.05
PLAYING TIME HOURS/WEEK	0.02	102	.09	.01	5.38	.00***	.31
HEALTH	1 (good)	5 (bad)	.51	.33	1.55	.12	.09
INCIDENTAL EXERCISE	1 (under 15 minutes per day)	4 (over an hour day)	.09	.26	.34	.73	.02
PHYSICAL ACTIVITY (MODERATE TO VIGOROUS)	1 (never)	7 (daily)	−.30	.17	−1.69	.09	−.10
DEPRESSION	1 (no)	4 (almost daily/daily)	.97	.30	3.14	.00**	.18
SATISFACTION WITH LIFE	extremely dissatisfied	extremely satisfied	.01	.03	.25	.79	.01
PREFERENCE FOR ONLINE INTERACTION	irrelevant	relevant	.68	.12	5.36	.00***	.30

* < 0.05, ** < 0.01, *** < 0.001, Base N = 250

normal and problematic game behavior. Even if gaming had been mostly considered as essentially a passive activity, previous studies had not indicated any connection between engagement in gaming and obesity (e.g. Bickham, Blood, Walls, Shrier & Rich, 2013; Wack & Tantleff-Dunn, 2009). However, a longitudinal study by Smyth (2007) had indicated that problematic involvement in online gaming was associated with, among other things, less physical activity and worse sleep quality. Correspondingly, a study by Serrano-Sanchez et al. (2011) revealed that boys' participation in organized physical activity might protect them from excessive gaming. The current study showed that a high level of moderate-to-vigorous physical activity could be a protective factor with regard to problematic gaming symptoms. Nevertheless, some previous studies had showed a connection between long-term involvement with dysfunctional gaming and physical health problems such as hand, wrist (e.g. Choo et al., 2010; Gentile, 2009), neck and shoulder discomfort (Lui et al., 2011).

The current study failed to identify a relationship between excessive involvement in digital games and increased susceptibility for musculoskeletal loading, as found in previous studies (Lui et al., 2011). However, this might be due to the fact this study focused on adolescents, whereas most existing studies having relied excessive gaming to musculoskeletal ailments have been conducted in young adults, characterized by prolonged use of digital games. Nevertheless, it is worth noting that problematic players reported relatively high engagement in gaming and are especially at risk of increased sedentary behavior.

Although the findings of this study have helped to clarify the health characteristics and consequences of digital game playing, we believe that caution needs to be exercised. We were not able to draw any conclusions about causality connections because of the study's cross-sectional design. A low response rate might restrict the possibility of making generalized conclusions, and the self-reported measures used in the study might cause under- or over-estimations of some results. A randomly selected and national-scale study protocol was felt to be a methodological strength in view of the fact that a lot of research in the field has been conducted with self-selected samples, which can result in bias (see Khazaal et al. (2014), for an example of this in the context of online game research). In addition, the population studied consisted of a wide age spectrum of adolescents and youths, providing a richer view of the role of problematic game behavior in their lives.

In conclusion, our findings show that problematic digital game use may be related to unfavorable psychological and social health characteristics and consequences for digital gamers. In our sample low satisfaction with life, depression and anxiety symptoms, fatigue, sleep interference and concentration problems are associated with increased symptoms of problematic game use. In addition, a low level of moderate-to-vigorous physical activity, depression and a marked preference for online interaction appear to act as predictors of problematic game use. These results imply that these psychosocial health problems may play a significant role among problematic players. High engagement with gaming can lead to neglect of sleep, hobbies and socializing. Thus, although we may say that in general prolonged and dysfunctional gaming can be detrimental, a better comprehension of the etiology and consequences of this activity would be useful in the multiform domains of health and education. More evidence is needed on who is at greatest risk, and where game-related health problems persist establishing what kind of help services would be most effective in tackling the issue would be invaluable.

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