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ORIGINAL CONTRIBUTION

Regular gaming behavior and internet gaming disorder in European adolescents: results from a cross-national representative survey of prevalence, predictors, and psychopathological correlates

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Abstract Excessive use of online computer games which leads to functional impairment and distress has recently been included as Internet Gaming Disorder (IGD) in Section III of the DSM-5. Although nosological classification of this phenomenon is still a matter of debate, it is argued that IGD might be described best as a non-substance-related addiction. Epidemiological surveys reveal that it affects up to 3 % of adolescents and seems to be related to heightened psychosocial symptoms. However, there has been no study of prevalence of IGD on a multi-national level relying on a representative sample including standardized psychometric measures. The research project EU NET ADB was conducted to assess prevalence and psychopathological correlates of IGD in seven European countries based on a representative sample of 12,938 adolescents between 14 and 17 years. 1.6 % of the adolescents meet full criteria for IGD, with further 5.1 % being at risk for IGD by fulfilling up to four criteria. The prevalence rates are slightly varying across the participating countries. IGD is closely associated with psychopathological symptoms, especially concerning aggressive and rule-breaking behavior and social problems. This survey demonstrated that IGD is a frequently occurring phenomenon among European adolescents and is related to psychosocial problems. The need for youth-specific prevention and treatment programs becomes evident.

Keywords Computer games · Europe · Internet Gaming Disorder · Prevalence · Psychopathology

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Introduction

In recent years, debates on the health-related effects of computer gaming behavior have emerged. Besides reports on positive effects of moderate computer gaming, e.g., on improved visual short-term memory [43] and increased quality of friendships [42], a lot of literature deals with the harmful effects of excessive and addictive gaming behavior [26]. The American Psychiatric Association (APA) [6] has decided to include Internet Gaming Disorder (IGD) in Section III of the DSM-5 as a condition warranting more scientific research and clinical experience before being considered as a full mental disorder, leading to both commendation and criticism among experts [36, 48].

It has been proposed that IGD has to be conceived as one subtype of addictive use of the internet (Internet Addiction, IA; [47]). As proposed by Young [47], IA can be understood as a multifactorial construct encompassing different kinds of online addictions [26] and

epidemiological studies have demonstrated that online gaming, use of social networking sites, and online pornography are significantly related to become addictive (e.g., [28]). However, this point has to be seen as courting controversies. There are also theories stressing that there is a difference between addictive use of specific internet contents and behavioral addictions that merely generalize to online contents through their sheer accessibility [15].

Symptoms of IGD and underlying neurobiological mechanisms (e.g., specific cue-reactivity towards gaming-related cues leading to craving and decreased cognitive control [25]) show parallels with other addictions [38, 46]. Patients report feeling an irresistible urge to play computer games (craving), are unable to control their gaming behavior (loss of control), and show patterns of tolerance by increasing time and frequency spent playing games. Signs of withdrawal can result in dysphoria, irritability, and even aggressive acts. Playing continues despite negative consequences in different areas of life, e.g., sleep disturbances [11] and diseases of the musculoskeletal system [20]. Furthermore, decreasing social contacts and increased feelings of loneliness have been reported [14, 40]. High rates of co-morbid disorders are common in IGD, especially ADHD, affective, and anxiety disorders [8, 9] although negative findings have also been reported [41]. Also, proneness to aggressive behaviors has been documented [21], but findings are inconsistent here [16].

Several epidemiological surveys have examined the prevalence of IA, showing that it seems to affect about 0.6–1.6 % of the general population, with adolescents being at greater risk [2, 10, 31, 35]. However, one problem of these surveys is the non-specific assessment of IA and at present only a few studies, mostly based on convenience samples, have dealt explicitly with IGD. For adolescents, prevalence estimations for IGD have been reported to amount to 2.7 % in Austria [7], 3.0 % in Germany [34] and 1.6 % in the Netherlands [41]. Higher rates have been documented for Asia (10.3 % in China [32]; 7.5 % in Taiwan [23]). One of the first representative studies to include subjects from the general population (aged 14–90 years) has been conducted in Germany [12]. A small prevalence of IGD of 0.2 % was found, which is partly due to the wide age range included but may also be explained by the higher threshold for IGS defined by the authors (instead of five criteria as proposed by the APA, the cutoff for IGD was set to seven criteria). In general, varying reports on prevalence rates seems partly due to the great variety of self-report measures applied. This heterogeneity makes it difficult to compare the results and has been critically reviewed [22, 33].

Despite these contributions, there are still many questions that need to be addressed in detail. At present, no epidemiological survey assessing IGD on a representative and multi-national basis is available. As IGD is recognized as a health problem, it is necessary to increase knowledge about its distribution within different groups of adolescents and its relationship with psychopathology. To this purpose, the research project, EU NET ADB [39] was conducted with the aim of further characterizing IA and IGD. The primary research questions of this paper are addressing country-specific prevalence of IGD, socio-demographic predictors and psychopathological correlates.

Method

Measures

The main questionnaire consisted of general socio-demographic characteristics (gender, age, country, parental situation). Computer gaming behavior was assessed with a specific questionnaire (see next paragraph) with four questions addressing use preference of different game genres (0 = never to 4 = very often). Additional information on the variables assessed can be found in the final report of the EU-NET-ADB project [39].

AICA-S-gaming

The Scale for the Assessment of Internet and Computer game Addiction—Gaming Module (AICA-S-gaming [45]) is a self-report questionnaire to classify computer gaming into non-problematic (0–6.5 points; fewer than 2 criteria fulfilled; NPG-group), at risk (7–13 points; 2–4 criteria met; at risk group) and addictive use indicating IGD (>13.5 points; 5 or more criteria met; IGD group). It consists of 13 questions (in 5-point Likert-type scales and in dichotomous format) based on the criteria of addictive disorders (e.g., tolerance, withdrawal, loss of control, emotion regulation, preoccupation, continued use of computer games despite negative consequences) that are also included into the current diagnostic criteria for IGD defined within the DSM-5 [6]. In previous studies, psychometric properties were successfully evaluated; the internal consistency ranges between 0.85 and 0.89 and correlations have been found with several external criteria (e.g., social insecurity, self-expectancy, proneness to stress) that point to a high construct and criterion-related validity [45]. Likewise, a recent investigation using the Component-Model of Addiction as a theoretical framework revealed good construct validity for AICA-S [27]. Moreover, a clinical validation of the general version of the AICA-S (aiming to assess not only IGD but also other forms of IA) has yielded good accordance between the classification of internet usage behavior according to the AICA-S and independent ratings on symptoms of IA in treatment seekers by trained

psychologists (sensitivity: 80.5 %; specificity: 82.4 %; [30]). In this survey, internal consistency (Cronbach's alpha) was $\alpha = 0.84$. The average inter-item correlations amounted to $r_{ii} = 0.36$ and discrimination power (r_{ii}) of the items ranged between 0.40 and 0.68.

Youth Self-Report

The Youth Self-Report (YSR; [3, 4]) is an empirically well established and widely used self-report instrument with excellent psychometric properties [1] consisting of 112 items (on three-point scales—0 = absent, 1 = occurs sometimes, 2 = occurs often). The YSR generates scores of competences (clustered on the three dimensions social competence, academic performance, and activities) and problem behaviors on eight sub-scales (anxious-depressed, withdrawn-depressed, somatic complaints, thought problems, social problems, attention problems, rule-breaking behavior, aggressive behavior). The latter can be clustered into the broader dimensions of internalizing (anxious-depressed, withdrawn-depressed, somatic complaints) and externalizing (rule-breaking behavior, aggressive behavior) problems.

Recruitment and description of participants

The study was based on a random probability sample selection with all secondary school classes (10th grade) serving as primary sampling units (PSU). To assure random selection of the classes, every class was assigned a unique number and a random starting point was created by random-number generating programs. The stratification was based on region according to the NUTS system (Nomenclature of Territorial Units for Statistics, a hierarchical classification scheme for identifying and segmenting geographical reference units) and population density. Further methodological details are described elsewhere [39].

A representative random sample of 13,708 children and adolescents was drawn. 129 (0.9 %) fell outside the eligible age range (14–17 years) and 641 (4.7 %) were excluded because of missing data. The final sample consisted of 12,938 adolescents (F/M: 6,841/6,097; mean age 15.8, SD = 0.7) from seven countries across Europe (Germany, $N = 2{,}315$; Greece, $N = 1{,}897$; Iceland, $N = 1{,}924$; the Netherlands, $N = 1{,}188$; Poland, $N = 1{,}892$; Romania, $N = 1{,}790$; Spain, $N = 1{,}931$).

If not otherwise declared, all the analyses are referred to a reduced sample of $N = 12{,}938$ adolescents. Analyses involving YSR data had to be conducted after the exclusion of the German subsample ($N = 2{,}143$), as the YSR was not administered in Germany ($N^* = 10{,}623$).

Data collection took place from October 2011 to May 2012 and was conducted by trained personnel. Every participant was informed about the purpose of the study and asked to give written informed consent. The investigation was approved by all of the local ethical commissions and was in accordance with the Declaration of Helsinki. Table 1 displays the main socio-demographic characteristics of the sample.

Table 1 Main socio-demographic characteristics of the sample

Socio-demographic variable	*N*	%
Gender		
Male	6,097	47.1
Female	6,841	52.9
Age[a]		
14–15 years	7,968	61.6
16–17 years	4,970	38.4
Migration background		
No	12,215	94.4
Yes	670	5.2
No response	53	0.4
Marital status of parents		
Married/living together	10,079	77.9
Separated/divorced	1,886	14.6
Other	513	4.7
No response	360	2.8
Employment (father/mother)		
Employed	10,321/8,542	79.8/66.0
Unemployed	633/626	4.9/4.8
Other (student, homemaker, retired)	966/2,923	7.5/22.6
No response	1,010/847	7.9/6.5
Educational status (father/mother)		
None	16//120	1.3/1.2
Primary education	1,285/1,145	9.9/8.8
Secondary	3,130/3,543	24.2/27.4
Post-secondary	2,584/2,360	20.0/18.2
Tertiary/university	2,704/2,875	20.9/22.2
Other	77/53	0.6/0.4
Do not know	2,648/1,767	20.5/13.7
No response	343/1,075	2.6/8.3

[a] Mean age of the participants = 15.8 (SD = 0.7)

Data analysis

The study design was based on a complex sampling plan (clustered sampling method), thus the assumption of independent and identical distributed elements (i.i.d. assumption) was violated. This made it necessary to conduct all analyses using the module for complex analyses provided by SPSS 22.0. In the presentation of prevalence rates, the 95 % confidence intervals are reported. Chi square tests were used for comparisons of nominal

Table 2 Prevalence of Internet Gaming Disorder by gender and age across participating countries

Prevalence of IGD					
		Gender		Age	
Country	Total sample (*n*, %) ($N = 12{,}938$)	Boys (*n*, %) ($N = 6{,}097$)	Girls (*n*, %) ($N = 6{,}841$)	14–15 years (*n*, %) ($N = 7{,}968$)	16–17 years (*n*, %) ($N = 4{,}970$)
Germany	37 (1.6 %)	33 (3.1 %)	4 (0.3 %)	20 (1.5 %)	17 (1.7 %)
Greece	49 (2.5 %)	42 (4.4 %)	7 (0.7 %)	34 (2.5 %)	15 (2.5 %)
Iceland	34 (1.8 %)	31 (3.4 %)	3 (0.3 %)	30 (1.8 %)	4 (1.8 %)
The Netherlands	13 (1.0 %)	12 (1.9 %)	1 (0.2 %)	2 (0.4 %)	11 (1.4 %)
Poland	40 (2.0 %)	34 (3.6 %)	6 (0.6 %)	29 (2.0 %)	11 (2.2 %)
Romania	24 (1.3 %)	23 (2.8 %)	1 (0.1 %)	5 (1.0 %)	19 (1.4 %)
Spain	12 (0.6 %)	11 (1.2 %)	1 (0.1 %)	10 (0.8 %)	2 (0.3 %)
Total sample	209 (1.6 %)	186 (3.1 %)	23 (0.3 %)	130 (1.6 %)	79 (1.6 %)

variables with the coefficient Phi (φ) and Cramer-V as measures of effect size. Correlations according to Pearson (r) were calculated for metric variables. Analyses of Variance with covariates (ANCOVA) were performed to analyze sub-group differences with η^2 as an indicator for effect sizes. Games–Howell test was used for post hoc comparisons. Linear regression models were conducted to specify the amount of influence of predictive variables on a criterion.

Results

Prevalence of Internet Gaming Disorder and relation to socio-demographic characteristics

60.5 % (7,828) of the sample reported playing online games regularly with a higher percentage of boys (84.7 %; $n = 5{,}036$) compared to girls (42.8 %; $n = 2{,}792$; $\chi^2 = 2{,}384.19$; $p \leq 0.001$; $\varphi = 0.43$). Among them, first-person shooters ($M = 2.89$; SD = 1.62), single player games ($M = 2.82$, SD = 1.42) and Massively Multiplayer Online Role-Playing Games (MMORPGs; $M = 2.68$, SD = 1.62) were almost equally popular.

According to AICA-S-gaming, 1.6 % ($n = 209$; 95 % CI 1.4–1.8) of the sample met criteria for IGD and 5.1 % ($n = 660$; 95 % CI 4.8–5.5) being at risk for IGD. Taking only regular online gamers ($n = 7{,}828$), these rates increase to 2.7 % ($n = 209$; 95 % CI 2.3–3.0) with IGD and 8.4 % ($n = 660$; 95 % CI 7.8–9.1) at risk for IGD. Across all countries, more boys than girls met the criteria for IGD. In the total sample, 3.1 % (95 % CI 2.6–3.5) of boys compared to 0.3 % (95 % CI 0.2–0.5) of girls were classified with IGD, and 9.5 % (95 % CI 8.7–10.2) of boys compared to 1.2 % (95 % CI 1.0–1.5) of girls at risk for IGD (cf. Table 2).

Table 3 Results of multiple linear regression analysis with game genres and age as predictors and AICA-S-gaming score as dependent variable

	B	SE *B*	*β*	*p*
Age	0.070	0.036	0.015	0.05
Single player games	0.153	0.028	0.046	0.001
MMORPGs	0.627	0.031	0.214	0.001
First-person shooters	0.762	0.028	0.271	0.001
Strategy games	0.460	0.033	0.138	0.001

$N = 12{,}938$ Model $F(5, 11{,}918) = 1{,}022.47$, $p \leq 0.001$, $R^2 = 30$

B regression coefficient, *SE B* standard error of *B*, *β* standardized beta coefficients, *p* level of significance, *MMORPGs* Massively Multiplayer Online Role-Playing Games

No age differences were observed ($\chi^2 = 0.15$; ns.): The rates for both IGD (1.6 %, 95 % CI 1.4–1.9) and at risk for IGD (5.1 %, $n = 407$, 95 % CI 4.6–5.6) among those aged 14–15 years are similar to adolescents aged 16–17 (IGD: 1.6 %, 95 % CI 1.3–1.9; at risk: 5.1 %, $n = 253$, 95 % CI 4.4–5.7). The IGD rate among all adolescents was similar across countries, with only a small significant effect ($\chi^2 = 44.066$; $p \leq 0.001$; Cramer-V = 0.05). The highest prevalence rates were found in Greece (2.5 %) and Poland (2.1 %), the lowest in Spain (0.6 %).

For the analyses of further socio-demographic variables, only the IGD group and non-problematic gamers were taken into account. A slight difference was found for migration background: Adolescents with IGD were more often born abroad (7.8 %) than NPG (4.7 %; $\chi^2 = 4.08$; $p \leq 0.05$), however, the effect size ($\varphi = 0.02$) suggests that this difference is negligible. A small significant difference was observable according to the parents' marital status. 23.1 % of the IGD group reported that their parents were divorced while this was the case in just 14.5 % of NPG ($\chi^2 = 13.71$; $p \leq 0.001$; Cramer-V = 0.04). The

IGD group (3.9 %) were more likely to report that their mother had no formal education compared to NPG (0.8 %; $\chi^2 = 25.28$; $p \leq 0.001$; Cramer-V = 0.07). No such differences were found regarding the fathers' employment and educational status.

Internet Gaming Disorder and preferred game genre

To examine whether the preferred type of online game is related to a higher risk of IGD, a multiple regression analysis was carried out with the four genres as predictors and the score of AICA-S-gaming as the criterion (see Table 3).

Internet Gaming Disorder is predicted by all game genres assessed with the use of shooter games and MMORPGs as strongest predictors.

ANCOVAs for every genre were performed with gender, age and country as between-subjects factors. All four genres yielded significant main effects (each $p \leq 0.001$) with highest effect sizes for shooter games ($\eta^2 = 0.030$), MMORPGs ($\eta^2 = 0.025$) and strategy games ($\eta^2 = 0.023$). Significant effects for gender were found regarding every genre (each $p \leq 0.001$). Age yielded a significant effect for single player games and MMORPGs with younger adolescents using single player games more frequently and MMORPGs less often (each $p \leq 0.001$). Also country-specific differences were found regarding all four genres (each $p \leq 0.001$).

Internet Gaming Disorder and associated psychosocial features

Correlations between AICA-S-gaming and the YSR-subscales Activities ($r = -0.14$, $p < 0.01$), Social Competence ($r = -0.03$, $p < 0.01$), Academic Performance ($r = -0.10$, $p < 0.01$), and the Total Competence Score ($r = -0.10$, $p < 0.01$) were significant. Afterwards, the sample was analyzed according to the classification based on AICA-S-gaming which led to the following groups: IGD group, at-risk group, non-problematic group, and non-gamers.

ANCOVAs were carried out on the three sub-scales with the four gaming groups and gender, age-group, and country as between-subjects factors. For Social Competence, a small significant main effect was found ($F = 5.589$, $p < 0.001$; $\eta^2 = 0.001$). Likewise, all three covariates reached significance (each $p < 0.001$). For Academic Performance ($F = 11.54$, $p < 0.001$; $\eta^2 = 0.004$), post hoc tests showed that the IGD group ($M = 1.92$, SD = 0.85) had lower mean scores than non-problematic ($M = 2.18$, SD = 0.59) and non-gamers ($M = 2.18$, SD = 0.59; each $p < 0.001$). The same was true for at-risk gamers ($M = 2.02$, SD = 0.67; each $p < 0.001$). The covariates country and age had additional significant influence (each $p < 0.001$). Regarding Activities ($F = 13.94$, $p < 0.001$; $\eta^2 = 0.001$), the same differences were found with IGD group ($M = 6.9$, SD = 4.42) and at-risk gamers ($M = 6.7$, SD = 3.99; $p < 0.001$) showing significantly decreased scores compared to non-problematic ($M = 8.0$, SD = 3.79) and non-gamers ($M = 8.3$, SD = 3.74; each $p < 0.001$). Country, age, and gender had additional significant effects (each $p < 0.001$).

Internet Gaming Disorder and associated psychopathological features

Significant correlations between AICA-S and the total problem score of the YSR ($r = 0.26$, $p < 0.01$), externalizing ($r = 0.30$, $p < 0.01$) and internalizing problems ($r = 0.15$, $p < 0.01$) were found. The four gaming groups were then compared according to their mean scores for total problems and externalizing/internalizing problems by applying ANCOVAs with gender, country and age as between-subjects factors. A main effect was found for total problem score of the YSR with gender ($p < 0.001$), country ($p < 0.001$) and age ($p < 0.001$) yielding independent effects (see Table 4). The post hoc tests revealed that the IGD group had significantly increased scores ($M = 68.53$, SD = 48.26; $p < 0.001$) compared to at-risk gamers ($M = 50.99$, SD = 29.95), non-problematic ($M = 33.94$, SD = 22.26) and non-gamers ($M = 36.87$, SD = 21.99). At-risk gamers displayed significantly elevated scores compared to non-problematic and non-gamers (each $p < 0.001$).

Similar main effects were found for externalizing and internalizing problems (cf. Table 4) with the IGD group displaying significantly increased scores compared to all the other groups (each $p < 0.001$). Likewise adolescents in the at-risk group had significantly higher scores than non-problematic and non-gamers (each $p < 0.001$). For externalizing problems, additional effects of gender ($p < 0.05$), country ($p < 0.001$) and age ($p < 0.001$) were identified. For internalizing problems, additional effects of country ($p < 0.05$) and gender ($p < 0.001$) were found, indicating that girls had elevated scores across all gaming groups.

Afterwards, YSR-subscales were analyzed using ANCOVAs with age and gender as covariates (see Table 5).

Significant main effects were found for every subscale with largest effect sizes for Rule-Breaking Behavior and Aggressive Behavior. Post-hoc tests revealed that the IGD group had significantly elevated scores compared to all the other groups. Likewise, adolescents at risk for IGD showed significantly higher scores than non-problematic gamers and non-users (except for Somatic Complaints).

Table 4 Comparison of Total Problem Score, externalizing and internalizing problems (YSR) in adolescents (IGD, at risk, non-problematic and non-users of computer games) according to gender

Youth Self-Report	IGD group (M, SD)		At-risk gamers (*M*, SD)		Non-problematic gamers (*M*, SD)		Non-gamers (*M*, SD)		Main effect (F, η^2)
	Male	Female	Male	Female	Male	Female	Male	Female	
Total problem Score	68.5^a (46.3)	78.0^a (41.6)	49.4^b (30.2)	61.5^a (26.3)	30.7^c (30.7)	38.9^b (23.2)	32.7^c (24.1)	37.9^b (21.3)	92.54, 0.036***
Externalizing problems	24.5^a (15.9)	25.9^a (10.9)	17.4^b (10.9)	19.2^a (9.9)	10.9^c (8.2)	11.5^b (7.6)	11.2^c (9.9)	11.1^b (7.6)	92.81, 0.033***
Internalizing problems	19.0^a (16.2)	23.2^a (14.4)	13.6^b (10.7)	19.1^a (11.3)	7.9^c (6.9)	12.9^b (9.6)	8.2^c (7.7)	12.6^b (8.4)	67.86, 0.031***

All analyses were adjusted for age; means with differing subscripts within rows and within the variable "gender" are significantly different at $p \leq 0.05$ based on Games–Howell post hoc comparisons

$N = 10{,}623$, $df = 3$, *M* mean, *SD* standard deviation, *F* F value (main effect ANCOVA), η^2 eta-square

*** $p \leq 0.001$

Country-specific effects of symptoms associated with Internet Gaming Disorder

As the analyses showed that country had a high independent effect on the total problem score, a further ANCOVA with the six countries as group factors and gaming group as covariate on the total problem score was conducted. Significant effects for country ($F = 47.98$, $p < 0.001$; $\eta^2 = 0.023$) and gaming group ($F = 195.58$, $p < 0.001$; $\eta^2 = 0.053$) appeared and the post hoc tests showed that IGD adolescents from Spain were displaying higher psychosocial symptoms compared to Iceland and Romania. Likewise, Greek IGD adolescents were more distressed than adolescents from Romania (see Fig. 1).

Discussion

The aim of this project was to investigate the prevalence and correlates of IGD in a sample representative of adolescents in the seven participating European countries. The prevalence rate for IGD was 1.6 %, a further 5.1 % of adolescents were classified as being at risk of IGD. These rates increased to 2.7 % with IGD (and 8.4 % being at risk for IGD) within adolescents who engage in online computer games regularly. Prevalence rates did not differ by age. More boys than girls were affected by IGD, matching findings from other studies [13, 34].

Although significant, only small effect sizes were found for other socio-demographic variables. As indicated by previous studies [7], adolescents with IGD reported living in a broken home context more often, which is in accordance with research on risk factors in other conduct problems [5]. One hypothetical explanation for this might be that parental monitoring in single parent families may be restricted due to the lack of support by the other parent. However, alternative explanations are also reasonable. For example, we only asked if the parents were living together, but not if there was a new partner living with the family. Thus, the underlying reasons for this relationship with IGD remain unclear.

Regarding country-specific differences, the highest rates of IGD were to be found in Greece (2.6 %) and Poland (2.1 %). Comparatively low rates were found in Spain (0.6 %). However, the differences between the countries yielded very small effect sizes. The reason for this cannot be answered adequately. It may be due to country-specific prevention campaigns. Despite those minor differences, IGD seems to be a phenomenon that is present in different parts of Europe, suggesting that cross-national prevention and intervention programs should be taken into consideration.

Table 5 Comparison of the subscales of YSR in adolescents (IGD, at risk, non-problematic and non-users of computer games)

Subscale of Youth Self-Report	IGD group (*M*, SD)	At-risk gamers (*M*, SD)	Non-problematic gamers (*M*, SD)	Non-gamers (*M*, SD)	Main effect (F, η^2)
Anxious-depressed	8.35 (7.38)[a]	6.45 (5.33)[b]	4.44 (4.45)[c]	5.48 (4.45)[d]	58.57; 0.028***
Withdrawn-depressed	5.95 (4.62)[a]	4.36 (3.39)[b]	2.90 (2.64)[c]	3.14 (2.73)[d]	73.08; 0.030***
Somatic complaints	5.34 (5.69)[a]	3.67 (3.88)[b]	2.57 (2.78)[c]	3.21 (3.26)[b]	37.38; 0.023***
Social problems	6.22 (5.64)[a]	4.58 (3.88)[b]	2.90 (2.61)[c]	2.99 (2.60)[c]	59.89, 0.037***
Thought problems	7.26 (6.31)[a]	4.96 (4.30)[b]	3.09 (3.14)[c]	2.30 (3.15)[c]	53.76, 0.037***
Attention problems	8.44 (4.54)[a]	6.87 (3.53)[b]	5.04 (3.17)[c]	5.34 (3.40)[d]	76.92, 0.029***
Rule-breaking behavior	10.47 (7.38)[a]	7.34 (4.91)[b]	4.43 (3.87)[c]	4.22 (3.85)[c]	69.92, 0.059***
Aggressive behavior	14.29 (9.03)[a]	10.07 (6.29)[b]	6.71 (5.08)[c]	6.87 (5.26)[c]	92.41, 0.047***

All analyses were adjusted for age class and gender; means with differing subscripts within rows are significantly different at $p \leq 0.05$ based on Games–Howell post hoc comparisons

$N = 10{,}623$, $df = 3$, *M* mean, *SD* standard deviation, *F* *F* value (main effect ANOVA), η^2 eta-square

*** $p \leq 0.001$

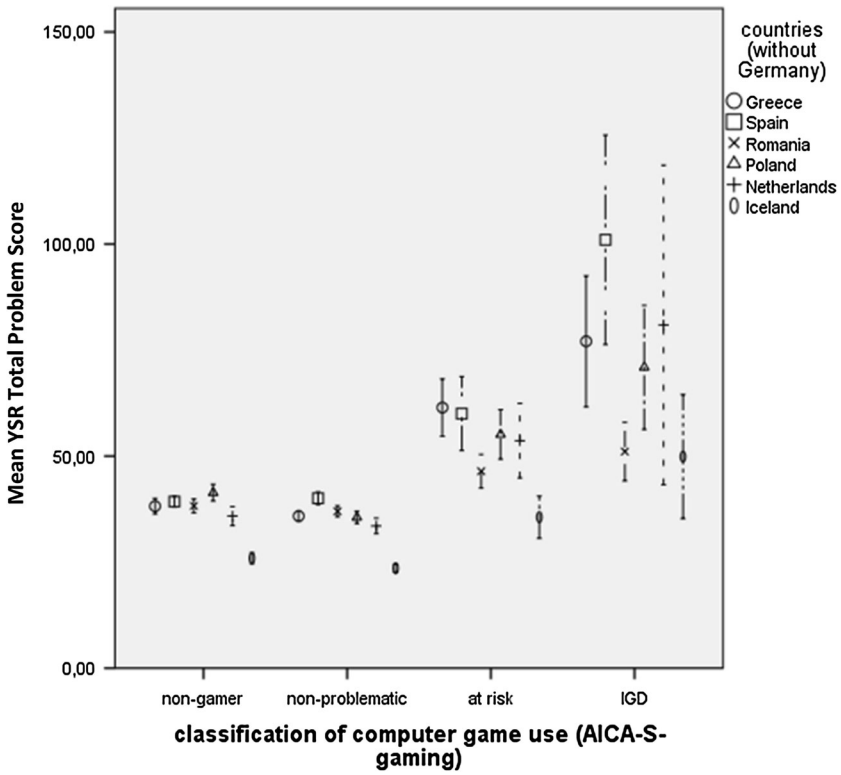

Fig. 1 Country-specific mean scores and standard errors of the YSR-total problem score according to gaming behavior. Comments: $N = 10{,}623$

Compared to previous studies [7, 34], the prevalence rate of 1.6 % is relatively low. However, in this study, it was found that in addition to those 1.6 %, a further 5.1 % have to be regarded as showing signs of IGD. These adolescents might be at greater risk for developing full symptoms of IGD. Alternatively, discrepancies in prevalence rates might be—at least to some extent—due to differences in the assessment of IGD and, therefore, reflect a methodological bias.

Analyses of preferred game genres reveal that IGD was associated with the use of every genre covered. Especially using shooter games and MMORPGs was significantly associated to IGD. This finding supports theoretical expectations concerning the addictive potential of MMORPGs and underpins findings from smaller samples [37]. Although evidence is still lacking, it has been supposed that specific characteristics of MMORPGs [17], like over-stimulation of sensory and cognitive components of curiosity, social interactions (commitment and belonging), role-playing, and the competition with like-minded might contribute to an enhanced involvement of the player that—under certain

circumstances, e.g., the player's personality traits [29]—can result in addiction.

A further focus of this investigation was on the examination of psychopathological symptoms in adolescents with IGD. Our results show that IGD was related to both increased psychosocial problems and psychopathological symptoms. Adolescents with IGD had lower scores concerning recreational activities. Moreover, academic performance was significantly diminished, indicating poorer achievement within scholastic contexts—a finding that has been reported before [7]. As mentioned above, IGD has been reported to lead to a number of restrictions (social withdrawal, deteriorating academic achievement; cf. [8]). A vicious cycle may arise: adolescents with excessive computer gaming start to neglect alternative activities and social contacts, spending more and more time in virtual worlds. As the amount of online time increases, (offline) events that could serve as a source of reward are experienced less often. In consequence, the individual develops attribution biases leading to a deepened retreat into the comfortable virtual worlds of online games [29].

It was found that IGD adolescents displayed elevated scores particularly in Aggressive Behavior, Rule-breaking Behavior, Social Problems, and Thought Problems, indicating that IGD is related to a large variety of co-occurring mental problems. Again, this matches findings from previous studies [18, 24], emphasizing the clinical relevance of IGD and indicating the need for specific interventions. Since parallels between IGD and other types of addiction have been demonstrated, it is reasonable to assume that adapted treatment strategies derived from substance-related addictions could be beneficial in treating IGD. Indeed, there is first evidence that transfer of treatment strategies has positive effects [44]. Likewise, a meta-analysis on therapy effects has shown that cognitive-behavioral therapy and psychopharmacological treatment display good effects in treating IA [44]. Since there is evidence that IGD is frequently accompanied by comorbid disorders and heightened psychopathological distress (e.g., aggressive behavior, social problems), therapy approaches should be embedded in holistic settings addressing these co-occurring problems (e.g., by containing social skill trainings etc.).

As this investigation used a cross-sectional design, it is not possible to clear whether heightened symptoms are triggers for developing IGD or if IGD causes further psychopathological strain. Looking at the latest longitudinal study from Asia, both pathways are probable. Gentile et al. [13] found that depressive symptoms and social anxiety decreased in those adolescents who were able to stop excessive gaming. Likewise impulsivity was found to be both a predisposing and maintaining factor for IGD, whereas van Rooij et al. [41] found no specific associations. More research is needed, especially regarding representative longitudinal approaches allowing for an investigation of the causality between IGD and psychopathology.

This study has a number of limitations. Self-report data include sources of error (e.g., by social desirability) and classification of IGD was not based on clinical interviews but obtained from a self-report measure. Although AICA-S-gaming demonstrated adequate psychometric properties and has been validated in previous studies, the classification of addictive behavior by questionnaires does not compensate for a clinical diagnostic using, for instance, a structured clinical interview for IGD. From that perspective, it is not appropriate to rule out the possibility of false-positive or false-negative classifications within this investigation. However, it is unrealistic assessing IGD by conducting diagnostic interviews in such a big sample. Thus, future research should focus on validating questionnaire-based data on IGD, for example, by conducting structured clinical interviews in a sub-sample derived from bigger samples.

Despite these limitations, this study has some unique features that may enhance the understanding on IGD. It was demonstrated that across different European countries, IGD shows an almost similar distribution with prevalence rates that prevent the dismissal of IGD as of a mere clinical side issue. In addition, it became evident that IGD is related to psychopathological and psychosocial symptoms, which places emphasis on the seriousness of IGD requiring counseling. In accordance with previous studies [18], psychosocial distress is a correlate of IGD emphasizing its clinical relevance. From this perspective, it is recommended to perceive IGD as a clinical disorder that should be included as an official diagnosis into the diagnostic classification systems like DSM and ICD.

As an inspiration for further research, it should also be stated that girls with IGD showed significantly increased emotional and behavioral symptoms compared to boys. Future studies should address the currently under-investigated issue of IGD in girls; it may be necessary to adapt existing treatment programs to meet the specific needs of girls with IGD.

Also, a large number of adolescents were identified as at risk for IGD. This was the case throughout the participating countries, indicating that there is a necessity for developing prevention and short-term intervention programs for these adolescents. To our opinion, it is also necessary to further characterize those adolescents showing risky usage patterns. Since adolescence is a period of transition, it is expectable that some of these minors will cease showing risky usage while some might develop enduring problematic gaming behavior that might become addictive. It is necessary to find out about mechanisms (e.g., personality traits, social factors) indicative for remission versus

exacerbation of the gaming habits. Conducting methodologically sound longitudinal approaches has to be the next step for a better understanding of these processes.

Likewise, the significance of appropriate prevention programs is emphasized. While there are some prevention programs already existing [19], a scientific evaluation of their (long term) effectiveness is the next important step towards providing a holistic health care.

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