

Problematic computer game use among adolescents, younger and older adults

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ABSTRACT

Aims Playing digital games has been associated with forms of addictive behavior. Past research on the subject has often been criticized on theoretical and empirical grounds, due mainly to measurement or sampling issues. The present study aims to overcome these two limitations, and presents data from a representative study in Germany using an already established instrument for measuring problematic game use. **Design** Large-scale, representative study using a computer-assisted telephone survey. **Setting** Germany. **Participants** A total of 580 adolescents between 14 and 18 years of age, 1866 younger adults between 19–39 years and 1936 older adults aged 40 years and older (overall $n = 4382$). **Measurements** Problematic game use was measured with the Gaming Addiction Short Scale (GAS), which covers seven criteria including salience, withdrawal and conflicts. Additionally, differential aspects of personality, as well as gaming behaviour, were measured. **Findings** Only seven respondents [0.2%, 95% confidence interval (CI): 0.1, 0.3] met all criteria of the GAS Scale. In contrast, 3.7% (95% CI: 3.1, 4.3) of the respondents can be considered problematic users, meeting at least half these conditions. The percentage of problematic gamers among adolescents is above average (7.6%, 95% CI: 5.6, 10.1). High GAS scores are associated with aggression, low sociability and self-efficacy and lower satisfaction with life. Additionally, these scores correspond with intensive use and preferences for certain gaming genres across all age groups. **Conclusions** Following Gaming Addiction Short Scale criteria, gaming addiction is currently not a widespread phenomenon among adolescents and adults in Germany. Gaming Addiction Short Scale scores are associated with intensive use, as well as certain problematic aspects of individuals' personalities and social lives.

Keywords Adolescents, adults, gaming addiction, prevalence study, problematic computer game use.

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INTRODUCTION

Addiction is one of the most prominent aspects discussed in the public and scientific debate about computer and video games. In contrast to substance-related phenomena (alcohol, tobacco and drugs) and other forms of behavioural disorders (gambling), gaming addiction has not been recognized as a disorder in its own right by the American Psychiatric Association [1]. The *Diagnostic and Statistical Manual of Mental Disorders* version 5 (DSM-V, expected to be released in 2013) considers problematic gaming only in the context of internet use disorder [2]. Although studies suggest that there are some gamers who experience considerable problems that resemble dependency-like syndromes [3], there is no agreement on whether these really are cases of gaming addiction.

LaRose, Lin & Eastin [4] warn against quickly defining any problematic media use as a destructive behaviour that cannot be corrected by the individuals themselves; in their view, media use always lies on a continuum between normal and problematic use. In contrast to substance-related behaviours, computer gaming (and media use in general) cannot be seen as problematic *per se*, as even frequent playing can result simply from a healthy enthusiasm. In this respect, computer gaming is very similar to gambling, which has been studied widely in the context of addiction [5]. According to Griffiths & Wood [6], gambling and videogame playing resemble each other on both a psycho-behavioural level (e.g. reinforcement schedules) and structural conception (e.g. light and sound effects). Problematic gambling is already accepted as a relevant mental disorder within the DSM classification: seen

originally as a variant of impulse control disorders, there are efforts to regroup problematic gambling and substance-related disorders into a new category: 'addiction and related disorders' [7]. This proposition reflects the assumption that gambling (and also gaming) is not simply an impulsive reaction, but a planned behaviour similar to other leisure activities. Behavioural control problems, therefore, may be related to other symptoms than impulse control problems such as, in the case of gambling, money- and time-related problems. As with gambling, many risks and harms of problematic gaming have been identified in numerous studies [8]. Negative consequences were found for health-related aspects, such as sleep deprivation [9,10], stress [11] or lower psychosocial wellbeing [12], as well as social functioning such as decreasing time for partner, friends and family [11,13] and personal function indicated, for example, by lower academic achievement [14,15]. Due to the above-mentioned similarities between gambling and gaming, there are many studies on gaming addiction—including this study—that use the established diagnostic criteria for pathological gambling [16,17], and consider problematic gaming as another manifestation of this behavioural addiction.

Despite, or because of, this orientation towards the established concept of pathological gambling, there remains some criticism of current gaming addiction research. First, there is no well-established definition of or differentiation between enthusiastic game play, problematic game use and gaming addiction. Second, the socio-cognitive framework, according to which flow experience increases habit strength which, in turn, leads to increased playing time [18,19], does not fully explain problematic gaming, gambling or other media-related behaviours. In addition to these definitional and theoretical problems, Petry [20] also notes critically that the measures used to assess problematic gaming behaviour are applied inconsistently, with different scales and cut-off thresholds for addiction. Cut-off points in particular must be treated with caution: derived from substance-related forms of addiction, it seems questionable whether a person's classification according to several criteria can be related to dysfunctional behaviour and clinical problems. In this paper we will refer to the general concept as 'problematic game use', except when referring to the existing labels 'problematic gamer' and 'addicted gamer' for different cut-off values of established scales. Finally, Petry [20] mentions critically that reported prevalence does not only depend on the definition and measures used, but also on the samples upon which the findings are based. She states that 'almost all the samples are derived from school- or university-based surveys, and representation of older and even young adult to middle-aged respondents in surveys assessing "gaming addiction" are sorely lacking' (p. 213).

In the following, we address this last concern specifically by reporting data from a large-scale, representative study of German gamers. We used an established scale with tested psychometric properties and cut-off values from previous studies. Although we are aware of the limitations of this cut-off approach, our primary aim is to provide comparative data rather than test a diagnostic instrument. While this study may not answer the general question of whether, and under which conditions, gaming addiction is a psychiatric disorder, the empirical data presented below can help us understand the prevalence of problematic gaming behaviour in the general population.

International comparison of prevalence rates

Although researchers have investigated the phenomenon for at least two decades, there have been relatively few efforts to integrate different findings on problematic game use (as an exception, see [8]). In order to gain perspective on our own findings, we start with a review of existing studies on the prevalence of problematic use in different countries (Table 1).

When reporting prevalence rates, studies in different countries vary greatly in the proportion of affected players. However, it must be considered that these variations often seem to be caused by different sampling populations and measures rather than cultural differences. In several studies from the United States [16] and Taiwan [21], a large proportion of players were classified as addicted (39% and 46%, respectively). These results must be interpreted with caution, as the researchers focused on a special subgroup of digital gamers, namely the users of online role-playing games [massively multi-player online role-playing games (MMORPG)]. Grüsser, Thalemann & Griffiths [22] also report a comparably high number of game addicts (11.9%). As in the US and Taiwanese studies, they relied upon data from a self-selected sample—the readership of an online game magazine. In contrast, despite including data taken mainly from younger age groups, studies using representative samples report much lower prevalence rates, often less than 5% of the interviewed game users [23,24].

Prevalence variations must also be viewed from another perspective: the applied criteria. For Grüsser *et al.* [22], individuals are considered addicted if they meet three of the six ICD-10 criteria for dependence syndromes. Studies using the Game Addiction Scale (GAS) [23] also include this polythetic approach (half the criteria must be met), but label this kind of behaviour as 'problematic use'. Only 2% of the Dutch and 0.6% of the Norwegian respondents met all the criteria and are therefore described as 'addicted'. Low prevalence rates were also confirmed by a Dutch (3%) [25] and a German study

Table 1 International comparison of studies on problematic game use.

Country: scale	Sample	Prevalence	Source
Australia: Young's Diagnostic Questionnaire for Internet Addiction	n = 709 17–54 (Ø 21) years n = 1.326 12–19 (Ø 14.8) years	7% classified as addicted to computer games 2.8% classified as addicted to computer games	[39]
Germany: Video Game Dependency Scale	n = 10.060 Ø 15.3 years	2.8% dependent on video games	[26]
Germany: Classified after WHO ICD-10	n = 7.069 Ø 21.1 years	11.9% of participants fulfilled diagnostic criteria of addiction	[22]
Netherlands: Game Addiction Scale	n = 644 12–18 (Ø 14.8) years n = 573 12–18 (Ø 15.2) years	Around 2% classified as addicted 9% fulfilled criteria of problematic game use	[23]
Netherlands: Compulsive Internet Use Scale and Gaming Frequency	n = 4074 13–16 (Ø 14.3) years	3% of online gamers classified as addicted	[25]
Norway: Gaming Addiction Scale [23]	n = 816 16–40 years	0.6% classified as addicted 4.1% fulfil criteria of problematic video game use	[24]
Taiwan: Online Games Addiction Scale for Adolescents in Taiwan (OAST)	n = 177 (MMORPG users) 16–24 years	46% classified as addicted	[21]
USA and Canada: the Addiction Engagement Questionnaire	n = 442 (MMORPG users) 18–67 (Ø 28.8) years	39% classified as addicted	[16]

MMORPG: massively multi-player online role-playing game.

(3.3%) [26], using different but related instruments and criteria to define gaming addiction.

Correlates of problematic game use: personality and gaming behaviour

A meta-analysis by Kuss & Griffiths [8] revealed that problematic game use is related to a variety of personality traits: according to Jeong & Kim [15], low self-efficacy in real life is correlated positively with problematic game use, especially when contrasted with high expectations of self-efficacy in the virtual world. Aggressive tendencies were also found to correlate with problematic game use [22,23,27]. According to Lemmens and colleagues [23], social competence was associated negatively with GAS scores. In a related study, Porter *et al.* [28] found problematic game use to be associated positively with social inhibition.

In addition to personality traits, gaming-related aspects must be considered as relevant correlates of problematic use [29]. Lemmens *et al.* [23] found a strong positive correlation between GAS scores and time spent on games.¹ Moreover, there is evidence indicating a relationship between different genre preferences and problematic gaming behaviour. Specifically, internet and arcade games were found to be related more strongly to proble-

matic use than other types of games [8]. One genre of online games especially prominent in gaming addiction research is MMORPG games. Considering the findings of Wan & Chiou [21], as well as Charlton & Danforth [16], there may be structural game characteristics that support and encourage problematic behaviour in MMORPG play, such as positive reinforcements within the game [30], or multi-player features that increase the desire (or even peer pressure) to continue playing.

Our literature review shows that empirical research on problematic game use has not yet yielded consistent and comparable results on the prevalence of problematic behaviour and addiction and its causes and consequences. The present study tries to address some of the problems discussed by Petry [20] by employing an established measurement procedure in a large, representative sample of German players. Following Kuss & Griffiths [8], we used an existing instrument, the seven-item short scale developed by Lemmens *et al.* [23]. We establish links with previous studies by using the same criteria for addiction and problematic use, thus enabling comparisons across different samples. Finally, we add to the existing body of research by focusing not only on adolescents or core gamers, but all age groups and player types.

¹ Conceptualizing the phenomenon solely by gaming frequency was criticized strongly, as definitions of excessive or heavy gamers vary greatly according to different studies. Griffiths, Davies & Chappell [13] further refer to the necessity to supplement the amount of time spent on gaming with information about what has been neglected in order to play the game.

METHOD

Participants and procedure

The present study relies on a large representative sample of computer and console gamers in Germany. Sampling and recruiting was conducted using a two-stage approach. First, a representative sample of 50 000 individuals aged 14 and older were asked about their gaming behaviour in an omnibus telephone survey. The sample was drawn using the German standard computer-assisted telephone interviewing (CATI) sampling procedure [31] and had an average daily response rate of 55%. Approximately 25% ($n = 12\,587$) of the respondents could be identified as at least occasional gamers. From this sample, we recruited a stratified random sample of 4500 gamers for a second telephone interview, which comprised 3500 social gamers who played multi-player games at least occasionally and 1000 respondents who played only single-player titles. Multi-player games are defined by any kind of co-playing regardless of whether it happens online, in a local-area network (LAN) or co-located in front of a shared monitor. The response rate for this second survey was 79.6%. The data were collected in March and April 2011 by a professional market research institute in Germany. We excluded 118 respondents (2.3%) from the analysis because either they did not complete the interview or failed to provide answers for a majority of the items used for this study.

Measures

In order to obtain reliable measures while minimizing respondent burden in a telephone interview, we employed short scales for many constructs as a compromise between using the full versions and single items. All scales were pre-tested with an online survey among university students.

Problematic game use

We used the GAS created by Lemmens *et al.* [23] in its seven-item short version. Each of the seven criteria—salience, tolerance, mood management, relapse, withdrawal, conflict and problems—is measured by one item derived from the original 21-item scale, based on the highest factor loading.² Participants were asked to indicate how often they had experienced each of the situations described in the items within the last 6 months. They answered on a five-point scale: 0 (never), 1 (almost

never), 2 (sometimes), 3 (often) and 4 (very often). Cronbach's alpha for the GAS in the present study was 0.72, which is slightly below the value found in other studies using the instrument (0.86 [17]; 0.84 [23]). A confirmatory factor analysis provided support for a single-factor model, as indicated by an acceptable model fit [32]: χ^2 (Satorra–Bentler scale correction, d.f. = 14) = 51.9, $P < 0.01$; root mean square error of approximation (RMSEA) = 0.03; standardized root mean square residual (SRMR) = 0.02; comparative fit index (CFI) = 0.97. The significant χ^2 value can most probably be attributed to the high power of the test resulting from the large sample size. While the full scale is probably more reliable and nuanced, the short form of the GAS seems to be psychometrically sound and useful for large-scale telephone surveys.

Personality traits

To measure relevant correlates of problematic game use, the survey included items relating to different aspects of personality identified as important within previous findings. For all the scales described below, participants were asked to indicate whether they agreed with the particular item on a five-point Likert scale, ranging from 1 (not at all) to 5 (completely). The social competence of a person was measured using two items adopted from the California Psychological Inventory [33] (Cronbach's alpha = 0.61). In addition, we collected data about perceived social support using four items (Cronbach's alpha = 0.86) from the Berlin Social Support Scales (BSSS) [34]. Self-efficacy was measured using five items from the General Self-Efficacy Expectations Scale by Schwarzer & Jerusalem [35] (Cronbach's alpha = 0.70). Participants were then asked about two aspects of aggression. To measure physical aggression, we used two items from the Aggression Questionnaire by Buss & Perry [36] (Cronbach's alpha = 0.75). We used three items to assess anger aggression, two adopted from Buss & Perry [32] and one item from the revised NEO Personality Inventory by Costa & McCrae [37]. The anger aggression scale was somewhat less consistent than the one for physical aggression (Cronbach's alpha = 0.67).³

Life satisfaction

In order to measure self-perceived consequences of excessive gaming behaviour, we additionally asked the participants how satisfied they were with their life. They answered

² In contrast to the original version [23], we used items with the second highest loadings for the dimensions 'tolerance' and 'relapse' because the original items proved difficult to translate into German. We also removed all references to school and homework in order to make the items more suitable for adults.

³ Item wordings for physical aggression are 'There are people who pushed me so far that we came to blows' and 'Given enough provocation, I may hit another person'. For anger aggression the items were 'I have trouble controlling my temper', 'Sometimes I fly off the handle for no good reason' and 'I often lose my temper'.

this single item on a five-point Likert scale ranging from 1 (not satisfied at all) to 5 (absolutely satisfied).

Gaming-related variables

General gaming frequency was measured in hours per day. We also asked respondents whether they played online games at all, and they additionally indicated their preferences for role-playing games and first-person shooters on a five-point Likert scale ranging from 1 (do not like it at all) to 5 (like it very much), with the additional option 'don't know the genre at all'.

Variable coding and statistical methods

In accordance with Charlton & Danforth [16], Lemmens and colleagues [23] define different criteria for classifying individuals as being addicted or merely problematic users. We follow this procedure and differentiate similarly between these two stages: all seven criteria of the GAS must be answered with 'sometimes', 'often' or 'very often' in order to classify a respondent as addicted, following a monothetic approach. In contrast, problematic use is defined in a polythetic way, requiring at least four of the seven items to be answered with the responses of 'sometimes', 'often' or 'very often'. Missing data were excluded listwise. In order to account for measurement errors, we conducted a correlation analysis with a latent variable (structural equation) model while using mean GAS scores for the descriptive analyses. Data were analysed using the software R and the Lavaan package for the confirmatory factor analysis and the structural equation model [38].

RESULTS

Sample characteristics

The respondents' ages range from 14 to 90 (mean = 37.8), and 58.4% of the respondents are male. The gamers in our sample spend an average of 52 minutes per day playing digital games. However, gaming frequency varies considerably with age and gender. Male players use digital games for about 1 hour per day, whereas females play an average of 40 minutes. Regarding the gamers' age, there is a weak negative correlation with gaming frequency ($r = -0.12$, $P < 0.05$); that is, younger players are exposed more frequently to digital games. For the statistical analyses, we divided our sample into three age groups in order to allow for comparisons with previous studies [23,24]. Specifically, these age groups are adolescents between 14 and 18 years ($n = 580$), younger adults aged 19–39 ($n = 1866$) and older adult players aged 40 and older ($n = 1936$). Due to the stratified sampling procedure, the proportion of

multi-player game users is slightly higher in our sample than in the overall German gamer population (77.8% versus 68.4%). However, as the results reported below do not differ significantly from the analysis of a re-weighted sample, we present the findings from the unweighted data for easier interpretation.

Prevalence of GAS scores, problematic game use and addiction

Across all age groups, mean GAS scores among German gamers are very low and skewed strongly to the right (see Table 2). With a mean value of 1.63, adolescents score slightly higher than younger (1.46) and older adults (1.40) ($P < 0.05$).

Dichotomizing the GAS with regard to the monothetic procedure indicating addiction, the data show a very low prevalence within our representative sample in Germany. In total, only 0.2% ($n = 7$) [95% confidence interval (CI): 0.1, 0.3] of all respondents across all age groups can be classified as addicted; considerably more individuals can be labelled as problematic users (3.7%, 95% CI: 3.1, 4.3). Of these 166 individuals, 65% are male. In other words, 4.1% (95% CI: 3.4, 4.9) of all male and 3.2% (95% CI: 2.4, 4.1) of all females who use digital games are problematic users according to GAS criteria. The difference between males and females, however, is not statistically significant. The amount of problematic users among people below the age of 19 years is above the average, at 7.6% (95% CI: 5.6, 10.1).

Correlates of problematic game use: personality and gaming behaviour

In order to understand more clearly different covariates of problematic gaming behaviour, we estimated a multi-group structural equation model in which the latent variable GAS was correlated with several personality traits and types of gaming behaviour. To allow cross-group comparisons of the correlations, factor loadings for GAS and personality traits were constrained to be equal in the different age groups. The model shows acceptable fit, and the results are summarized in Table 3.

Looking at gaming behaviour, problematic game use is associated strongly with the daily amount of time spent on games. The positive correlation is equally strong for younger and older game users. In addition to general gaming intensity we can also see that, across all ages, online gamers tend to score higher on the GAS. Our analyses also support the hypothesis that genre preferences, especially for 'core-game' genres, are related to problematic game use. In general, we found a positive correlation between a preference for role-playing and shooter games and problematic game use, varying slightly between the different age groups. Adolescents

Table 2 Game Addiction Scale (GAS): item description, scale means and prevalence rates across age groups.

	Adolescents (14–18)	Younger adults (19–39)	Older adults (40+)
	(n = 562)	(n = 1809)	(n = 1836)
How often during the last six months . . .			
Did you think about playing a game all day long? (salience)	0.62 (0.54, 0.69)	0.35 (0.32, 0.39)	0.24 (0.21, 0.26)
Did you play longer than intended? (tolerance)	1.54 (1.45, 1.64)	1.58 (1.52, 1.63)	1.50 (1.45, 1.55)
Did you play games to forget about real life? (mood modification)	0.31 (0.25, 0.37)	0.28 (0.25, 0.31)	0.28 (0.24, 0.31)
Have you failed when trying to reduce game time? (relapse)	0.45 (0.38, 0.52)	0.27 (0.24, 0.30)	0.26 (0.23, 0.29)
Have you felt bad, when you were unable to play? (withdrawal)	0.34 (0.29, 0.40)	0.21 (0.19, 0.24)	0.15 (0.13, 0.17)
Did you have fights with other (e.g. family, friends) over your time spent on games? (conflict)	0.65 (0.58, 0.73)	0.24 (0.21, 0.26)	0.17 (0.15, 0.19)
Have you neglected other important activities (e.g. school, work, sports) because you were playing games? (problems)	0.52 (0.45, 0.59)	0.29 (0.26, 0.32)	0.20 (0.18, 0.23)
Mean GAS score	1.63 (1.59, 1.68)	1.46 (1.44, 1.48)	1.40 (1.38, 1.42)
Proportion problematic users (%)	7.6 (5.6, 10.1)	3.3 (2.5, 4.2)	3.0 (2.3, 3.8)
Proportion addicted users (%)	0.2 (0.1, 0.5)	0.2 (0.1, 0.4)	0.2 (0.1, 0.5)

Means and proportions (point estimates and 95% confidence intervals); items were scored on a five-point Likert scale from 0 (never) to 4 (very often).

Table 3 Relationships between the Game Addiction Scale (GAS), psychological and gaming-related variables.

	Game Addiction Scale		
	Adolescents (14–18)	Younger adults (19–39)	Older adults (40+)
	(n = 562)	(n = 1809)	(n = 1836)
Gaming frequency	0.34 (0.27, 0.41)	0.33 (0.29, 0.37)	0.36 (0.32, 0.40)
Online multi-player game use	0.23 (0.15, 0.30)	0.23 (0.19, 0.28)	0.24 (0.20, 0.28)
Preference for role-playing games	0.11 (0.02, 0.19)	0.19 (0.14, 0.23)	0.12 (0.07, 0.16)
Preference for first-person shooter games	0.26 ^a (0.18, 0.33)	0.17 (0.13, 0.22)	0.08 (0.03, 0.13)
Physical aggression	0.30 (0.22, 0.37)	0.20 (0.15, 0.24)	0.22 (0.18, 0.26)
Anger aggression	0.32 ^a (0.25, 0.40)	0.19 (0.15, 0.23)	0.22 (0.18, 0.26)
Self-efficacy	-0.21 (-0.29, -0.13)	-0.15 (-0.19, -0.10)	-0.15 (-0.19, -0.10)
Social support	-0.32 ^a (-0.39, -0.25)	-0.13 (-0.18, -0.09)	-0.15 (-0.19, -0.10)
Sociability	-0.24 ^a (-0.32, -0.16)	-0.13 (-0.18, -0.09)	-0.10 (-0.15, -0.05)
Life satisfaction	-0.19 (-0.27, -0.11)	-0.24 (-0.29, -0.20)	-0.26 (-0.30, -0.22)

Pearson’s correlation coefficients and 95% confidence intervals. ^aSignificant difference between two or more groups. Multiple-group structural equation model with metric invariance between groups (equal factor loadings). Multiple linear regression (MLR) estimation, Satorra–Bentler scaled χ^2 (d.f. = 1218) 1631.4, $P < 0.01$, comparative fit index (CFI) 0.97, standardized root mean square residual (SRMR) 0.03, root mean square error of approximation (RMSEA) 0.02.

who prefer first-person shooters are more likely to be problematic gamers than older adults ($P < 0.05$), although this could be due to the fact that older gamers do not prefer the shooter genre as much as adolescents.

Turning to the relationship between problematic game use and personality traits, our study can confirm many previous findings. For all gamers, social competence and social integration are related negatively to GAS scores. Problematic gaming coincides significantly with low sociability and a perceived lack of social support. This

relationship is more pronounced among adolescents than among adult gamers ($P < 0.05$). By contrast, aggressive tendencies—whether physical or anger-related—coincide consistently with problematic game use. Moreover, our analyses showed that low levels of self-efficacy are associated significantly with higher GAS scores.

In order to understand the implications of problematic game use on psychosocial wellbeing, we also analysed the correlation with general life satisfaction. The data show a significant negative relationship between life

satisfaction and problematic game use. In summary, the present study replicates previous results about individual differences and problematic gaming among adolescents, and also confirms these findings for older age groups, albeit at times with weaker correlations.

DISCUSSION

The aim of the present study was to close a research gap on problematic gaming behaviour by gathering data on the prevalence outside of the demographic group of adolescents and young adults. In line with previous studies from Norway and the Netherlands, the prevalence of gaming addiction is very low in our representative sample of German gamers: only 0.2% of the respondents met the required criteria suggested by Lemmens *et al.* [23]. This percentage is evidently lower than the findings of certain studies focusing on a special sample of gamers, such as users of MMOPRG [16,21]. A vast majority of gamers cannot be classified as addicted, even if they use digital games extensively. Although there may be some individuals who require professional help, our results do not provide evidence that gaming addiction is a serious societal problem, at least in Germany.

Focusing on problematic game use according to the GAS criteria, we found slightly higher prevalence rates (3.7%) than a similar Norwegian study [24], especially among adolescents. Taking this into account, young gamers seem to be occupied temporally and mentally by digital games more often in their everyday life. Given the low percentage of addiction cases, this can also be a result of more spare time and less work or family obligations, rather than a reflection of a psychiatric disorder. Overall, we conclude that there is a small number of people whose gaming behaviour can be described as problematic, whereas addiction according to the GAS criteria must be considered a marginal phenomenon.

However, when taking into account previous studies, the question remains as to what criteria should be used in order to define gaming addiction. This concerns not only the number of criteria, but also the frequency of problematic behaviour. Lemmens *et al.* [23] follow the arguments presented by Charlton & Danforth [16] that all seven criteria must be fulfilled at least occasionally. This definition should be discussed critically, especially as the chosen cut-off threshold is relatively low. Is occasional problematic behaviour already alarming, or should problematic game use and especially addiction be defined only for users who show the corresponding symptoms regularly? Based on this approach, gaming addiction would be even less frequent. Moreover, it is doubtful whether some items from the GAS, for example for tolerance or withdrawal, can discriminate reliably between healthy enthusiasm and problematic use at all. Due to the lack of

agreement about the criteria, van Rooij *et al.* [25] suggest an alternative inductive (i.e. data-driven) approach to detect a probably addicted subgroup of gamers. However, this approach is less useful when trying to provide representative data to compare the diffusion of addicted gamers in different countries. For this purpose, we had to use an established, standardized instrument that could be applied among different samples.

Confirming previous findings, problematic game use is associated with lower levels of sociability [23,28], less perceived social support, lower expectations of self-efficacy [15], aggressive behaviour—both physical and anger-related [22,23,27]—as well as lower life satisfaction [23,24]. A higher score on the GAS coincides not only with an extensive use of digital games [23,24], but also with a preference for role-playing games and first-person shooters. Besides social obligations arising from social relations built into the game's world, such online games are often based on a long history of use; as a result, time and energy that have already been invested can influence motivation to stay in the game.

Our data show that certain aspects of personality, genre preferences and extensive game use are correlated with problematic gaming behaviour. However, present findings are based on a cross-sectional analysis, meaning that no conclusions can be made about causal effects. Accordingly, the question remains as to whether extensive gaming leads to problematic behaviour or whether individuals with an impulse control disorder tend to engage in many forms of excessive behaviour, including intensive gaming. To answer questions concerning causality, and to analyse temporal patterns and the stability of problematic game use more longitudinal data are needed [25].

Declarations of interest

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