Psychology Research and Behavior Management

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ORIGINAL RESEARCH

The Role of Self-Control Dimensions, Game Motivation, Game Genre, and Game Platforms in Gaming Disorder: Cross-Sectional and Longitudinal Findings

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Introduction: Gaming disorder (GD) is the result of an interplay between gaming-related factors, individual factors, and environmental factors. Current research primarily highlights single types of factors. Consequently, the present study simultaneously analyzed the role of individual factors, such as self-control dimensions and motives for gaming, and gaming-related factors, such as game genres, and gaming platforms in GD among female and male gamers. Additionally, the study provides a comprehensive analysis of these factors in relation to GD both cross-sectionally (Study 1) and longitudinally (Study 2).

Methods: Study 1 comprised 620 active gamers (M=22.16 years; SD=2.99), and Study 2 comprised 405 active gamers (M=28.05 years; SD=4.51). The instruments used in the studies included the Gaming Disorder Test, the nine-item Internet Gaming Disorder Short-Form (IGDS9-SF), Motives for Online Gaming Questionnaire, Video Game Questionnaire, and Self-Knowledge New Sheet.

Results: The results showed that GD was associated with (i) self-control deficits associated with difficulties in implementation control and taking actions related to goals without unnecessary delay, (ii) retaining information about intentions and long-term plans, (iii) refraining from immediate, impulsive behavior, and (iv) inhibiting emotional reactions. GD was also associated primarily with escape, coping, and competition motives for gaming. However, the longitudinal study showed that social, fantasy, and skill-development motives were also related to GD development over time. The action game genres associated with GD but were not very important for GD over time. The cross-sectional study results indicated a negative relationship between GD and tablets and consoles used as gaming platforms. However, the longitudinal study showed that desktop computers and consoles use as gaming platforms were associated with the GD over time. Moreover, gaming-related factors explained only 9% of the variance in the GD model among female gamers and only 10% of the variance in the GD model among male gamers in cross-sectional study. In contrast, individual factors such as self-control dimensions and gaming motivation explained 32% of the variance in the GD model among both female and male gamers.

Conclusion: Individual factors, such as self-control dimensions and motives for gaming, were more important in explaining GD than gaming-related factors, such as game genres and gaming platforms. Moreover, self-control deficits and motivation related to escape, coping and competence can be important factors to consider in the prevention and treatment of GD.

Keywords: gaming disorder, self-control dimensions, game motivation, game genre, game platforms

Introduction

The development of new technologies has contributed to making videogames one of the popular pastimes. In this context, videogames can be characterized as:

> *"an activity that utilizes a digital video screen in some way. It is constrained by a system of rules in which a player combats with another player, or with the game itself, often to achieve a definite desirable outcome."* (p.2)[1]

Received: 7 September 2023
Accepted: 31 October 2023
Published: 22 November 2023

Playing videogames is an entertainment activity that engages many individuals.[2] It is increasingly common to see individuals gaming on smartphones or portable consoles in public areas. Consequently, understanding the impact of videogame playing on gamers is an important research area. Previous research has primarily focused on the positive and negative consequences of gaming.[3,4] On one hand, it has been shown that playing videogames can improve gamers' cognitive functioning, such as perception, spatial cognition, and top-down attention.[5] On the other, attention has been paid to the negative consequences of problematic involvement in videogames, such as gaming disorder (GD).[6]

Considering the increasing number of empirical studies pointing to the possible addictive effect of videogames,[7] criteria for GD were included in the eleventh revision of the *International Classification of Diseases* (ICD-11)[8] and the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5).[9] According to the ICD-11, GD is a:

> *"persistent or recurrent gaming behavior, which results in marked distress or significant impairment in personal, family, social, educational, occupational, or other important areas of functioning.".*

Stevens et al[10] conducted a meta-analysis of previous studies on GD. They showed that the worldwide prevalence of GD was between 1.96% and 3.05% depending on the stringency of the sampling criteria. Additionally, in a meta-analysis, Kim et al[11] reported that the overall pooled prevalence of GD was 3.3%, with a 95% confidence interval between 2.6% and 4.0%. Moreover, they indicated that male gamers were more likely to experience GD than female gamers.[10,11]

Consequently, gaming disorder presents a challenge to the healthcare system in relation to the prevention and treatment of the disorder. Prevention and treatment require increased economic spending and identifying relevant risk factors for addiction to optimize the healthcare system's cost.[12,13] Additionally, it should be noted that excessive gaming over a long time can lead to negative consequences in various areas of the gamer's functioning, such as compromising work (eg, work conflicts, work/school dropouts), family (eg, family conflicts), mental health (eg, poor mental health), and social relationships (eg, social isolation).[14–16] Consequently, a thorough understanding of the factors involved in developing GD is important for the healthcare system and for protecting gamers from the negative consequences of problematic gaming. Therefore, the present study's aim was to simultaneously investigate the relationship between individual factors, gaming-related factors, and GD using both a cross-sectional study and longitudinal study. Unlike previous studies which have focused on a single gaming disorder determinant factors group,[17–20] the present study's aim was to comprehensively verify the importance of individual and gaming-related factors for GD.

In this context, Griffiths[21,22] and Király et al[7] point out that GD is the result of an interplay between gaming-related factors, individual factors, and environmental factors. The gaming-related factors are linked to online games, including specific game genres (especially action games such as massively multiplayer online role-playing games [MMORPGs], first-person/third-person shooter [FPS/TPS] games, real-time strategy [RTS] games, and multiplayer online battle arena [MOBA) games] and the monetization techniques implemented in games.[7] The individual factors contributing to GD include (i) demographic risk factors such as male gender and young age, (ii) personality traits such as low extraversion, low conscientiousness, low agreeableness, high neuroticism, high impulsivity, and high narcissism, (iii) individual vulnerabilities such as generalized anxiety disorder, depression, ADHD, and substance use disorders, and (iv) motivational factors such as escapism, achievement-related motives, social motives, and immersion.[7] The environmental factors are linked to family factors, early life experiences, peers, school-related factors, cultural and esport contexts.[7] Additionally, considering the multifactorial background of GD, Király et al[7] postulated paying more attention to exploring the relationship between different groups of factors in its development. Consequently, the present study focused on gaming-related and individual factors relevant to GD.

Király et al[7] highlighted that in relation to individual factors, low conscientiousness and high impulsivity are drivers of GD. However, these factors are related to the more general factor of self-control defined as:

> *"the ability to behave in relative autonomy from external pressures, automatisms, or impulses. This ability manifests itself in delay of gratification, inhibition of prepotent responses, emotion regulation, and adequate adaptation to a social milieu."* (p. 26)[23]

Previous research has reported a negative relationship between GD and self-control.[24–27] Moreover, the results of the longitudinal study also indicated a negative association between self-control and GD.[28] Additionally, the Interaction of the Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors highlights the importance of the self-regulation

deficit in GD development.[29,30] More specifically, deficiencies in self-control may contribute to difficulties in delaying the gratification associated with gaming and greater engagement in gaming when internal (eg, thoughts on the videogame) and external (eg, advertising for videogames) triggers associated with gaming arise. It should be noted that, according to the Integrative Self-control Theory,[31] self-control is not a homogeneous construct, and several systems can be distinguished within it.

In this context, Nęcka et al[32] pointed to the following five self-control components: (i) goal maintenance, (ii) proactive control, (iii) initiative and persistence, (iv) switching and flexibility, and (v) inhibition and adjournment. The goal maintenance component of self-control is associated with the individual's ability to retain information about their intentions and long-term plans. The proactive control component concerns an individual creating plans, setting priorities, analyzing consequences, and anticipating obstacles. The initiative and persistence component is the motivational aspect of self-control related to the individual's ability to implement control and take actions related to their goals without unnecessary delay. Self-control's switching and flexibility component is associated with the individual's ability to adapt to changing circumstances and manage attention while performing relevant activities. The inhibition and adjournment component is an individual refraining from immediate, impulsive behavior and inhibiting emotional reactions.[23] In the self-control dimension context, previous research by Cudo et al[33] showed that some self-control dimensions were negatively associated with GD. More specifically, a negative relationship was reported between GD and self-control dimensions such as initiative and persistence among female gamers. Additionally, there was a negative relationship between GD and self-control dimensions such as initiative and persistence, and inhibition and adjournment among male gamers. Moreover, proactive control was negatively associated with weekly gaming hours.[33] However, to date, the relationship between self-control dimensions based on the Integrative Self-control Theory[31] and GD has not been tested using a longitudinal study design.

In the individual factors context, Király et al[7] also pointed out the motivational factors such as escapism (gaming as a way to escape from problems and difficulties in the real world), achievement-related motives (gaming as a way of achieving competences expressed through game achievements), social motives (gaming as a way of socializing, forming relationships with other gamers, and being with other gamers in the game), and immersion (gaming as a source of deep experience of the virtual world within the game) may contribute to GD development. More specifically, previous research reported a positive relationship between GD and (especially) escape, competition (gaming as an opportunity to compete with other gamers), coping motives (gaming as a way of coping with stress and moodiness), and a negative relationship between GD and skill development (gaming as a method to improve cognitive skills), and recreation (gaming as a source of relaxation and entertainment).[34–36]

Additionally, Wang and Cheng's meta-analysis showed that GD was associated with achievement, immersion, social motives, and escape.[37] They also highlighted that the strongest relationship was between GD and escape. Bäcklund et al's meta-analysis also showed that escape was one of the strongest gaming motives associated with GD.[38] Richard et al's review of longitudinal studies showed that gaming escape and achievement motives predicted symptoms of GD.[14] However, only a few longitudinal studies have analyzed the relationship between gaming motives and the GD development across time.[14] Consequently, there is a research gap in this area. It should be noted that previous research has also indicated differences between female and male gamers in gaming motives.[25,36] More specifically, Cudo et al[25] reported that GD was positively associated with social, fantasy, and escape motives among male gamers. Additionally, GD was positively associated with the competition motive and negatively associated with the recreation motive among female gamers.

Beyond the individual factors related to self-control and motives for gaming, Király et al[7] also highlighted the importance of gaming-related factors (eg specific game genres), which are often overlooked in research examining GD. They postulated that specific game genres (eg, MMORPGs, FPS/TPS games, RTS games, and MOBA games) can facilitate GD development. Previous studies have reported a positive relationship between addiction and gaming in these game genres.[39–43] It should be pointed out that these game genres are classified more broadly as action games,[3,5,44] which are characterized as games which include fast character and scenes motion, multiple targets that must be tracked by the player simultaneously, and first- or third-person views.[3,5,44]

It should also be noted that these specific game genres have distinct structural characteristics, such as the complex reinforcement systems, in-game social interactions systems, and complex virtual world structures in which the gamers

can create their characters.[7,17] These structural characteristics can contribute to accessing the game and maintaining engagement with the game over time.[17] Moreover, Syvertsen et al[45] showed that gamers who use consoles or computers as gaming platforms were more likely to be at-risk from GD. In contrast, gamers using mobile platforms were less likely to be at-risk from GD. However, gamers concurrently using mobile platforms and consoles/computers as gaming platforms were more likely to experience GD. Syvertsen et al[45] indicated that the higher prevalence of mobile platform use among the low GD risk group may be due to the casual nature of mobile games or the higher prevalence of mobile platform use by female gamers, who show lower levels of GD.[10] Consequently, gaming-related factors such as game genres and gaming platforms can be important factors in GD development. However, there is a research gap regarding their importance compared to individual factors in GD. Moreover, there is a lack of longitudinal studies investigating relationships between specific game genres use, game features, and GD.[17]

The Present Study

As aforementioned, Király et al[7] highlighted that GD is the result of an interplay between gaming-related factors, individual factors, and environmental factors. Additionally, they pointed out that to better understand GD development, it is important to consider not only single groups of factors but also the groups of factors and interconnections between them. Consequently, the present study analyzed the relationship between individual factors, gaming-related factors, and GD. Based on the aforementioned literature, it was hypothesized that the GD would be negatively associated with self-control dimensions such as initiative and persistence (H_{1a}), and inhibition and adjournment (H_{1b}).

With regard to gaming motivation,[37,38] it was hypothesized that the GD would be positively associated with gaming motivations such as escape (H_{2a}), social (H_{2b}) and competition (H_{2c}) motives. Király et al[7] posited that specific game genres such as MMORPGs, FPS/TPS games, RTS games, and MOBA games can facilitate GD development. As aforementioned, these specific game genres have been described as action games.[3,5,44] Consequently, it was hypothesized that the GD would be positively associated with action game genres (H_3). Moreover, based on previous research,[45] it was hypothesized that GD would be positively associated with using computers and laptops as gaming platforms (H_4).

Given the differences between female and male gamers with regards to GD prevalence,[10] game genres,[46] gaming platforms,[25] and the relationship between self-control,[33] gaming motivation[25,36] and GD, it was hypothesized that there would be a difference between female and male gamers in relationship between self-control dimensions and GD (H_{5a}), gaming motivation and GD (H_{5b}), and gaming-related factors and GD (H_{5c}).

Despite ongoing research, there is still a research gap regarding the impact of specific factors (gaming-related, individual, and environmental factors) on the development of GD.[7] Additionally, there are only a small number of studies examining the role of these factors in GD across time. Therefore, two studies were designed to test the stated hypotheses: a cross-sectional study (Study 1), and a longitudinal study (Study 2). This approach allowed for a comprehensive verification of the relationship between the analyzed factors and GD. Moreover, considering that the change of gaming disorder symptoms across time among gamers may have different trajectories in different gamer groups,[47] the verification of the hypotheses in the longitudinal study was based on the analysis of gaming-related and individual factors between gamer groups with different trajectories of gaming disorder development. More specifically, the cross-sectional study was carried out to verify associations between individual factors, gaming-related factors, and gaming disorder. To complement this, the longitudinal study was carried out to verify whether the same variables as in Study 1 differentiated trajectories with low levels of gaming disorder across time from trajectories with high levels of gaming disorder across time or trajectories with increasing levels of gaming disorder across time. Therefore, the cross-sectional study (Study 1) served as an initial step for collecting data and establishing potential associations, which were subsequently explored more thoroughly in a follow-up longitudinal study (Study 2). It was expected that the findings of Study 1 and Study 2 would complement each other.

Methods (Study 1)

Participants and Procedure

The study comprised 620 Polish active gamers (314 females; mean age=22.16 years; SD=2.99; age range: 18–38 years) who played videogames for at least two hours per week in the past 12 months. Gamers completed questionnaires at the

Perception & Cognition Laboratory (at the first author's university). Participants came from the following places of residence: (i) village (N=147; 23.71%), (ii) city up to 20,000 inhabitants (N=39; 6.29%), (iii) city from 20,000 inhabitants to 100,000 inhabitants (N=98; 15.81%), and (iv) city above 100,000 inhabitants (N=336; 54.19%). Recruitment was carried out using convenience sampling incorporating the snowball method. More specifically, information about the study and a link to the survey was advertised on social media. Individuals who completed the short survey on daily activities including those related to gaming were asked to send the survey to other gamers who they thought might be interested in completing the survey. Those who indicated that they played videogames at least two hours a week during the 12 months were then invited to the university laboratory. In the laboratory, gamers then completed a questionnaire assessing individual and gaming-related factors. The study was conducted following the Declaration of Helsinki, and was approved by the first author's university. The participants received a remuneration of 100 PLN. It should also be noted that the present study was part of a larger research project on gamers' cognitive functioning. Considering the specificity of the issue in the present paper and the consistency of the case, only the variables needed to verify the hypothesized relationship are presented. The dataset from the Study 1 is available from https://hdl.handle.net/20.500.12153/5458.

Based on Cohen[48] and Cohen et al's[49] guidelines, the required samples size for regression analysis was estimated as 252 participants for each group (effect size: f^2=0.10; statistical power: 0.80; number of predictors: 26; probability level: 0.05).

Measures

The nine-item Internet Gaming Disorder Scale Short-Form (IGDS9-SF)[50] in Polish adaptation[51] was used to assess disordered gaming. Items (eg, *"Do you systematically fail when trying to control or cease your gaming activity?"*) are rated on a five-point Likert scale from 1 (*never*) to 5 (*very often*). Higher scores indicate greater levels of GD. In the present study the Cronbach's alpha was 0.81.

The 27-item Motives for Online Gaming Questionnaire (MOGQ)[52] in Polish adaptation[53] was used to assess motives for gaming. The scale comprises seven subscales: (i) social (eg, *"I play online games because gaming gives me company"*), (ii) escape (eg, *"I play online games because gaming helps me to forget about daily hassles"*), (iii) competition (eg, *"I play online games because I enjoy competing with others"*), (iv) coping (eg, *"I play online games because it helps me get rid of stress"*), (v) skill development (eg, *"I play online games because it improves my skills"*), (vi) fantasy (eg, *"I play online games to be somebody else for a while"*), and (vii) recreation (eg, *"I play online games because I enjoy gaming"*). Items are rated on a five-point response scale from 1 (*almost never/never*) to 5 (*almost always/always*). Higher scores indicate higher levels of one of seven motives for gaming. In the present study, the Cronbach alphas for the subscales were 0.81 for social, 0.90 for escape, 0.87 for competition, 0.78 for coping, 0.88 for skill development, 0.86 for fantasy, and 0.74 for recreation.

The Video Game Questionnaire (VGQ)[54] was used to assess the frequency of playing various game genres such as first/third-person shooters, action-RPG/adventure, sports/driving, real-time strategy/MOBA, turn-based/nonaction role-playing /fantasy, turn-based strategy/life, simulation/puzzle, music games, and other. Participants answered questions about the number of hours played in these game genres in the past 12 months on a six-point response scale: 1 (never), 2 (less than 1 hour), 3 (between 1 and 3 hours), 4 (between 3 and 5 hours), 5 (between 5 and 10 hours) and 6 (more than 10 hours).

The 50-item Nowy Arkusz Samowiedzy (Self-Knowledge New Sheet; NAS-50)[32] was used to assess self-control dimensions based on Integrative Self-control Theory.[20] The scale comprises five subscales: goal maintenance (eg, "It happens to me to go to a particular place and not remember for what purpose I did it" - reverse question), proactive control (eg, *"When making difficult decisions, I try to analyze all the 'pros' and 'cons'"*), initiative and persistence (eg, *"When I am engaged in housework, I allow myself to rest after completing all the tasks"*), switching and flexibility (eg, *"It's easy for me to do two things at once"*), and inhibition and adjournment (eg, *"When I have something important to say, I cannot resist getting into my interlocutor's words"* - reverse question). Items are rated on a five-point scale from 1 (*definitely not*) to 5 (*definitely yes*). Higher scores indicate higher levels of self-control on the specific dimension. In the present study, the Cronbach's alpha for the subscales were 0.73 for goal maintenance, 0.75 for proactive control, 0.85 for initiative and persistence, 0.73 for switching and flexibility, and 0.76 for inhibition and adjournment.

Additionally, participants answered questions about gaming platforms which they used for gaming, such as desktop computers, laptops, tablets, consoles and/or smartphones. They responded to each playing device using a dichotomous scale (Yes/No). Participants also answered questions regarding demographic information such as age, gender, and place of residence.

Statistical Analysis

Rho Spearman correlation coefficients were used to calculate the correlation between self-control dimensions, motives for gaming, game genres, game platforms, age, and GD, separately for female and male gamers. Additionally, for continuous variables, the Mann–Whitney two-sample tests with η^2 effect size coefficient[55] were used to examine differences between female and male gamers in the analyzed variables. Moreover, χ^2 tests with φ coefficient[55] were used to verify these differences for nominal variables. It should be noted that the correlation and difference analysis results are included in Tables S1 and S2, respectively).

A hierarchical linear regression model was used separately for female and male gamers to examine the relationship between the self-control dimensions, motives for gaming, game genres, gaming platforms, and GD. The gaming-related factors such as gaming platforms and frequency of playing specific game genres were added in the first two steps. The individual factors such as gaming motives self-control dimensions were added in the next two steps. More specifically, in the first step, age and gaming platforms were introduced as predictors of GD. In the second step, the frequency of playing specific game genres was entered into the regression model. In the third step, gaming motives were introduced, and in the fourth step, the self-control dimensions were implemented into the regression model. After the models for female and male gamers were calculated, the homoscedasticity assumption was checked. Considering the non-fulfilment of the homoscedasticity assumption (the Breusch-Pagan test: female gamers: χ^2 [df=1]=34.89, p<0.001; male gamers: χ^2[df=1]= 31.02, p<0.001), robust standard error estimation was used and models were re-calculated. Variable inflation factors (VIFs) were used to assess multicollinearity and Ramsey's (RESET)[56] right-hand-side regression specification-error test was used to simultaneously analyze omitted variables and check for nonlinearity (misspecification model form) associated with squared, cubic, and quartic form of predictors in regression model. More specifically, it was used to check that inputting variables in a linear manner was sufficient for understanding how the data are produced as there may be nonlinear relationships between motivation and problem gaming. Based on Ramsey's (RESET)[56] right-hand-side regression specification-error test, it was shown that there were no omitted variables in any of the analyzed groups (female gamers: F[63, 216]=1.17, p=0.207; male gamers: F[63, 216]=1.11, p=0.290). Multicollinearity was assessed by variable inflation factors (VIFs), below the multicollinearity threshold 2.5 for the male gamers group. In the female gamers group, the variable inflation factors (VIFs) were below 2.5, apart from the coping motive for gaming (VIF=3.11) and escape motive for gaming (VIF=2.81). However, considering the Vittinghoff et al[57] guidelines, a VIF between 2.5 and 5 may indicate low to moderate multicollinearity, which, occurring in isolated variables, may not significantly affect the outcome of the regression analysis. Additionally, the beta coefficients among regression models for female and male gamers were compared using the z-test.[58,59] IBM SPSS version 28 was used to compute descriptive statistics, and Stata 14 was used to conduct the regression analyses.

Results

The hierarchical regression analysis results among female gamers showed that GD was positively related to real-time strategy/MOBA game genre (B=0.053, SE=0.019, β=0.146, p=0.004), escape (B=0.106, SE=0.041, β=0.214, p=0.010), and coping (B=0.099, SE=0.042, β=0.167, p=0.018) in the final step. Additionally, there was a negative relationship between GD and self-control dimensions of goal maintenance (B=−0.012, SE=0.005, β=−0.144, p=0.013) and inhibition and adjournment (B=−0.015, SE=0.005, β=−0.166, p=0.006) in the final step. The whole model explained 41% of the variance. Moreover, the turn-based strategy/life simulation/puzzle game genre was positively associated with GD in Step 2 (B=0.058, SE=0.027, β=0.147, p=0.034) and Step 3 (B=0.050, SE=0.025, β=0.125, p=0.050). However, this relationship was not statistically significant in the final step. Other analyzed variables were not significantly related to the GD. Detailed results are shown in Table 1.

Table 1 Hierarchical Regression Results for Female Gamers (N = 314)

Variables		Step 1			Step 2			Step 3			Step 4		
		B	SE	β	B	SE	β	B	SE	β	B	SE	β
Age		−0.005	0.013	−0.026	0.002	0.014	0.011	0.002	0.011	0.009	0.002	0.011	0.010
Gaming platforms	Laptop (1 – yes; 0 – no)	0.015	0.090	0.010	−0.077	0.088	−0.054	−0.087	0.074	−0.060	−0.065	0.074	−0.046
	Stationary computer (1 – yes; 0 – no)	−0.005	0.072	−0.004	−0.071	0.066	−0.056	−0.114	0.062	−0.090	−0.085	0.058	−0.067
	Tablet (1 – yes; 0 – no)	0.048	0.119	0.027	−0.004	0.122	−0.002	−0.047	0.095	−0.026	−0.022	0.084	−0.012
	Console (1 – yes; 0 – no)	0.053	0.070	0.044	0.013	0.070	0.010	−0.006	0.062	−0.005	−0.006	0.059	−0.005
	Smartphone (1 – yes; 0 – no)	0.020	0.094	0.013	0.008	0.090	0.005	0.004	0.083	0.002	−0.022	0.084	−0.014
Game genres	First/Third person shooters				0.033	0.027	0.064	−0.003	0.025	−0.006	0.008	0.024	0.015
	Action-RPG/adventure				0.004	0.023	0.012	−0.005	0.023	−0.014	0.006	0.022	0.018
	Sports/driving				0.007	0.028	0.015	−0.017	0.026	−0.038	−0.025	0.024	−0.055
	Real-time strategy/MOBA				0.066	0.019	0.179**	0.052	0.020	0.143**	0.053	0.019	0.146**
	Turn-based/Non-action role-playing/Fantasy				0.023	0.024	0.060	0.006	0.021	0.014	0.006	0.020	0.015
	Turn-based strategy/Life simulation/Puzzle				0.058	0.027	0.147*	0.050	0.025	0.125*	0.044	0.023	0.111
	Music games				0.023	0.026	0.051	0.026	0.022	0.056	0.023	0.023	0.051
	Other				0.005	0.023	0.011	0.002	0.022	0.004	0.001	0.021	0.003
Motives for gaming	Social							−0.001	0.040	−0.002	−0.012	0.036	−0.020
	Escape							0.129	0.041	0.261**	0.106	0.041	0.214*
	Competition							0.064	0.035	0.126	0.048	0.032	0.094
	Coping							0.122	0.043	0.206**	0.099	0.042	0.167*
	Skill development							−0.010	0.032	−0.019	0.027	0.031	0.053
	Fantasy							0.045	0.029	0.097	0.037	0.028	0.079
	Recreation							−0.014	0.034	−0.023	−0.006	0.033	−0.010

(*Continued*)

https://doi.org/10.2147/PRBM.S435125 DovePress

Table 1 (Continued).

Variables		Step 1			Step 2			Step 3			Step 4		
		B	SE	β	B	SE	β	B	SE	β	B	SE	β
Self-control dimensions	Goal maintenance										−0.012	0.005	−0.144*
	Proactive control										−0.007	0.006	−0.069
	Initiative and persistence										0.005	0.004	0.064
	Switching and flexibility										−0.009	0.005	−0.095
	Inhibition and adjournment										−0.015	0.005	−0.166**
Constant		1.942	0.319		1.538	0.324		0.903	0.282		2.249	0.441	
R^2		0.01			0.09			0.35			0.41		
F-statistic		0.22			2.46**			9.26***			8.62***		
ΔR^2					0.08			0.26			0.06		
F-statistic for change		–			3.86***			13.49***			4.94***		

Note: ***$p<0.001$, **$p<0.01$, *$p<0.05$.

For male gamers, the hierarchical regression analysis results showed that GD was positively related to real-time strategy/MOBA game genre (B=0.051, SE=0.017, β=0.159, p=0.003), escape motive (B=0.089, SE=0.037, β=0.172, p=0.017), competition (B=0.067, SE=0.029, β=0.126, p=0.023), and coping (B=0.138, SE=0.046, β=0.226, p=0.003) in the final step. Additionally, GD was negatively related to gaming on tablets (B=−0.223, SE=0.098, β=−0.071, p=0.023), console platforms (B=−0.171, SE=0.060, β=−0.139, p=0.005), recreation (B=−0.100, SE=0.042, β=−0.129, p=0.018), and the self-control dimensions of goal maintenance (B=−0.016, SE=0.006, β=−0.153, p=0.006), initiative and persistence (B=−0.014, SE=0.005, β=−0.187, p=0.003), and switching and flexibility (B=−0.014, SE=0.005, β=−0.141, p=0.012) in the final step. The whole model explained 42% of the variance. It should be noted that there was a positive relationship between GD and gaming on computers (B=0.180, SE=0.084, β=0.147, p=0.034) in Step 1. Other analyzed variables were not significantly related to the GD. Detailed results are shown in Table 2.

The findings also showed differences between female and male gamers in the relationship between GD and initiative and persistence (z=3.04, p=0.002) and between GD and inhibition and adjournment (z=−2.79, p=0.005). More specifically, there was a statistically significant negative relationship between GD and initiative and persistence among male gamers (B=−0.014, SE=0.005, β=−0.187, p=0.003). However, female gamers had no such relationship (B=0.005, SE=0.004, β=0.064, p=0.230). Additionally, there was a statistically significant negative relationship between GD and inhibition and adjournment among female gamers (B=−0.015, SE=0.005, β=−0.166, p=0.006) with no such relationship among male gamers (B=0.004, SE=0.004, β=0.049, p=0.307). Detailed results are shown in Table 3.

Discussion (Study 1)

The purpose of Study 1 was to examine the relationships among female and male gamers between GD and (i) self-control dimensions, (ii) gaming motivations, (iii) game genres, and (iv) gaming platforms. The findings showed that GD was positively associated with real-time strategy/MOBA games, and the motives of escape and coping among both groups. There was a negative relationship between GD and the self-control dimension of goal maintenance among female and male gamers. For female gamers only, GD was negatively associated with the inhibition and adjournment self-control dimension. For the male gamers only, there was a negative relationship between GD and gaming on platforms such as tablets and consoles. Additionally, among male gamers, GD was positively associated with the competition motive, and negatively associated with the recreation motive and self-control dimensions of initiative and persistence, and switching and flexibility.

The results showed a negative relationship between GD and self-control dimensions such as initiative and persistence, and inhibition and adjournment which supported H_{1a} and H_{1b}. However, there were gender differences. More specifically, among female gamers there was a positive relationship between GD and deficits in the ability to refrain from immediate, impulsive behavior and to inhibit emotional reactions. In contrast, among male gamers there was an association between GD and deficits in the ability to implement control and take actions related to their goals without unnecessary delay. These results are partly in line with previous research concerning the relationship between GD and self-control dimensions. For example, Cudo et al[33] also reported a negative relationship between GD and initiative and persistence self-control among male gamers. However, in that study, there was a negative relationship between GD and initiative and persistence self-control dimension among female gamers, whereas, in the present study, there was a negative relationship between GD and inhibition and adjournment self-control dimension among female gamers. One possible explanation for these differences is related to the fact that Cudo et al's study[33] also analyzed other addictions that may have played a mediating role in the relationships explored.

It should be noted that it was hypothesized that there would be a difference between female and male gamers in the relationship between self-control dimensions and GD (H_{5a}). Consequently, H_{5a} was supported in the context of the self-control dimensions. There were no other statistically significant gender differences in the relationship between analyzed variables and GD. Consequently, H_{5b} and H_{5c} were not supported. These differences may be linked to two mechanisms of dysfunction in the self-control function. One is related to the lack of motivation by individuals to take control of their behavior, and the other is related to the difficulty of inhibiting an action already in progress.[23,31,32] It is reasonable to assume that deficits in these self-control dimensions may have a different pattern in female and male gamers. However, more research is needed on the factors moderating the relationship between these self-control dimensions and GD among both female and male gamers.

Table 2 Hierarchical Regression Results for Male Gamers (N = 306)

Variables		Step 1			Step 2			Step 3			Step 4		
		B	SE	β	B	SE	β	B	SE	β	B	SE	β
Age		0.017	0.014	0.085	0.018	0.014	0.094	0.012	0.011	0.060	0.018	0.010	0.092
Gaming platforms	Laptop (1 – yes; 0 – no)	0.113	0.089	0.088	0.068	0.092	0.053	0.032	0.083	0.025	0.014	0.077	0.011
	Stationary computer (1 – yes; 0 – no)	0.180	0.084	0.147*	0.084	0.093	0.069	0.031	0.083	0.025	0.005	0.077	0.004
	Tablet (1 – yes; 0 – no)	−0.142	0.124	−0.045	−0.183	0.140	−0.058	−0.302	0.123	−0.096*	−0.223	0.098	−0.071*
	Console (1 – yes; 0 – no)	−0.185	0.069	−0.151**	−0.197	0.077	−0.161*	−0.149	0.063	−0.121*	−0.171	0.060	−0.139**
	Smartphone (1 – yes; 0 – no)	0.033	0.072	0.027	0.031	0.071	0.025	0.007	0.061	0.006	0.035	0.059	0.028
Game genres	First/Third person shooters				−0.005	0.024	−0.016	0.003	0.021	0.008	0.004	0.019	0.010
	Action-RPG/adventure				0.002	0.026	0.006	0.008	0.025	0.023	0.018	0.023	0.050
	Sports/driving				−0.002	0.024	−0.004	0.001	0.021	0.004	0.014	0.019	0.039
	Real-time strategy/MOBA				0.074	0.019	0.231***	0.058	0.018	0.182**	0.051	0.017	0.159**
	Turn-based/Non-action role-playing/Fantasy				−0.005	0.022	−0.016	−0.015	0.020	−0.045	−0.015	0.018	−0.044
	Turn-based strategy/Life simulation/Puzzle				0.019	0.022	0.055	0.007	0.021	0.021	0.000	0.018	0.001
	Music games				0.019	0.041	0.030	0.001	0.035	0.001	0.010	0.033	0.017
	Other				−0.015	0.027	−0.036	−0.014	0.023	−0.035	−0.019	0.022	−0.048
Motives for gaming	Social							−0.011	0.039	−0.017	0.014	0.035	0.021
	Escape							0.117	0.039	0.226**	0.089	0.037	0.172**
	Competition							0.079	0.031	0.148*	0.067	0.029	0.126*
	Coping							0.164	0.048	0.269***	0.138	0.046	0.226**
	Skill development							−0.080	0.035	−0.152*	−0.020	0.034	−0.038
	Fantasy							0.065	0.033	0.129	0.056	0.032	0.113
	Recreation							−0.088	0.045	−0.110	−0.100	0.042	−0.126*

Self-control dimensions	Goal maintenance										−0.016	0.006	−0.153**
	Proactive control										−0.001	0.006	−0.013
	Initiative and persistence										−0.014	0.005	−0.187**
	Switching and flexibility										−0.014	0.005	−0.141*
	Inhibition and adjournment										0.004	0.004	0.049
Constant		1.451	0.335		1.291	0.337		1.040	0.303		2.368	0.386	
R^2		0.05			0.010			0.33			0.42		
F-statistic		2.21*			2.41**			6.04***			6.90***		
ΔR^2					0.05			0.23			0.09		
F-statistic for change		–			2.20*			11.62***			7.65***		

Note: ***p<0.001, **p<0.01, *p<0.05.

https://doi.org/10.2147/PRBM.S435125 DovePress

Table 3 Difference Between Female Gamers (N = 314) and Male Gamers (N = 306) in the Regression Weights

Variables		Female Gamers			Male Gamers			z	p
		B	SE	β	B	SE	β		
Age		0.002	0.011	0.010	0.018	0.010	0.092	−1.08	0.278
Gaming platforms	Laptop (1 – yes; 0 – no)	−0.065	0.074	−0.046	0.014	0.077	0.011	−0.74	0.457
	Stationary computer (1 – yes; 0 – no)	−0.085	0.058	−0.067	0.005	0.077	0.004	−0.93	0.350
	Tablet (1 – yes; 0 – no)	−0.022	0.084	−0.012	−0.223	0.098	−0.071*	1.55	0.120
	Console (1 – yes; 0 – no)	−0.006	0.059	−0.005	−0.171	0.060	−0.139**	1.95	0.051
	Smartphone (1 – yes; 0 – no)	−0.022	0.084	−0.014	0.035	0.059	0.028	−0.55	0.582
Game genres	First/Third person shooters	0.008	0.024	0.015	0.004	0.019	0.010	0.14	0.889
	Action-RPG/adventure	0.006	0.022	0.018	0.018	0.023	0.050	−0.36	0.717
	Sports/driving	−0.025	0.024	−0.055	0.014	0.019	0.039	−1.28	0.202
	Real-time strategy/MOBA	0.053	0.019	0.146**	0.051	0.017	0.159**	0.09	0.930
	Turn-based/Non-action role-playing /Fantasy	0.006	0.020	0.015	−0.015	0.018	−0.044	0.77	0.438
	Turn-based strategy/Life simulation/Puzzle	0.044	0.023	0.111	0.000	0.018	0.001	1.47	0.141
	Music games	0.023	0.023	0.051	0.010	0.033	0.017	0.32	0.747
	Other	0.001	0.021	0.003	−0.019	0.022	−0.048	0.68	0.499
Motives for gaming	Social	−0.012	0.036	−0.020	0.014	0.035	0.021	−0.51	0.608
	Escape	0.106	0.041	0.214*	0.089	0.037	0.172**	0.31	0.757
	Competition	0.048	0.032	0.094	0.067	0.029	0.126*	−0.43	0.665
	Coping	0.099	0.042	0.167*	0.138	0.046	0.226**	−0.63	0.528
	Skill development	0.027	0.031	0.053	−0.020	0.034	−0.038	1.02	0.306
	Fantasy	0.037	0.028	0.079	0.056	0.032	0.113	−0.46	0.646
	Recreation	−0.006	0.033	−0.010	−0.100	0.042	−0.126*	1.75	0.080
Self-control dimensions	Goal maintenance	−0.012	0.005	−0.144*	−0.016	0.006	−0.153**	0.52	0.604
	Proactive control	−0.007	0.006	−0.069	−0.001	0.006	−0.013	−0.61	0.540
	Initiative and persistence	0.005	0.004	0.064	−0.014	0.005	−0.187**	3.04	0.002
	Switching and flexibility	−0.009	0.005	−0.095	−0.014	0.005	−0.141*	0.68	0.493
	Inhibition and adjournment	−0.015	0.005	−0.166**	0.004	0.004	0.049	−2.79	0.005
Constant		2.249	0.441		2.368	0.386			
R^2		0.41			0.42				
F-statistic		8.62***			6.90***				

Note: ***p<0.001, **p<0.01, *p<0.05.

Moreover, both groups had a negative relationship between GD and the individual's ability to retain information about their intentions and long-term plans. Consequently, it appears that gamers who have difficulty organizing their behavior in the context of their goals and aspirations may engage in gaming more easily. In this context, previous

research has shown a positive relationship between GD and procrastination[60,61] which is characterized as *"self-regulatory failure of not exerting self-control necessary for task engagement"* (p. 116).[62] Here, difficulties for individuals implementing self-control of their behavior (see initiative and persistence self-control dimension) combined with individuals having difficulties in maintaining information about the goals of their actions (see goal maintenance self-control dimension) can both make it easier for gamers to begin a gaming session and harder to end a gaming session. Consequently, it appears that gamers who manifest deficits in these self-control dimensions can become addicted to gaming more easily. Additionally, for male gamers, there was a negative relationship between GD and the ability to adapt to changing circumstances and managing attention while performing relevant activities. In this context, it appears that gamers with deficits in this area may be more rigid in activity (eg, gaming) despite changing conditions (eg, increase in the number of tasks at work or homework tasks). In conclusion, deficits in various dimensions of self-control can foster greater engagement in gaming and, in some cases, can lead to the development of GD.

The present study's results found a positive relationship between GD and motives for gaming, such as escape and coping among female and male gamers, which supports H_{2a}. These results align with previous research indicating an association between escape motives and GD.[25,63,64] Based on the compensatory internet use model,[65] gamers who have difficulties in coping with difficult everyday situations and fulfilling their needs in the real world may treat the game world as a space for fulfilling these needs, alleviating negative emotions, and escaping from difficulties occurring in the real world. Moreover, for male gamers, GD was positively associated with the competition motive, which supports H_{2c}. However, it should be noted that although this relationship was non-significant among female gamers, there was no statistically significant difference between female and male gamers in this relationship. Moreover, considering the differences in gaming motivation between female and male gamers,[66–68] it appears that female gamers have less need for competitive gaming than male gamers, and they may experience negative interactions (eg, sexism, gender violence, harassment, objectification) from male gamers while gaming.

The results did not find a statistically significant relationship between social motives for gaming and GD, indicating that H_{2b} was not supported. Laconi et al[36] found no relationship between social motive for gaming and GD in the regression model among female or male gamers. Cudo et al[25] reported this relationship only among male gamers. However, it should be noted that the development of instant messaging and social networking may have contributed to a change in the way gamers communicate. More specifically, players can communicate with each other outside of gameplay by creating various types of online groups and theme channels on instant messengers like *Discord, Telegram, WhatsApp,* etc. Consequently, the need for social relationships, despite the connection to gaming, can be fulfilled outside of the videogame. Therefore, further research is needed to verify in more detail gamers' activities related to gaming outside the game.

GD was hypothesized to be positively associated with action games. The results showed a positive relationship between RTS/MOBA games and GD among both female and male gamers. Consequently, H_3 was partially supported. MOBA games are a genre in which gamers play against each other individually or in groups (eg, *League of Legends*). In this game genre, gamers may create their characters, interact with gamers on their team, and gain various in-game rewards and achievements. This game genre may meet multiple needs of gamers that cannot be satisfied in the real world (eg, social, achievement, competition motives). Additionally, when this game genre includes gambling-type activities (eg, the buying of loot boxes), players can become more engaged in the gameplay, sometimes leading to problematic gaming.[69,70]

The present study's findings indicated a negative relationship between GD and gaming platforms such as tablets and consoles among male gamers. Consequently, these findings did not support H_4 that GD would be positively associated with using computers and laptops as gaming platforms. One possible explanation for this is the characteristics of the gaming scene in Poland. More specifically, Poland is dominated by the desktop computer as a gaming platform and the smartphone as a gaming platform among the younger generation of gamers. Consoles, on the other hand, are the least-used gaming platform among Polish gamers.[71] Consequently, the low prevalence of consoles among Polish gamers may have contributed to the finding. For gaming on tablets, the results were consistent with the findings of Syvertsen et al,[45] who reported that the use of mobile devices for gaming was associated with a low risk of GD.

Methods (Study 2)

Participants

Study 2 comprised five waves conducted in the following months: (i) Wave 1 – October 2022 (N=1525), (ii) Wave 2 – December 2022 (N=1063), (iii) Wave 3 – February 2023 (N=883), (iv) Wave 4 – April 2023 (N=715), and (v) June 2023 (N=630). The study included active gamers who had played videogames in the past year. Only active gamers who took part in all five waves were included in the analyses. However, data from 225 participants were removed from the analyses for the following reasons: the incorrect answer to attention check questions (N=142), the low self-assessment of participants' involvement in completing the survey (N=71), and the reported unrealistic number of gaming hours per week (N=12). Consequently, the final sample comprised 405 active gamers (224 female gamers; M=28.05 years; SD=4.51; age range: 18–35 years).

The characteristics of the participants in Study 2 are shown in Table 4. Participants were recruited online from the Polish nationwide research panel *Ariadna* and received points for completing the survey. Participants could exchange these points for rewards offered by the *Ariadna* research panel, such as electronic devices, games, cosmetics, books, etc. It should be noted that the *Ariadna* research panel verified each individual on the panel to ensure they were not a bot or had multiple accounts. The study was conducted according to the Declaration of Helsinki guidelines, and was approved by the first author's university Ethical Committee. The dataset from the Study 2 is available from https://hdl.handle.net/20.500.12153/5459. Additionally, it should be noted that Study 1 and Study 2 were conducted with two separate samples.

Measures

The four-item Gaming Disorder Test (GDT)[72] in Polish adaptation[24] was used assess gaming disorder symptoms. Items (eg, *"I have given increasing priority to gaming over other life interests and daily activities"*) `are rated on a five-point response scale from 1 (*never*) to 5 (*very often*). Higher scores indicate a higher level of GD. In the present study, Cronbach's alphas were 0.92 for Wave 1, 0.91 for Wave 2, 0.92 for Wave 3, 0.93 for Wave 4, and 0.93 for Wave 5.

As in Study 1, the Motives for Online Gaming Questionnaire (MOGQ)[52] in Polish adaptation[53] was used to assess motives for gaming. In the present study, the Cronbach alphas for the subscales were 0.90 for social, 0.91 for escape, 0.90 for competition, 0.85 for coping, 0.92 for skill development, 0.92 for fantasy, and 0.86 for recreation.

As in Study 1, the Video Game Questionnaire (VGQ)[54] was used to assess the frequency of playing various game genres. Participants answered questions about the the number of hours played in the different game genres in the past 12 months. However, in contrast to Study 1, participants were allowed to input the actual number of hours of gaming per week on specific game genres.

As in Study 1, the NAS-50[32] was used to assess self-control dimensions. In the present study, the Cronbach's alphas were 0.88 for goal maintenance, 0.84 for proactive control, 0.79 for initiative and persistence, 0.84 for switching and flexibility, and 0.85 for inhibition and adjournment.

As in Study 1, participants answered questions about gaming platforms which they used for gaming, such as desktop computers, laptops, tablets, home consoles, smartphones, and portable consoles with the same scoring method. Participants also answered questions regarding demographic information such as age, gender, place of residence, marital status, and education. The GD symptom assessment was from three waves. The evaluation of self-control dimensions, motives for gaming, and gaming platforms were made in a single wave.

Statistical Analysis

Before the main statistical analyses were carried out, preliminary data analysis was performed. This was done to verify the psychometric equivalence of the GD constructs across time. Measurement invariance of the GDT across time was assessed using confirmatory factor analysis (CFA).[73,74] The results showed strict invariance, which suggested that the factor structure, factor loadings, indicator intercepts, and indicator error variances were equal across time (see Table S3). To examine whether there were differences between those who completed all waves and those who did not complete all waves in the variables analyzed and the sociodemographic variables, a difference analysis was carried out using the Mann–Whitney two-sample tests with η^2 effect size coefficient.[55] However, for nominal variables, the χ^2 tests with φ coefficient or Cramer's V were used to verify these differences.[55] Participants with unreliable data were removed from

Table 4 Sample Characteristics

Variable	Category	Wave 1 (N = 1525)		Wave 2 (N = 1063)		Wave 3 (N = 883)		Wave 4 (N = 715)		Wave 5 (N = 630)		Wave 5# (N = 405)	
		N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
Gender	Female	775	50.82	593	55.79	475	53.79	375	52.45	325	51.59	224	55.31
	Male	750	49.18	470	44.21	408	46.21	340	47.55	305	48.41	181	44.69
Residence	Village	455	29.84	308	28.97	248	28.09	194	27.13	176	27.94	121	29.88
	Small city (up to 20,000)	250	16.39	151	14.21	122	13.82	102	14.27	91	14.44	61	15.06
	Medium city (between 20,000 and 100,000 residents)	343	22.49	249	23.42	201	22.76	170	23.78	150	23.81	86	21.23
	Large city (above 100,000 residents)	477	31.28	355	33.40	312	35.33	249	34.83	213	33.81	137	33.83
Marital status	Single	615	40.33	398	37.44	327	37.03	275	38.46	241	38.25	158	39.01
	In a relationship	505	33.11	325	30.57	263	29.78	201	28.11	173	27.46	118	29.14
	Married	393	25.77	329	30.95	282	31.94	232	32.45	210	33.33	128	31.60
	Widowed	4	0.26	4	0.38	4	0.45	3	0.42	3	0.48	1	0.25
	Divorced	8	0.52	7	0.66	7	0.79	4	0.56	3	0.48	0	0
Education	Primary education	123	8.07	47	4.42	36	4.08	28	3.92	22	3.49	18	4.44
	Vocational education	147	9.64	83	7.81	65	7.36	52	7.27	45	7.14	20	4.94
	Secondary education	543	35.61	339	31.89	269	30.46	217	30.35	197	31.27	125	30.86
	Post-secondary education	155	10.16	114	10.72	90	10.19	75	10.49	65	10.32	38	9.38
	University degree	557	36.52	480	45.16	423	47.90	343	47.97	301	47.78	204	50.37

Note: #Sample characteristics of Wave 5 after exclusion of non-reliable observations.

https://doi.org/10.2147/PRBM.S435125 DovePress

the group of gamers who started the study and did not complete all waves. Consequently, the gamers that did not complete all waves comprised 793 participants. The results showed differences between gamers who completed all waves and gamers who had not completed all waves in the frequency of different game genres used, such as first/third-person shooters, action-RPG/adventure, sports/driving, real-time strategy/MOBA and others (see Table S4). Additionally, these groups differed in laptop use as a gaming platform, age and self-control dimensions such as goal maintenance, and initiative and persistence (see Table S4). However, it should be noted that differences between these groups had a weak effect size. There was also a difference between these groups in marital status and education (see Table S5). However, the differences between these groups had a weak and moderate effect size.

The main statistical analysis involved in testing the development of change in GD over time, identifying trajectories of GD development, and identifying the variables that differentiated the identified trajectories. Unconditional, univariate latent growth curve modelling (LGCM) was used to verify whether GD changed over time. Considering the non-normal distribution of data, linear growth was tested using the robust maximum likelihood estimation (MLR). The fit indices such as CFI Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) values higher than 0.90, and Root Mean Square Error of Approximation (RMSEA) and Standardized Root Means Squared Residual (SRMR) lower than 0.08 suggest that the model is well matched to the data.[75] Additionally, the difference between the no change model (without any change in GD across time), linear model (with linear change in GD across time), and quadratic model (with quadratic change in GD across time) was verified using the Satorra scaled chi-square difference test.[76]

Latent class growth analysis (LCGA)[77] was used to identify gamer groups (latent classes) with similar trajectories of GD across time. LCGA is a special case of growth mixture modelling (GMM)[78] that assumes the existence of different subgroups with different growth trajectories. LCGA also assumes that the error variances are the same for all classes and all time points.[77] Additionally, LCGA estimates a mean intercept and slope per class. This method allows classifying participants into subgroups based on the highest estimated posterior probability of group membership. It should be noted that the LCGA method captures the nature of the addiction's symptom development, which can increase, decrease or remain unchanged over time.[47]

More specifically, it should be pointed out that there is a high within-person variability of gaming disorder severity among gamers and the lack of a main direction of change in the addiction severity.[47] In this context, it can be assumed that modelling the longitudinal change in gaming disorder severity as a single latent growth curve (LGC) model for the entire group of gamers would not match the phenomenon characteristics. Consequently, latent class growth analysis (LCGA) was used. This analysis assumes that gamers come from different subgroups and a single growth trajectory cannot adequately approximate an entire gamers population.

The selection of a model related to the number of classes reflecting different GD trajectories across time was based on the following metrics: Akaike Information Criterion (AIC), Bayesian information criteria (BIC), sample-size adjusted BIC (SABIC), integrated complete-data likelihood criterion (ICL) and entropy. Better goodness of fit was indicated by the lowest AIC, BIC, SABIC, ICL and higher entropy.[78]

Next, to test for differences between groups identified in the LCGA in self-control dimensions, motives for gaming, and frequency of gaming in different game genres, multivariate variance analysis (MANOVA) was used. The T3 Dunnett post hoc test was used to compare the variables across groups when the variances were heterogeneous. The Scheffe post hoc test was used to compare the variables across groups when the variances were homogeneous. The effect size was calculated using a partial eta square (η_p^2). The difference between groups in gaming platforms and gender were calculated using the χ^2 test with Cramér's V as effect size metrics. The χ^2 test with Bonferroni corrections for multiple comparisons was also used as a post hoc test.

IBM SPSS version 28 used to compute descriptive statistics, correlations, differences, and variances. R software with the lavaan package[79] was used for invariance analysis and latent growth curve modelling (LGCM). R software with the lcmm package[80] was also used for the LCGA (see Table S6).

Results (Study 2)

Based on the LGCM results, the no change, linear, and quadratic models all fitted the data. However, there was a difference between the no-change and linear models. Additionally, there was no statistically significant difference between the linear and quadratic models (see Table 5). These results may indicate that GD changes across time in a linear pattern.

Table 5 Fit Indices for Univariate Latent Growth Curve Modelling of Gaming Disorder

Models	χ^2	df	*p*	CFI	TLI	RMSEA	SRMR	Difference Test		
								$\Delta\chi^2$	Δdf	*p*
No change	27.78	13	0.010	0.972	0.978	0.053	0.060	–	–	–
Linear	13.54	10	0.195	0.993	0.993	0.030	0.035	14.24	3	0.003
Quadratic	6.15	6	0.407	1.000	1.000	0.008	0.031	7.39	4	0.198

The LCGA analysis showed that AIC, BIC, SABIC, and ICL were the lowest for the four-class model. Additionally, entropy was higher than the 0.8 thresholds for the four-class model (see Table 6).[78] Therefore, the four-class model was considered in the analyses. For the four-class solution, Class 1 comprised 6.42% gamers (N=26), Class 2 comprised 13.58% gamers (N=55), Class 3 comprised 57.28% gamers (N=232), and Class 4 comprised 22.72% gamers (N=92). Figure 1 shows the trajectories of GD symptoms for the four classes identified. It should be noted that the total scores on the GDT range from 4 to 20. Pontes et al[72] postulated that a GDT score of 16 and above may indicate potentially disordered gamers. Consequently, gamers in Class 1 were considered to be at high risk of GD (high-risk group). In contrast, gamers in Class 3 were considered to be at low risk of GD (low-risk group). Based on the GDT results across time, gamers in Class 2 were considered to be at moderate risk of GD with a tendency to increase (moderate-risk increase group). Gamers in Class 4 were considered to be at moderate risk of GD with a tendency to decrease (moderate-risk decrease group). Detailed results are shown in Figure 1.

The findings showed that there were differences between groups in relation to gaming motivation, including social (F [3,401]=73.88; $p<0.001$; $\eta_p^2=0.356$), escape (F [3,401]=49.64; $p<0.001$; $\eta_p^2=0.266$), competition (F[3,401]=49.64; $p<0.001$; $\eta_p^2=0.271$), coping (F (3,401)=57.79; $p<0.001$; $\eta_p^2=0.302$), skill development (F[3,401]=44.24.88; $p<0.001$; $\eta_p^2=0.249$), fantasy (F[3,401]=57.73; $p<0.001$; $\eta_p^2=0.302$), and recreation (F[3,401]=2.94; $p=0.033$; $\eta_p^2=0.022$) motives. More specifically, gamers in the low-risk group had lower levels of social (M=1.46; SD=0.74), escape (M=1.85; SD=0.95), competition (M=1.78; SD=0.89), coping (M=1.87; SD=0.83), skill development (M=1.77; SD=0.95), and fantasy (M=1.65; SD=0.86) motives than gamers in other groups: moderate-risk decrease group – social (M=1.95; SD=0.82), escape (M=2.64; SD=1.01), competition (M=2.39; SD=0.94), coping (M=2.52; SD=0.87), skill development (M=2.35; SD=1.01), and fantasy (M=2.40; SD=1.04); moderate-risk increase group: social (M=2.78; SD=0.90), escape (M=3.19; SD=0.86), competition (M=3.06; SD=0.91), coping (M=3.10; SD=0.78), skill development (M=3.11; SD=0.81), and fantasy (M=2.94; SD=0.95): high-risk group – social (M=3.32; SD=0.89), escape (M=3.34; SD=0.86), competition (M=3.38; SD=0.82), coping (M=3.50; SD=0.79), skill development (M=3.20; SD=0.75), and fantasy (M=3.48; SD=0.82). Moreover, gamers in the moderate-risk decrease group had significantly lower levels of these motives than gamers in the moderate-risk increase and high-risk groups. Additionally, the moderate-risk increase group had significantly lower social motives than the high-risk group. For the recreation motive, the low-risk group had a significantly lower score (M=2.88, SD=1.23) than the high-risk group (M=3.46, SD=0.86). Detailed results are shown in Table 7.

The results showed that there were significant differences between groups in self-control dimensions including goal maintenance (F[3,401]=61.02; $p<0.001$; $\eta_p^2=0.313$), proactive control (F[3,401]=3.06; $p=0.028$; $\eta_p^2=0.022$), initiative and persistence (F[3,401]=11.54; $p<0.001$; $\eta_p^2=0.080$), switching and flexibility (F[3,401]=8.46; $p<0.001$; $\eta_p^2=0.060$), and inhibition and adjournment (F (3,401)=19.02; $p<0.001$; $\eta_p^2=0.125$). More specifically, gamers in low-risk group had a significantly higher level of self-control dimensions including goal maintenance (M=4.06, SD=0.64), initiative and persistence (M=3.28, SD=0.72), and inhibition and adjournment (M=3.14, SD=0.69) than gamers in other groups: moderate-risk decrease group – goal maintenance (M=3.52, SD=0.65), initiative and persistence (M=2.91, SD=0.52), and inhibition and adjournment (M=2.88, SD=0.67): moderate-risk increase group – goal maintenance (M=3.33, SD=0.64), initiative and persistence (M=2.95, SD=0.43), and inhibition and adjournment (M=2.68, SD=0.58): high-

Table 6 Model Fit Statistics for Latent Class Growth Analysis (LCGA) of Gaming Disorder Symptoms Across Time

Class Solution	Log-Likelihood	AIC	BIC	SABIC	Entropy	ICL1	Sample Percent per Class					
							Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
1-Class	−5518.384	11,042.77	11,054.78	11,045.26	1.000	11,054.78	100.00					
2-Class	−4977.613	9967.22	9991.25	9972.21	0.923	10,012.75	29.38	70.62				
3-Class	−4844.979	9707.96	9743.99	9715.43	0.906	9785.81	26.92	59.75	13.33			
4-Class	−4809.576	9643.15	9691.20	9653.12	0.879	9759.07	6.42	13.58	57.28	22.72		
5-Class	−4809.576	9649.15	9709.21	9661.61	0.652	9935.93	55.06	6.42	0.00	24.94	13.58	
6-Class	−4809.576	9655.15	9727.22	9670.11	0.670	9966.17	24.20	0.00	0.00	55.80	13.58	6.42

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criteria; SABIC, sample-size adjusted BIC; ICL, integrated complete-data likelihood criterion.

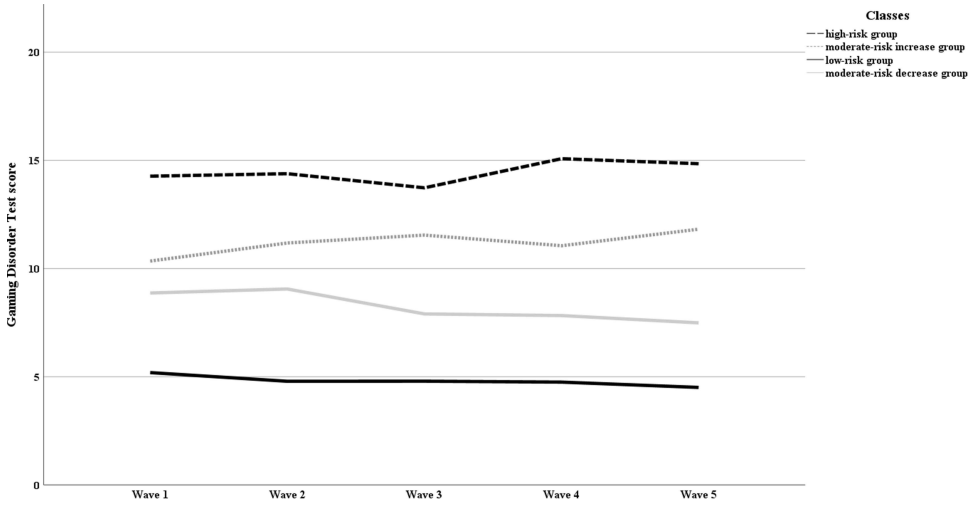

Figure 1 Trajectories of gaming disorder development across five waves.

risk group – goal maintenance (M=2.51, SD=0.70), initiative and persistence (M=2.81, SD=0.33), and inhibition and adjournment (M=2.25, SD=0.56).

Moreover, the high-risk group had a significantly lower level of goal maintenance than the moderate-risk increase and moderate-risk decrease groups. There was a significant difference between the high-risk and moderate-risk decrease groups in inhibition and adjournment. More specifically, gamers in the high-risk group had a significantly lower level of the self-control dimension than gamers in the moderate-risk decrease group. Additionally, the moderate-risk decrease group had a significantly lower level of switching and flexibility (M=3.17, SD=0.62) compared to the low-risk group (M=3.53, SD=0.71) and high-risk group (M=3.75, SD=0.59). Detailed results are shown in Table 7.

There were also differences between groups in frequency of playing other game genres ($F[3,401]=4.41$; $p=0.005$; $\eta_p^2=0.032$). More specifically, gamers in the moderate-risk decrease group significantly more often played other game genres (M=2.08, SD=4.58) than gamers in the high-risk group (M=0.62, SD=1.36). It should be noted that despite the statistical significance of the F-test, post-hoc tests showed no statistically significant difference between groups in proactive control and frequency of gaming in the following game genres: sports/driving, real-time strategy/MOBA, turn-based strategy/life simulation/puzzle, and music games (see Table 7).

There were also differences between groups in relation to gaming platforms. More specifically, gamers in the high-risk group used a computer (73.08%), tablet (46.15%), home console (73.08%), and portable console (50.00%) as a gaming platform significantly more frequently than gamers in the low-risk group (29.31%, 15.52%, 37.92%, and 10.78%, respectively). Additionally, gamers in the moderate-risk increase group had a significantly greater frequency of laptop (80.00%) and portable console (30.91%) use as gaming devices than gamers in the low-risk group (59.48%, and 10.78%, respectively). The high-risk gamers were significantly more likely to use a computer, home console and portable console as a gaming platform than gamers in the moderate-risk decrease group (38.04%, 33.70%, and 21.74%, respectively). Detailed findings are shown in Table 7.

Discussion (Study 2)

The purpose of Study 2 was to examine whether the self-control dimensions, gaming motivations, game genres, and gaming platforms were associated with different trajectories of GD development across time. In Study 2, four groups with varying trajectories of GD risk across time were identified: (i) the low-risk group, (ii) the moderate-risk decrease group, (iii) the moderate-risk increase group, and (iv) the high-risk group. The findings showed differences between these groups in self-control dimensions, gaming motivations, gaming platforms, and game genres.

The findings showed a difference between groups with different trajectories of GD risk across time in the self-control dimensions except for proactive control. More specifically, the low-risk group, which had the lowest GD level across

Table 7 Predictors of Gaming Disorder Trajectories

Variables		Groups								F	*p*	η_p^2	Statistically Significant Difference Between Groups
		Low-Risk-Group [1]		Moderate-Risk Decrease Group [2]		Moderate-Risk Increase Group [3]		High-Risk Group [4]					
		M	SD	M	SD	M	SD	M	SD				
Age		28.19	4.45	27.88	4.78	27.73	4.64	28.15	3.99	0.21	0.890	0.002	–
Game genres	First/Third person shooters	1.13	4.13	1.87	4.51	1.33	2.52	2.65	3.22	1.65	0.177	0.012	–
	Action-RPG /adventure	2.43	6.43	2.97	6.01	2.51	8.12	1.85	3.03	0.26	0.855	0.002	–
	Sports/driving	1.09	3.39	1.89	3.29	1.58	3.07	3.65	9.72	3.59	0.014	0.026	–
	Real-time strategy/ MOBA	0.78	2.44	1.92	4.47	1.38	2.46	1.42	2.19	3.36	0.019	0.025	–
	Turn-based/Non-action role-playing /Fantasy	0.93	3.16	1.63	4.92	0.78	1.63	1.27	2.54	1.09	0.355	0.008	–
	Turn-based strategy/ Life simulation/ Puzzle	1.77	3.42	3.25	7.22	1.51	2.25	1.54	2.21	2.95	0.033	0.022	–
	Music games	0.12	0.46	0.64	2.70	0.58	1.51	1.00	2.47	4.60	0.004	0.033	–
	Other	0.91	1.87	2.08	4.58	1.22	2.17	0.62	1.36	4.41	0.005	0.032	2>4

https://doi.org/10.2147/PRBM.S435125 DovePress

Motives for gaming	Social	1.46	0.74	1.95	0.82	2.78	0.90	3.32	0.89	73.88	0.000	0.356	1<2 1<3 1<4 2<3 2<4 3<4
	Escape	1.85	0.95	2.64	1.01	3.19	0.86	3.34	0.86	48.50	0.000	0.266	1<2 1<3 1<4 2<3 2<4
	Competition	1.78	0.89	2.39	0.94	3.06	0.91	3.38	0.82	49.64	0.000	0.271	1<2 1<3 1<4 2<3 2<4
	Coping	1.87	0.83	2.52	0.87	3.10	0.78	3.50	0.79	57.79	0.000	0.302	1<2 1<3 1<4 2<3 2<4
	Skill development	1.77	0.95	2.35	1.01	3.11	0.81	3.20	0.75	44.24	0.000	0.249	1<2 1<3 1<4 2<3 2<4
	Fantasy	1.65	0.86	2.40	1.04	2.94	0.95	3.48	0.82	57.73	0.000	0.302	1<2 1<3 1<4 2<3 2<4
	Recreation	2.88	1.23	2.94	1.08	3.19	0.78	3.46	0.86	2.94	0.033	0.022	1<4
Self-control dimensions	Goal maintenance	4.06	0.64	3.52	0.65	3.33	0.64	2.51	0.70	61.02	0.000	0.313	1>2 1>3 1>4 2>4 3>4
	Proactive control	3.49	0.61	3.30	0.65	3.51	0.57	3.63	0.63	3.06	0.028	0.022	–
	Initiative and persistence	3.28	0.72	2.91	0.52	2.95	0.43	2.81	0.33	11.54	0.000	0.080	1>2 1>3 1>4
	Switching and flexibility	3.53	0.71	3.17	0.62	3.39	0.49	3.75	0.59	8.46	0.000	0.060	1>2 2<4
	Inhibition and adjournment	3.14	0.69	2.88	0.67	2.68	0.58	2.25	0.56	19.02	0.000	0.125	1>2 1>3 1>4 2>4

(*Continued*)

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Table 7 (Continued).

Variables			N	Percent	N	Percent	N	Percent	N	Percent	χ	*p*	Cramér's V	Statistically significant difference between groups
Gaming platforms	Stationary computer	No	164	70.69%	57	61.96%	31	56.36%	7	26.92%	21.56	0.000	0.231	1<4 2<4
		Yes	68	29.31%	35	38.04%	24	43.64%	19	73.08%				
	Laptop	No	94	40.52%	25	27.17%	11	20.00%	5	19.23%	13.67	0.003	0.184	1<3
		Yes	138	59.48%	67	72.83%	44	80.00%	21	80.77%				
	Tablet	No	196	84.48%	70	76.09%	38	69.09%	14	53.85%	17.50	0.000	0.208	1<4
		Yes	36	15.52%	22	23.91%	17	30.91%	12	46.15%				
	Home console	No	144	62.07%	61	66.30%	28	50.91%	7	26.92%	15.50	0.001	0.196	1<4 2<4
		Yes	88	37.93%	31	33.70%	27	49.09%	19	73.08%				
	Smartphone	No	33	14.22%	10	10.87%	3	5.45%	1	3.85%	5.15	0.161	0.113	–
		Yes	199	85.78%	82	89.13%	52	94.55%	25	96.15%				
	Portable console	No	207	89.22%	72	78.26%	38	69.09%	13	50.00%	32.52	0.000	0.283	1<4 1<3 2<4
		Yes	25	10.78%	20	21.74%	17	30.91%	13	50.00%				

time, showed higher self-control dimensions such as goal maintenance, initiative and persistence, and inhibition and adjournment than other groups. Moreover, the moderate-risk decrease group had higher goal maintenance and inhibition and adjournment self-control dimensions than the high-risk group. The moderate-risk increase group also had a higher level of goal maintenance than the high-risk group. It should be noted that effect sizes were the highest for goal maintenance, initiative and persistence, and inhibition and adjournment. Consequently, it appears that similar to Study 1, the higher-risk GD group across time (compared to the low-risk GD group across time), was related to difficulties in implementation control and taking actions related to their own goals without unnecessary delay and restraining immediate, impulsive behavior and inhibition emotional reactions. These results supported both H_{1a} and H_{1b}.

Moreover, similar to Study 1, the increased risk of GD was accompanied by deficits among individuals maintaining information about their plan and activity goals. Additionally, the moderate-risk decrease group gamers had lower switching and flexibility than gamers from the low-risk and high-risk groups. Therefore, it appears that gamers having difficulty with changing circumstances and managing attention while performing relevant activities may have difficulties sharing different activities and experience more daily problems related to trying to share daily activities with gaming. Consequently, it is reasonable to assume that in this group of gamers, despite the moderate risk of GD, there is a decrease in this risk over time because they cannot divide their attention between different activities (eg, gaming vs. work responsibilities).

These results align with research concerning behavioral addictions and media multitasking, characterized as engagement in tasks or switching between tasks involving digital media.[81,82] More specifically, Błachnio et al[83] reported a positive relationship between media multitasking and addictions to Facebook, the internet, and smartphones. Here, gamers with difficulties in shifting attention between different activities that require the use of media may limit the use of one of them. Additionally, it should be noted that both work and study increasingly require electronic devices, which can provide additional competition for gaming. Therefore, it can be assumed that moderate-risk gamers may be unable to balance the use of several media devices and may begin to abandon gaming. However, this speculation requires further research.

There was a difference between the low-risk group and other groups, and between the moderate-risk decrease group and other groups in all motives for gaming except recreation. More specifically, the low-risk group had lower levels of these motives for gaming than other groups. Additionally, the moderate-risk decrease group had lower levels of these motives for gaming than the moderate-risk increase group and high-risk group. It should also be noted that there was a higher level of social motives for gaming in the high-risk group compared to the moderate-risk increase group. In relation to the recreation motive, the low-risk group had a lower level than the high-risk group. These results supported the hypothesis that GD would be positively associated with gaming motivations such as escape (H_{2a}), social (H_{2b}), and competition (H_{2c}) motives. The recent meta-analysis by Bäcklund et al[38] showed that social, escape, coping, competition, skill development, recreation, and fantasy motives for gaming were all associated with GD. However, escape, coping, and fantasy motives presented the strongest relationship with the GD.

The present study's findings also showed that gamers in the moderate-risk decrease group spent more time playing other game genres than those in the high-risk group. Therefore, these results did not support H_3. However, it should be noted that despite the statistical significance of the F-test for frequency of gaming in game genres (ie, sports/driving, real-time strategy/MOBA, turn-based strategy/life simulation/puzzle, and music games; see Table 7), the post-hoc tests showed no statistically significant difference between groups with different trajectories of GD risk across time. Therefore, it can be assumed that the high variance in the frequency of different game genres in the groups may have caused this.

There was a difference between groups with different trajectories of GD risk across time in gaming platforms except for the use of smartphones. More specifically, gamers from the high-risk group used computers, tablets, and consoles more often as gaming platforms than gamers from the low-risk group. Additionally, gamers from the moderate-risk increase group used laptops as a gaming platform more often than gamers from the low-risk group. The moderate-risk decrease group used computers and consoles less frequently than the high-risk group.

In relation to portable consoles, gamers from the low-risk group used this type of gaming platform less often than the moderate-risk increase group. These findings supported the hypothesis that the GD would be positively associated with using computers and laptops as gaming platforms (H_4). However, it should be noted that the high-risk group used different gaming platforms (computer, tablet, home console, portable console) more frequently than the low-risk group. Therefore, it can be assumed that it is not the type of platform itself but the use of different platforms simultaneously that

is associated with GD. Syvertsen et al[45] found that gamers using concurrent mobile platforms and console/computer platforms were more likely to be addicted to gaming than gamers who used only mobile or console/computer as gaming platforms.

Finally, it should be pointed out that due to the small size of the subgroups, no analysis of differences between female and male gamers group was conducted. Consequently, in Study 2, H_5 was not supported. Additionally, to avoid repeating the same conclusions, the results of Study 2, which were analogous to those of Study 1, should be considered according to the explanation in the Discussion section of Study 1.

General Discussion

The present research was aimed to better understand GD development by considering individual factors and gaming-related factors in GD. Unlike previous studies which focused on a single gaming disorder determinant factors group,[17–20] the present research comprehensively examined the role of individual and gaming-related factors for GD concurrently using both a cross-sectional study and a longitudinal study. The two studies comprehensively examined the relationship between self-control dimensions, motives for gaming, frequency of game genre use, and gaming platforms using both cross-sectional and longitudinal approaches. Based on the two studies, it can be concluded that GD is more related to individual factors, such as self-control deficits and motives for gaming, than to gaming-related factors, such as the frequency of game genre use and type of gaming platform used. Moreover, it should be noted that gaming-related factors explained only 9% of the variance in the GD model among female gamers (see Table 1) and only 10% of the variance in the GD model among male gamers (see Table 2). In contrast, individual factors such as self-control dimensions and gaming motivation explained 32% of the variance in the GD model among both female and male gamers (see Table 1 and Table 2). Additionally, in the longitudinal study, the individual factors differentiated more between the groups separated by level of GD across time than gaming-related factors (see Table 7). Consequently, it can be concluded that individual factors were more important in explaining GD than gaming-related factors such as game genres and gaming platforms.

The findings from Study 1 and Study 2 were consistent with the I-PACE model.[29,30] More specifically, games can have specific features that can facilitate excessive gaming (eg, loot boxes, gambling mechanics, an immersive game world, etc.).[7,69] However, gamers with specific individual characteristics may be more easily influenced by the addictive mechanisms contained within videogames or, irrespective of the mechanism contained in the game, treat the game as a place where they can realize their unmet needs from the real world. Here, gamers with deficits in the self-control dimensions may be more susceptible to addictive game mechanics.

On the other hand, a gamer's specific needs may be realized through the game, which may involve escaping from the real world into the game world or treating the game as a way to cope with difficult situations.[63,64] Consequently, gaming-related factors such as gaming platforms and game genres may have an important but smaller role in gaming disorder development than individual factors. Another explanation for the weaker role of gaming factors in explaining GD may be related to the process nature of GD development.[29,30] More specifically, gaming-related factors may be important for the initial engagement in gaming. On the other hand, individual factors may be relevant not only to initial gaming engagement, but also in maintaining that engagement when gaming becomes excessive. Consequently, it can be assumed that individual factors may be more strongly related to GD than gaming-related factors.

Based on the results of the two studies, it was observed that GD development was associated with self-control deficits related to difficulties in individuals maintaining information about their intentions and long-term plans (goal maintenance self-control dimension), and implementation control, taking actions related to their own goals without unnecessary delay (initiative and persistence self-control dimension). Additionally, these studies showed that GD development was associated with self-control deficits related to difficulties in refraining from immediate, impulsive behavior and inhibiting emotional reactions (inhibition and adjournment self-control dimension). These results concur with previous research regarding the relationship between self-control dimensions and GD.[33]

Additionally, it should be noted that deficits in self-control dimensions were both associated with GD in the cross-sectional (Study 1) and longitudinal (Study 2) studies. These results suggest that these deficits were not only related to the gaming disorder level but also to its development across time. Consequently, it can be noted that the results of Study 1 and Study 2 showed a consistent pattern of the importance of self-control deficits for the level and development of GD.

Moreover, the results of both studies found that the escape and coping motives for gaming appear to be essential in the development of GD. Previous research also highlighted these motives as significant predictors of gaming addiction.[37,63,64] However, the results of Study 2 indicated that other motives for gaming may also be related to the trajectory of GD development across time.

It can also be assumed that the GD level may be primarily associated with escape and coping motives, while GD development may be more complex and related to a more sophisticated configuration of gaming motives. Therefore, further research is needed to examine whether different motives can lead to different trajectories in GD development across time. Moreover, despite these differences, the importance of the escape and coping motive in the level and development of GD was consistently indicated in both studies.

The findings did not clearly indicate whether the action game genre was associated with GD development. Study 1 showed a positive relationship between action games (RTS/MOBA) and gaming disorder. However, Study 2 did not show this. This could be due to a large variance in the frequency of game genre use across groups with different trajectories of GD risk across time (see Study 2). Additionally, previous studies have also reported inconclusive results when examining the relationship between different game genres and GD.[39–43] It can be assumed that this may be due to the intermingling of different game genres among themselves.[44] For example, role-playing game (RPG) elements can be combined with FPS games to create so-called action RPGs. Consequently, gamers may have had a difficult task assigning the games they play to consistent genres.

Studies 1 and 2 did not provide conclusive results for the gaming platforms. It can be posited that gaming platforms have a role in the development of GD. However, it is difficult to identify a consistent pattern of gaming platform use that is risky and leads to problematic gaming engagement. Taking the findings of Syvertsen et al[45] with Study 2's results, further research is needed on whether multiplatform use over the same period can be a significant factor in the development of GD. Within the context of the I-PACE model,[29,30] it can be assumed that with the GD development, the gamer may want to game in different places, so they may use different gaming platforms depending on the location to be able to access the game all the time.

Study 1 showed differences between female and male gamers in the relationship between self-control dimensions and GD. These findings were in line with previous research indicating a difference between factors associated with the development of addictive game use among female and male gamers.[25,36,46,84,85] It should also be noted that understanding the differences between these groups may allow for the creation of more effective prevention and treatment methods dedicated to each of them.

The comprehensive results of Study 1 and Study 2 suggested that individual factors such as self-control deficits and gaming motives played a more important role in the GD development than gaming-related factors. These results bridge the research gap regarding the impact of specific factors (gaming-related, individual) on the development of GD.[7] Moreover, these findings were consistent with the I-PACE model,[29,30] in which addiction is a process spread across time and has different development stages. The present findings may confirm the importance of deficits in self-control mechanisms and specific gaming motives such as escape and coping in GD development.[26,63,64]

Limitations and Future Research

The findings of the studies here should be considered in the context of their limitations. The studies only considered some individual and gaming-related factors, so it is necessary to be cautious when generalizing conclusions to other factors associated with GD. Previous research has noted that it is not the game genres themselves but the mechanisms used within games that can contribute to the GD development.[4,69,86] Consequently, only examining the frequency of playing different game genres may be biased by the large variance associated with the different structures of games from the same game genre. Therefore, future research should also focus on the relationship between GD and game mechanics elements that may contribute to over-engagement in the game.

It should be noted that, in Study 2, there was a difference between gamers who completed all waves and gamers who did not complete all waves including the frequency of different game genres use, gaming platforms, and self-control dimensions such as goal maintenance, and initiative and persistence (see Table S4). Low goal maintenance and initiative and persistence reflect difficulties in maintaining plans and intentions for longer-term activities and difficulties in setting goals and taking action to implement decisions without unnecessary delays.[32] Consequently, participants with deficits in these self-control dimensions may have not continued participating in the study, which may have been due to these traits.

Therefore, it is important to be cautious when generalizing the results because individuals with specific self-control deficits may not have been represented in the final sample.

The research was conducted with a Polish sample, so caution is needed in generalizing the results to other cultures. In this regard, it should be noted that cultural aspects are relevant to the prevalence of GD and its predictors.[10,37] Consequently, further research is needed that includes other cultural contexts. It should also be noted that the data were all self-report. Therefore, it is necessary to consider possible distortions related to the specifics of the participants (eg, social approval, misunderstanding of the questions, lack of reflection on their behavior, etc.). Moreover, it should be pointed out that there were differences in the mean age of study participants in Study 1 and Study 2. Study 1 had younger participants than Study 2. However, both studies comprised individuals in younger adulthood. Therefore, it is necessary to consider possible differences related to the activities undertaken by individuals across the lifespan.

Conclusion

The present study showed that individual factors, such as self-control dimensions and motives for gaming, were more important in explaining GD than gaming-related factors, such as game genres and gaming platforms. The findings showed that GD was associated with (i) self-control deficits associated with difficulties in implementation control and taking actions related to goals without unnecessary delay, (ii) retaining information about intentions and long-term plans, (iii) refraining from immediate, impulsive behavior, and (iv) inhibiting emotional reactions. Additionally, GD was also associated primarily with escape, coping, and competition motives for gaming. Consequently, it should also be noted that understanding the role of the individual and gaming-related factors in GD may allow for the creation of more effective prevention and treatment methods and the formulation of policies regarding safer videogame playing.

Finally, the greater role of individual factors in the gaming disorder development may indicate that preventive and therapeutic work should be carried out to increase the ability to self-control behavior and identify constructive coping methods among gamers. However, despite the role of individual factors in GD development, the role of gaming-related factors in gamers' engagement in gaming during the first period of contact with gaming, when it is associated with gratification, cannot be overlooked.

Ethics Approval and Informed Consent

The studies were conducted according to the Declaration of Helsinki guidelines, and were approved by the Institute of Psychology's Ethical Committee at the John Paul II Catholic University of Lublin. Informed consent has been obtained from all participants.

Funding

The Study 1 was funded by a grant from the National Science Centre, Poland, No. UMO-2019/32/C/HS6/00340. The Study 2 was funded by a grant from the Gambling Problem Solving Fund (Polish: Fundusz Rozwiązywania Problemów Hazardowych), administered by the Minister of Health, Poland, No. 179/HE/2022.

Disclosure

Dr Mark Griffiths reports grants from *Norsk Tipping*, grants from *GambleAware*, and consultancy for gambling operators in the areas of responsible gambling and player protection, outside the submitted work. The authors report no other conflicts of interest in this work.

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