Network analysis of Internet Gaming Disorder IGD and Gaming Motivation GAMS

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INTRODUCTION: The global rise in online gaming has led to increased prevalence of Internet Gaming Disorder (IGD), now recognized by both the DSM-5 and ICD-11, albeit with differing diagnostic criteria. However, the relationships among IGD symptoms remain poorly understood. This study employed network analysis to examine symptom patterns, identify central and peripheral criteria, and explore associations between IGD symptoms and motivational constructs from Self-Determination Theory (SDT). The study sample consists of casual and esports players (N=300). **RESULTS:** We found that the criterion "Continued play despite problems" showed highest connectivity with the other criteria. This criterion, along with Withdrawal and Tolerance, were central and substantiated criteria in IGD according to our network analysis. For motivations based on SDT theory, we found that Integrated Regulation had the greatest number of connections with the other types of motivations and dominated in terms of centrality measures. Greater levels of amotivation were associated with the criterion escape, whereas integrated regulation was negatively associated with deception and positively associated with preoccupation.

CONCLUSIONS: The findings could enhance the conceptualization of gaming disorder criteria in clinical practice and aid in designing prevention and intervention programs targeting specific motivations. Further qualitative studies are needed to clarify the operational definitions of IGD criteria.

Keywords | Gaming disorder – Network analysis – IGD – Central and peripheral criteria – Gaming motivation GAMS

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1 INTRODUCTION

The number of players engaged in both online and offline gaming is steadily increasing annually. In 2008, approximately 1.1 billion individuals worldwide participated in computer games, a figure projected to reach 1.86 billion by 2024 (Statista, 2024). Players engage in gaming for various purposes, such as relaxation, entertainment, competition, and potential financial gain (Lipovaya et al., 2018; Ma et al., 2013). However, issues arise when gaming behavior becomes excessive or pathological. The manual DSM-V (APA, 2013) defines excessive gaming as playing for more than 30 hours per week, leading to various disruptions in the player's life.

Addressing this concern, the American Psychiatric Association (APA) recognized Internet Gaming Disorder (IGD) as early as 2013, incorporating it into its diagnostic manual, the DSM-V. IGD is characterized by gaming that significantly impairs or creates difficulty across multiple aspects of an individual's life. Diagnosis requires meeting at least 5 of the 9 established criteria over a period of 12 months. In 2018, the WHO included Gaming Disorder (GD) in its diagnostic manual, the ICD-11 (International Classification of Diseases). It defines GD as a mental disorder resulting from addictive gaming behavior, leading to substantial impairment in personal, familial, social, educational, occupational, or other critical areas of life. Diagnosis necessitates meeting all three criteria for a minimum of 1 year. ICD-11 employs a monothetic approach, requiring the fulfillment of all criteria for diagnosis, in contrast to the polythetic approach utilized in the DSM-V (refer to Table 1). While these two disorders are perceived as similar, discrepancies exist, particularly in how criteria are delineated. Karhulahti et al. (2022) identified disparities in criteria definition and disorder presentation, emphasizing the necessity for further research to comprehensively compare and elucidate both disorders.

The prevalence of gaming disorder is an important public-health issue nowadays, yet reported rates vary because case identification depends on differing diagnostic criteria, assessment instruments, and sampling methods. Karhulahti et al. (2022) emphasize that identical prevalence figures can nevertheless represent entirely different populations. Notably, prevalence rates for gaming disorder constructs differ significantly, ranging from 0.4% for ICD-11 to 6.9% for DSM-IV, indicating a substantial disparity. Conversely, self-reported gaming problems stand at 12.6% among players. Currently, the global prevalence rate is estimated at 3%, with 3.05% for IGD (Stevens et al., 2021) and 3.3% for GD (Kim et al., 2022). While current knowledge predominantly stems from the DSM-V diagnostic manual, clinical evidence suggests that many individuals diagnosed under this manual do not meet the criteria outlined by ICD-11 (Starcevic et al., 2020). Consequently, understanding the relationships between proposed symptoms is crucial.

Several network analyses have endeavored to elucidate the connections between different criteria (Adamkovic et al., 2022; Gomez et al., 2022; Yuan et al., 2022; Chen & Zhu, 2023; Li et al., 2023). A recurring finding across studies is the significance of the criterion "loss of control" (Adamkovic et al., 2022; Gomez et al., 2022; Yuan et al., 2022). Additionally, "continuing despite psychosocial problems" (Gomez et al., 2022; Yuan et al., 2022), "withdrawal symptoms" (Adamkovic et al., 2022; Gomez et al., 2022), "tolerance" (Gomez et al., 2022), and "preoccupation" (Yuan et al., 2022) have been identified as central criteria. Gomez et al. (2022) further explored the relationship between these criteria and various motivations based on Self-Determination Theory (SDT) (Deci & Ryan, 2000), finding intrinsic motivation to be significantly linked to preoccupation and escape symptoms, while negative consequences correlated with low identified regulation.

Motivation plays an important role in predicting Internet Gaming Disorder (IGD) (Kim et al., 2017; Ballabio et al., 2017; Husasin et al., 2015). Self-Determination Theory (SDT), as proposed by Ryan and Deci (2000), distinguishes between extrinsic and intrinsic motivation, highlighting psychological needs such as autonomy, competence, and relatedness. Lafreniére et al. (2012) applied SDT to explore the link between motivation and gaming, categorizing players as intrinsically or extrinsically motivated based on their reasons for engagement.

Although there are only a few network studies examining the connections between IGD symptoms and types of gaming motivation, previous research has primarily used standardized motivational scales such as MOGQ (Chen & Zhu, 2023), SCMQ (Li et al., 2023), MOCQ (Chen et al., 2023), or SIMS (Gomez et al., 2022), often focusing on populations from China or English-

Table 1 | IGD and GD criteria

IGD criteria	GD criteria
1. Preoccupation with internet games	1. Impaired control over gaming
2. Withdrawal and withdrawal symptom	2. Increasing priority of gaming over other interests and everyday activities
3. Tolerance	3. Continuing or escalating gaming despite negative consequences
4. Loss of control (unsuccessful attempts to control behavior)	
5. Loss of interest in other activities	
6. Continued excessive play despite psychosocial problems	
7. Deception of family members, therapists, or others regarding the amount of Internet gaming	
8. Gaming for escape or to relieve negative mood	
9. Conflict/Problems/loss due to gaming (related to loss of employment, education, other opportunities, etc.)	

speaking adults in the general community. These studies have explored different motivational typologies, not limited to Self-Determination Theory (SDT)-based motivations. Therefore, it is necessary to examine existing findings across a global population, encompassing not only China and the United States but also Europe, in order to provide a more comprehensive understanding of IGD and its motivational mechanisms. To address these gaps, given the insights from previous network analyses, this study aims to validate the criteria for IGD and explore associations with SDT-based motivations. Specifically, we seek to elucidate the structural relationships between IGD symptoms, identify central and peripheral symptoms, and examine the structural links between IGD symptoms and SDT-based motivations. Our research questions are as follows:

- **RQ1:** How are the symptoms of IGD (preoccupation, withdrawal, tolerance, loss of control, loss of interests, continue despite problems, deception, escape, problems/negative consequences) structurally related?
- **RQ2:** What are the central and peripheral symptoms in IGD networks?
- **RQ3:** How are the symptoms of SDT-based motivations structurally linked?
- **RQ4:** How are IGD symptoms and SDT-based motivations (intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation) structurally linked?

Through these inquiries, we aim to contribute to a deeper understanding of gaming disorder and its underlying motivations.

2 METHOD

2.1 Participants

Data collection for this study was conducted in 2020 (January – March). We utilized a combination of the Snowball technique and non-random opportunity sampling methods to gather information. Participants were recruited through social media platforms (i.e. Facebook, Discord, and Instagram) using an online questionnaire administered via Google Forms. The sample comprised 306 players aged between 15 and 59 years. Esports and casual players typically fall within the 18 to 34 age category (ESA, 2019). In our study, the mean age was 22 years, which is consistent with previous research. Gender distribution within the sample reflected 271 males (90.7%) and 29 females (9.3%). Six participants were excluded due to various reasons, such as substantial missing data, unclear responses, age below 15 years, or playing less than one hour per week. Consequently, the final sample comprised 300 players who met the predefined criteria. Among the participants, 64 individuals (21.3%) identified as professional esports players, 92 (30.7%) as amateur esports players, and 144 (48%) as casual players. We included different types of players in our research to work with a broad spectrum of the gaming community. The requirement for participation was that the player had been actively playing for at least a year. We recruited participants from various regions worldwide. Despite limited existing literature on this topic, we aimed to gather data from players representing different parts of the globe. The most prevalent countries among our participants were Slovakia (41.7%), the Czech Republic (26.2%), and the USA (9.3%).

2.2 Measures

For the assessment of gaming disorder based on the DSM-V criteria, we utilized the English version of the Internet Gaming Disorder Test (IGDS9-SF; Pontes & Griffiths, 2015). This psychometric instrument was developed to align with the nine core criteria defining IGD as outlined in the DSM-V (American Psychiatric Association, 2013). The instrument comprises nine items, each rated on a 5-point Likert scale ranging from 1 (never) to 5 (very often), with a possible total score exceeding 36, the cutoff for IGD. Quin et al. (2020) recommended a cut-off score of 32 for optimal diagnostic accuracy (96.1%). Higher scores on the IGDS9-SF indicate greater levels of Internet Gaming Disorder (IGD). Additionally, Quin et al. (2020) suggested that individuals scoring 5 ("very often") on at least five out of nine items should be considered for preventive interventions. The IGDS9-SF has demonstrated acceptable reliability with a Cronbach's alpha of 0.87 (Pontes & Griffiths, 2015), and in our study, Cronbach's alpha and McDonald's Omega coefficients were 0.75 and 0.76, respectively, indicating satisfactory reliability.

The Gaming Motivation Scale (GAMS) (Lafreniére et al., 2012), is rooted in Deci and Ryan's Self-Determination Theory (2000). According to this theory, individuals engage in gaming for various reasons, ranging from intrinsic enjoyment, skill enhancement, external rewards or avoidance of negative consequences. GAMS comprises six motivational factors: intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation. Intrinsic motivation represents engagement in gaming for the sheer pleasure of exploring new game options or experiencing the game environment. Integrated regulation reflects alignment with personal values, while identified regulation involves gaming as a means of personal development. Introjected regulation encompasses internal pressures, such as anxiety or guilt, that drive gaming behavior, while external regulation pertains to gaming motivated by external rewards or prestige. Amotivation characterizes individuals who lack motivation for gaming, even if they were previously intrinsically or extrinsically motivated.

Each subscale of the GAMS contains three items, rated on a 7-point Likert scale ranging from 1 (do not agree at all) to 7 (very strongly agree). The original Cronbach's alpha coefficients for intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation were reported as 0.75, 0.88, 0.82, 0.88, 0.75, and 0.89, respectively (Lafreniére et al., 2012). In our research, McDonald's Omega coefficients for the subscales were as follows: intrinsic motivation (0.43), integrated regulation (0.76), identified regulation (0.73), introjected regulation (0.74), external regulation (0.69), and amotivation (0.65). While Omega coefficients provide less biased estimates of reliability compared to Cronbach's alpha, intrinsic motivation demonstrated low reliability in our research.

2.3 Statistical analysis

The statistical analysis was conducted using JAMOVI software, where descriptive statistics were computed, and the dataset was checked for missing or incorrect data, ensuring that all conditions were met. Subsequently, network analysis was performed using the R program. We were inspired by Gomez et al. (2022) regarding the minimum sample size. In terms of power for network analysis, a sample size of at least 250 participants has been suggested for accurate and reliable network analysis results (Epskamp & Fried, 2018; Gomez et al., 2022). Networks were estimated for the nine IGD criteria and SDT-based motivations using the EBICglasso method. Measures of centrality (betweenness, closeness, expected influence, and strength) were computed for IGD symptoms and types of motivation. The weights of edges and nodes were compared in terms of their strength. The stability of centrality indices was assessed using case-dropping bootstrap (2,000 nonparametric resamples), which examines whether rankings remain consistent when the network is re-estimated with fewer cases or nodes. The correlation stability coefficient was computed with a value above 0.7 considered conventional, while Epskamp et al. (2018) recommend at least 0.25. The EBICglasso method applied a tuning parameter (γ) of 0.25, which regularizes partial correlations to eliminate spurious edges and improve interpretability of Likert-type data (Fried, 2017). Additionally, network simulations and replication analyses were conducted to verify the robustness of the network across different sample sizes, providing further assessment of stability and accuracy.

Network analysis is utilized to investigate the complexity of psychological disorders by conceptualizing symptoms as autonomous yet interacting components within a dynamic system. In this approach, psychopathology is understood as an emergent phenomenon arising from recurrent, causal interactions among symptoms. This methodology enables the identification of central (highly connected) and peripheral (less connected) symptoms, providing insights into the structure and potential mechanisms of a disorder. By visualizing conditional dependencies between symptoms, network analysis reveals nuanced patterns of association that evolve as other symptoms fluctuate. Unlike traditional correlation-based methods, network analysis accounts for the interdependence of symptom relationships, offering a more context-sensitive and mechanistic understanding of psychopathological processes (Adamkovic et al., 2022).

3 RESULTS

The descriptive statistics revealed notable differences among different player types regarding age, frequency of play, and total IGDS9-SF scale scores. Esports professional players exhibited higher average scores in the frequency of play (Me=5 (they play more than 30 hours per week), M = 4.45, SD = 0.85) compared to other player types. Regarding motivational factors, intrinsic motivation was found to be dominant among casual players, with a mean score of 4.23 (SD = 1.19). In contrast, esports professional players scored higher on average in integrated regulation (M = 4.50, SD = 1.47), identified regulation (M = 4.57, SD = 1.40), and introjected regulation (M = 2.57, SD = 1.41) compared to other player types. Additionally, professional esports players demonstrated lower scores in amotivation (M = 1.96, SD = 1.29) compared to amateur esports and casual players. These findings are summarized in Table 2.

Table 2 | Descriptive statistics of mean values between different types of players and age, frequency of playing and IGDS9-SF

	Casual players (n=144)		Esports amateur players (n=92)		Esports professional players (n=64)		Range
	M	SD	M	SD	M	SD	
Age	22.43	5.78	22.51	3.68	21.08	2.98	15-59
Frequency of playing	3.29	1.12	3.79	1.12	4.45	0.85	>1*
IGDS9-SF	19.28	6.03	19.97	5.88	20.83	5.59	1-7
Intrinsic motivation	4.23	1.19	3.88	1.16	3.49	1.31	1-7
Integrated Regulation	3.66	1.53	3.72	1.44	4.5	1.47	1-7
Identified Regulation	4.02	1.53	3.97	1.43	4.57	1.4	1-7
Introjected Regulation	2.17	1.27	2.14	1.96	2.57	1.41	1-7
External Regulation	3.46	1.67	3.5	1.52	3.49	1.35	1-7
Amotivation	2.56	1.22	2.36	1.24	1.96	1.29	1-7

Note: M - mean, SD - standard deviation, n=number of participants for each group of players; * play games more than 1 hour per week;

We also show the frequency statistics of the players for each country in which they live. The results are indicated in Table 3.

In the case of identifying players based on conditions derived from the IGDS9-SF (a score of 36+), we found that only 4 players would be identified as possibly having a gaming disorder. If we reduced the cut-off score to 32+, we found that 7 players would be identified as possibly having a gaming disorder.

In our analysis of the criteria for IGD using network analysis, we identified several important findings. Centrality betweenness and closeness metrics express how quickly nodes are

Table 3 | Frequency table of country representation, based on number of players

Country	*n*	%
Australia	4	1.3
Austria	2	0.7
Belgium	3	1.0
Bolivia	1	0.3
Brazil	1	0.3
Canada	2	0.7
Chile	1	0.3
Czech Republic	77	25.7
Denmark	2	0.7
England	2	0.7
Finland	1	0.3
France	2	0.7
Germany	9	3.0
Hungary	3	1.0
Indonesia	2	0.7
Ireland	1	0.3
Israel	1	0.3
Malaysia	1	0.3
Mexico	2	0.7
Namibia	1	0.3
Netherlands	1	0.3
Philippines	3	1.0
Poland	9	3.0
Romania	1	0.3
Russia	1	0.3
Slovak Republic	126	42.0
South Africa	2	0.7
Sweden	3	1.0
Thailand	2	0.7
United Arab Emirates	1	0.3
Ukraine	2	0.7
United Kingdom UK	2	0.7
USA	28	9.3
Uruguay	1	0.3
Missing	0	0.0
Total	300	100.0

Note: n - number of persons in the group;

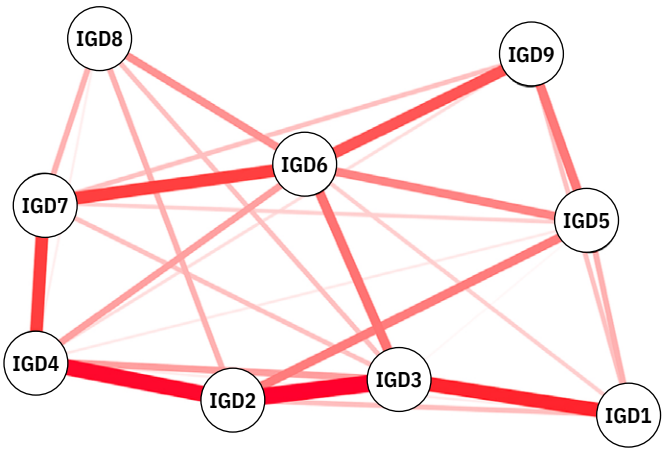
connected to other nodes and whether separate nodes have direct connections, or how often the closest node is connected directly and indirectly. In terms of closeness, continue despite problems (IGD6) (1.473) had the highest closeness value, indicating its key role in information transmission. Withdrawal (IGD2) (1.119) and Tolerance (IGD3) (0.772) were also deemed important, while Preoccupation (IGD1) (-0.926), Escape (IGD8) (-1.575), and Problems/Consequences (IGD9) (-0.763) were less central in the network.

We identified significant differences in betweenness centrality values among the nodes. Continue despite problems (IGD6) (1.812) showed the highest value, indicating its importance in connectedness among the other criteria. Withdrawal (IGD2) (0.813) and Tolerance (IGD3) (1.146) also exhibited high values of betweenness centrality, indicating their importance in the network. Conversely, nodes Preoccupation (IGD1) (-0.814), Escape (IGD8) (-0.851), and Problems/Consequences (IGD9) (-0.851) were less central, based on their low values. Strength centrality reflects how strongly the nodes are interconnected. The node Continue despite problems (IGD6) (1.312) exhibited the highest strength, while Tolerance (IGD3) (1.164) and Withdrawal (IGD2) (0.780) were also significant. Conversely, Preoccupation (IGD1) (-0.770), Escape (IGD8) (-1.542), and Problems/Consequences (IGD9) (-0.924) were weak.

Expected influence values ranged from –1.54 to 1.31. Expected influence is a centrality metric that reflects both the strength and sign of a node's connections. The node Continue play despite problems, coded IGD6, had the highest expected influence (1.31), indicating the greatest potential to affect other symptoms. By contrast, Escape, coded IGD8, had the lowest expected influence (–1.54), indicating minimal overall influence within the symptom network. These results identify IGD6 as a key node and IGD8 as a peripheral node.

In summary, the Continue despite problems appears to be the most central in the network. The nodes Withdrawal and Tolerance are also important, while Preoccupation, Escape and Problems/consequences are less important and can be considered peripheral in the context of this gaming disorder network.

A graphical visualization of the network is presented in Figure 1. The thicker lines indicate stronger connections between the criteria with each other. Continue despite play (IGD6) is positioned in the middle and expresses the most connections with the other criteria. From the graph, strong positive connections can be observed between Preoccupation (IGD1) and Tolerance (IGD3),



IGD1 Preoccupation
IGD2 Withdrawal
IGD3 Tolerance
IGD4 Loss of control
IGD5 Loss of interests
IGD6 Continue despite problems
IGD7 Deception
IGD8 Escape
IGD9 Problems/consequences

Figure 1 | Graphical visualization of the network structure among IGD criteria

Note: Thicker red lines reflect stronger positive associations between the criteria, indicating the strength of their relationships

Tolerance (IGD3) and Withdrawal (IGD2), Withdrawal (IGD2) and Loss of control (IGD4), Loss of control (IGD4) and Deception (IGD7), Deception (IGD7) and Continue despite problems (IGD6), and Continue despite problems (IGD6) and Problems/consequences (IGD9). However, in terms of significance and stability, it can be said that among the aforementioned connections, the more stable ones in terms of strength were between Preoccupation (IGD1) and Tolerance (IGD3), and Continue despite problems (IGD6) and Problems/consequences (IGD9).

The graphical representation (Figure 2) allows to compare the central indicators for different nodes in the network and to identify those that have the greatest impact or importance in the context of a given analysis. The nodes in the graph are ranked according to their values of the central indicator "Strength - centrality of strength". As part of the analysis, we utilized the bootstrap edge difference test to assess the significance of links between nodes in the network. The results of this test were visualized using colored rectangles, with red rectangles indicating significant differences in connections between nodes, while gray rectangles denote nonsignificant differences (Figure 2). These findings offer valuable insights into the statistically significant relationships between nodes in the network, which are crucial for understanding the structure and functionality of the network.

Subsequently, we evaluated the accuracy and stability of the network. The stability of the centrality indices (betweenness centrality, closeness, strength, and expected influence) were examined through bootstrapping, as depicted in Fig. 3. This figure illustrates that the stability coefficient of the correlation remains consistent across different subsets of the data, representing varying percentages of the total sample. As demonstrated in Fig. 3, as the subset of the sample decreases from 95% of the original sample to 20%, the correlations between the subset estimate and the estimate from the original full sample declines. This reduction in stability suggests that with less data

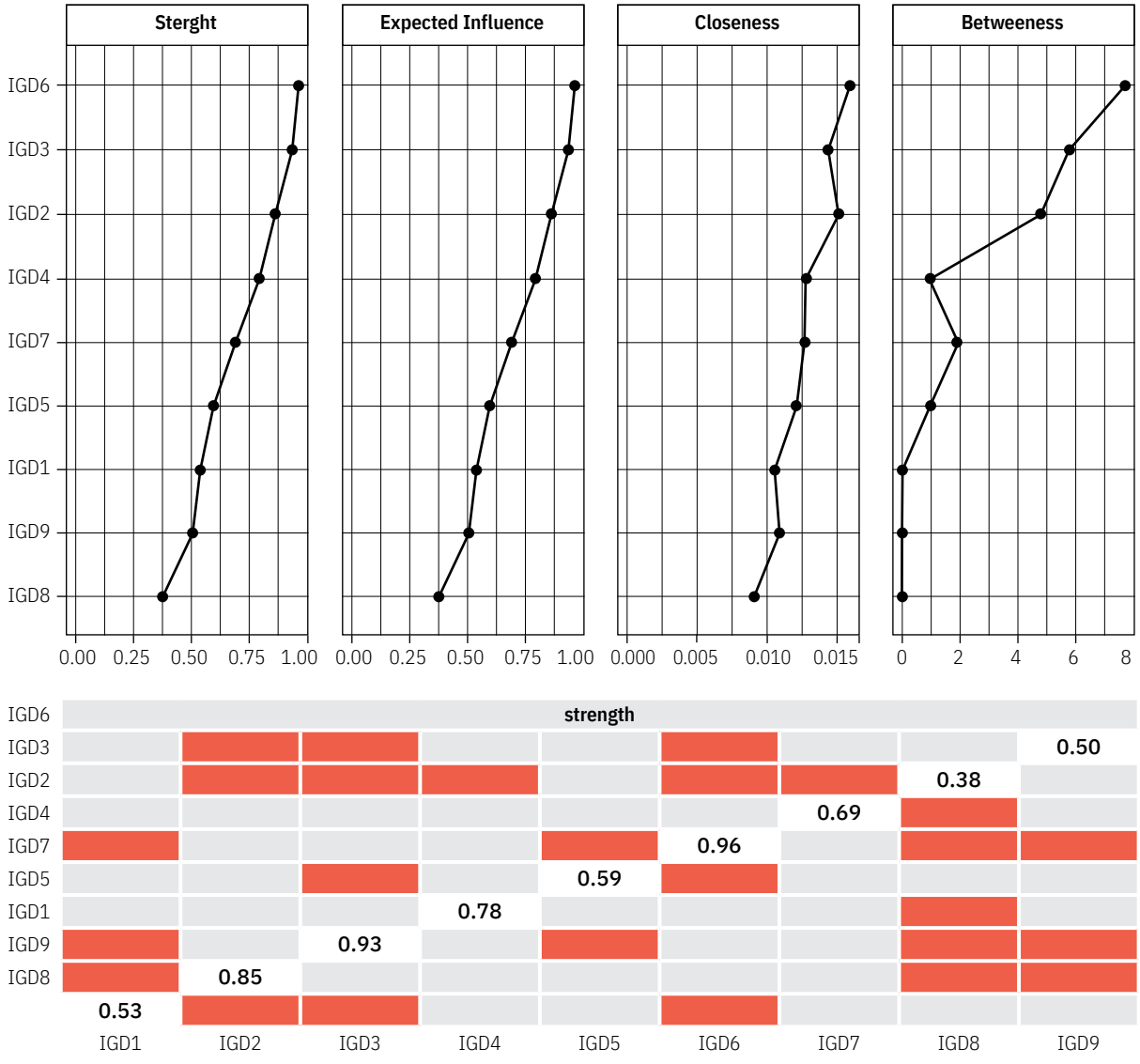


Figure 2 | Visualization of IGD centrality indices and Bootstrapped difference tests for the nodes' strength within IGD network

Note: Red rectangles indicate significant differences between node strengths, while grey rectangles represent non-significant ones

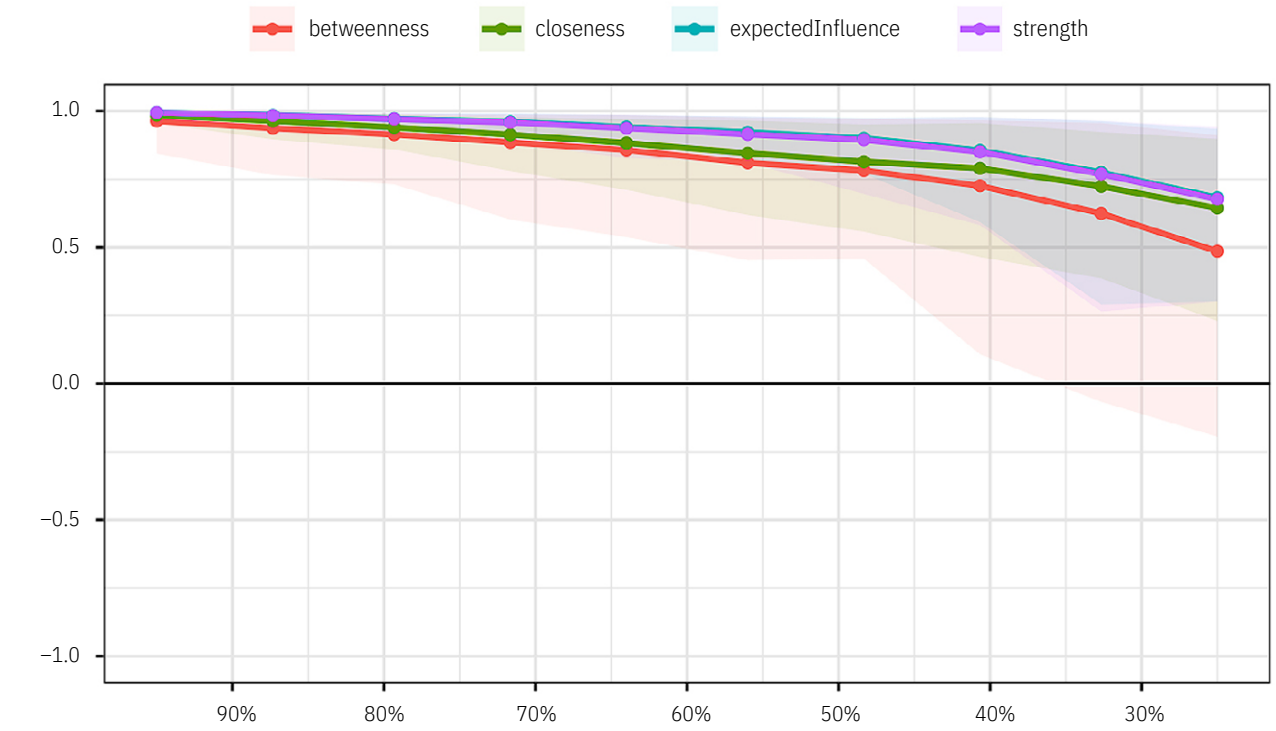


Figure 3 | Stability of central indices

Note: Correlations of centrality measures (betweenness, closeness, expected influence, and strength) as the sample size decreases

and higher correlation, the interpretation of the central variables may be influenced by a greater degree of randomness or outliers. Nevertheless, in this study, we adhere to the notion that network stability is adequately estimated when the correlation value exceeds 0.7 (Epskamp et al., 2018). Despite this, our focus in this study remains on centrality strength, as it is recognized to provide reasonably accurate centrality estimates for psychological networks (Santos et al., 2018). In our case, the stability of the strength centrality is slightly below 0.7, which means that it may not be a completely stable network.

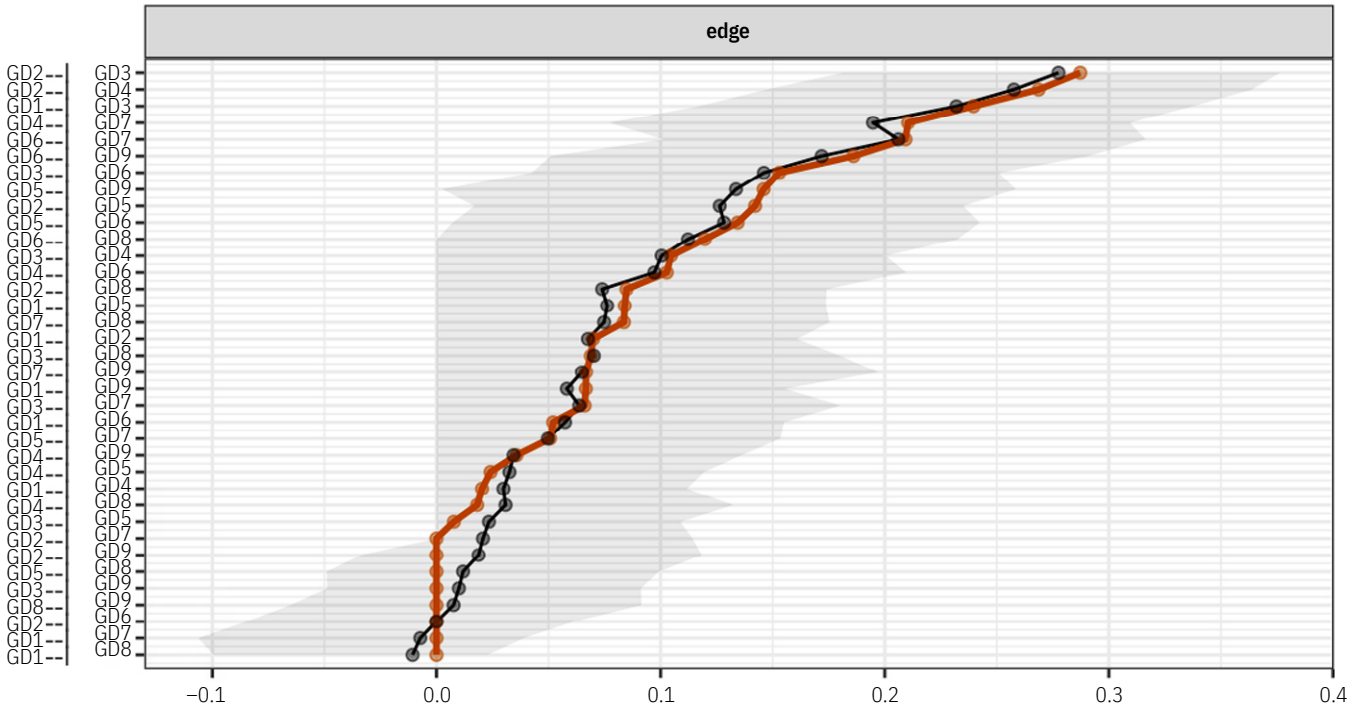


Figure 4 | Visualization of the accuracy of the edge-weight estimates (red line) and the 95% confidence intervals (grey bars) for the estimates

Note: Red color indicates how participants answered on average, black corresponds to averages using the bootstrap function, gray represents 95% confidence intervals, with narrower intervals indicating a more precise estimate.

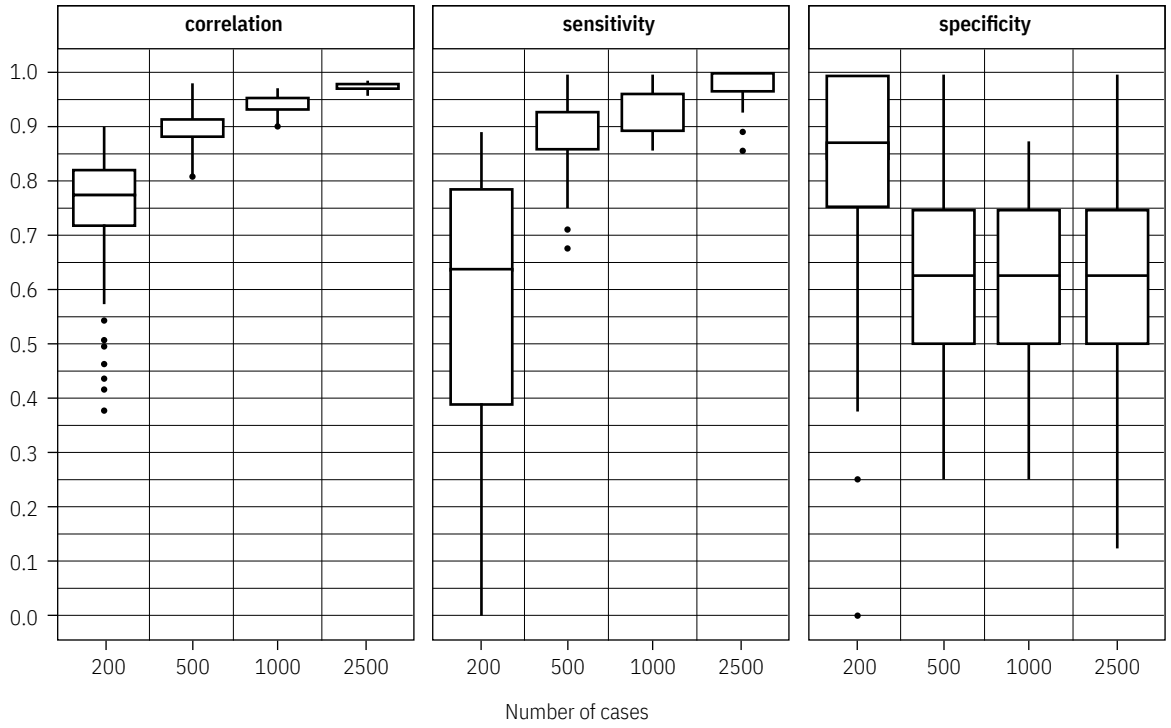


Figure 5 | Simulation of correlation, sensitivity and specificity

Note: Evaluation of correlation, sensitivity and specificity when simulating samples of 200, 500, 1000, and 2500.

The precision of the edge weights, as estimated using bootstrap 95% nonparametric confidence intervals (CIs), is illustrated in Figure 4. In this analysis, we compared participants› mean responses with the means obtained using the bootstrap function. Ideally, if the participant means closely align with the means derived from the bootstrap function, it indicates greater accuracy. However, in our case, we observed that the values approached zero to a lesser extent. Additionally, the confidence interval for our sample was wider, suggesting that these estimates lack stability. The wide confidence intervals around a significant number of the estimated edge weights indicate that many of these weights were not significantly different from each other. Consequently, the interpretation of the order of many edges in the network should be approached with caution.

We conducted simulations to evaluate correlation, sensitivity, and specificity using sample sizes of 200, 500, 1000, and 2500 (Fig. 5). During this process, we observed a trend where increasing the correlation sensitivity up to a value of one was associated with a decrease in specificity. This trend implies that the tests became more sensitive in identifying true positive cases; however, it also led to an increase in the number of false positive identifications. Such a development bears significant implications for the selection of testing procedures and their interpretation, underscoring the importance of striking a balance between sensitivity and specificity in accordance with the specific research goals and applications at hand.

3.1 Combination of Internet Gaming Disorder (IGD) criteria with GAMS motivations

Within the network connections of motivation types emerging from the GAMS scale, several key findings were identified. Integrated Regulation exhibited the most connections with other nodes in the network. Notably, two negative relationships were observed: one between Integrated Regulation and Amotivation, and another between Identified Regulation and Amotivation. Among the most strong connections, three relationships stood out: Identified Regulation and Integrated Regulation, Integrated Regulation and Introjected Regulation, and Amotivation and External Regulation. Moreover, according to the edge weight significance test, Integrated Regulation showed stable significant connections with Identified Regulation and Introjected Regulation. Across all centrality measures (strength, expected influence, closeness, betweenness centrality), Integrated Regulation demonstrated dominance, with values of 1.719, 1.562, 1.630, and 1.070, respectively. Conversely, Intrinsic Motivation exhibited the lowest values in terms of strength and betweenness centrality (-1.091, -0.627), while Amotivation showed the lowest value in terms of expected influence (-1.270), and External Regulation showed the lowest value in closeness centrality (-1.277). However, in our case, the stability coefficients for strength and expected influence centrality were slightly above 0.7, indicating that these centrality indices represent a stable network structure.

The visualization of both IGD and GAMS networks revealed several connections (see Figure 6). Specifically, Preoccupation (IGD1) positively correlated with Identified Regulation (0.123) and Integrated Regulation (0.160). Additionally, Escape (IGD8) showed positive correlations with Amotivation (0.189) and

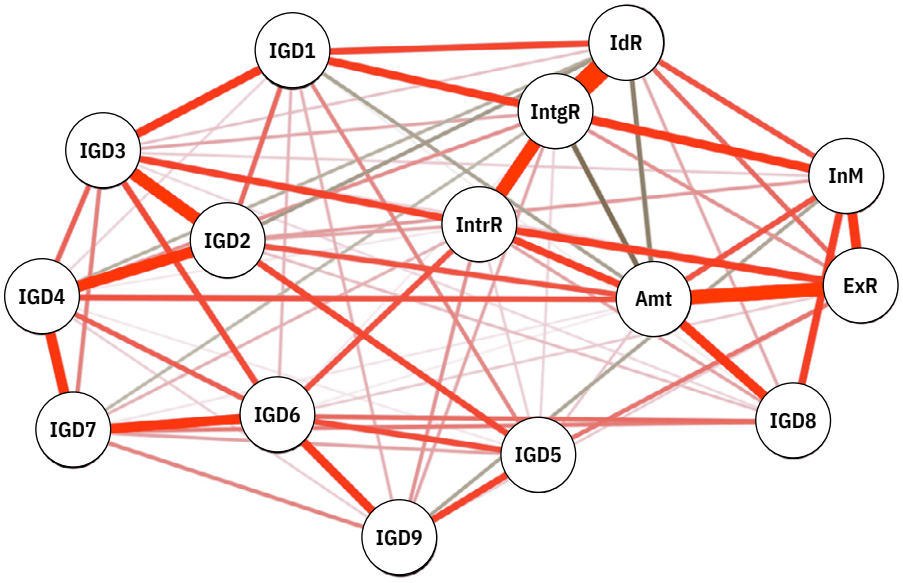


Figure 6 | Visualization of the IGD network in combination with GAMS motivations.

Note: Red connections indicate positive associations between nodes, grey connections indicate negative associations between nodes, thicker lines indicate stronger connections between node edges

Intrinsic Motivation (0.142), while Tolerance (IGD3) positively correlated with Introjected Regulation (0.133). Amotivation also exhibited positive correlations with Withdrawal (IGD2) (0.101) and Loss of Control over Gaming (IGD4) (0.104), although these relationships were weaker. Furthermore, negative correlations were observed, albeit predominantly weaker, including the relationship between Amotivation and Preoccupation (IGD1) (-0.056), Integrated Regulation and Deception (IGD7) (-0.044), Intrinsic Motivation and Problems/Consequences (IGD9) (-0.055), Identified Regulation and Withdrawal (IGD2) (-0.062), and Loss of Control (IGD4) (-0.047). Preoccupation and Integrated Regulation, Escape and Amotivation, Preoccupation and Amotivation, as well as Deception and Integrated Regulation demonstrated stable connections according to the edge weight significance test.

4 DISCUSSION

The aim of this study was to examine the structural interconnectedness of Internet Gaming Disorder (IGD) criteria and determine which criteria could be considered central and peripheral in terms of centrality. It is crucial to note that our discussion of criteria importance relies on statistical parameters and does not necessarily imply clinical or theoretical significance (Adamkovič et al., 2022).

The global prevalence rate of IGD is estimated to be around 3% (Stevens et al., 2021; Kim et al., 2022). In our study, the prevalence rate was approximately 1.33%, but it increased to around 2.33% when the cut-off score was reduced to 32. However, it›s important to consider that our data is from 2020. Much of the data from the enumerated network analyses in the context of IGD were collected during the COVID-19 pandemic (Adamkovic et al., 2022; Gomez et al., 2022; Yuan et al., 2022). It is worth mentioning that COVID-19 had an impact on various domains, one of which is gaming disorder. In their systematic review, Gopali et al. (2023) found that meta-analyses showed no significant difference in mean IGD scores before and during COVID-19. However, an increase in gaming disorder prevalence was noted in Asia (Kim et al., 2022; Stevens et al., 2020). In our case, we observed a similar or perhaps lower prevalence of gaming disorder compared to worldwide prevalence.

Based on structural connections, we found that Continued play games despite psychosocial problems was the most connected node with other criteria. The largest connections in terms of edges were observed between Loss of control over gaming and Withdrawal, Withdrawal and Tolerance, Tolerance and Preoccupation. However, the more stable ones in terms of strength were connections between Preoccupation and Tolerance, and Continue play games despite problems and Problems/consequences. Continued play games despite psychosocial problems emerged as the most central criterion, with Withdrawal and Tolerance also being among the stronger central criteria across all centrality measures. These findings are partially supported by other network analyses. Gomez et al. (2022) and Yuan et al. (2022) identified Continued play games despite psychosocial problems as an important central criterion, while withdrawal symptoms were highlighted by Adamkovič et al. (2022), Gomez et al. (2022), and Li et al. (2023). Regarding peripheral criteria, we identified those with the lowest values across centrality measures. Escape was deemed the most peripheral criterion, with Preoccupation and Problems/negative consequences due to gaming is also considered a peripheral. Similar results were reported by Gomez et al. (2022), who found that escape and loss of interest in other activities were not central for diagnosing gaming disorder. Adamkovič et al. (2022) also identified escape and preoccupation as peripheral criteria. However, Yuan et al. (2022) found preoccupation (excessive preoccupation with gaming) to be a central criterion. These findings are partially inconsistent with the study by Castro-Calvo et al. (2021), in which experts

evaluated the criteria for GD as defined in both the ICD-11 and DSM-5, focusing on their diagnostic validity and clinical utility. The authors found that, of the nine DSM-5 criteria, only four were rated by more than 80% of experts as "very important" or "extremely important," namely: jeopardizing relationships and/or career opportunities, impaired control, continued gaming despite negative consequences, and diminished interest in other activities. Notably, expert consensus was achieved for the exclusion of three criteria, tolerance, deception toward family members, therapists, or others, and mood regulation, as fewer than 20% of experts considered them highly important (Castro-Calvo et al., 2021). Discrepancies may arise from different operationalizations of constructs, such as preoccupation. Different measurement tools and sample characteristics across studies could also influence results.

In addition to examining the Internet Gaming Disorder (IGD) criteria themselves, we also explored connections between various types of motivations based on Self-Determination Theory (Deci & Ryan, 2000). Integrated Regulation emerged as the most connected node, suggesting that players perceive gaming as integral to their life goals or sense of life (Koestner & Losier, 2002; Razum & Huić, 2024). This type of motivation also dominated across all centrality measures. In contrast to previous findings by Gomez et al. (2022), where external regulation, identified regulation, and intrinsic motivation emerged as central motivation nodes in the combined IGD–motivation network and amotivation appeared as a peripheral type of motivation, our results identified integrated regulation as the most central motivational factor. In our analysis, both intrinsic motivation and amotivation showed the lowest centrality values. Erol & Çirak (2020) found that players are more intrinsically motivated while playing games. This discrepancy may be attributed to lower reliability for Intrinsic Motivation and Amotivation, potentially biasing the data. Factors such as population size, culture, and language barriers may also have influenced these results.

Notably, we observed three prominent positive relationships: between Integrated Regulation and Identified Regulation, Integrated Regulation and Introjected Regulation, Amotivation and External Regulation. Conversely, negative relationships were found between Integrated Regulation and Amotivation, and between Identified Regulation and Amotivation. This underscores that, as gaming aligns with a player›s life goals or sense of life, their amotivation decreases. This finding is consistent with the network analysis by Gomez et al. (2022). However, the edge weight significance test revealed that Integrated Regulation exhibited stable and significant connections with Identified and Introjected Regulation.

Considering a significance threshold of minimum absolute value of 0.03 (Isvoranu et al., 2017), we identified several important bridge connections in our network. For instance, Intrinsic Motivation positively correlated with Escape, while Integrated Regulation positively correlated with Preoccupation. Additionally, Identified Regulation positively correlated with Preoccupation, while Introjected Regulation positively correlated with Tolerance, and Continued gaming despite problems. Furthermore, External regulation positively correlated with Loss of interest, and Amotivation positively correlated with Withdrawal, Loss of control over gaming and Escape. Interestingly, only certain pairs of criteria showed consistently robust associations. Specifically, stable connections were observed between Preoccupation and Integrated Regulation, Escape and Amotivation, Preoccupation and Amotivation (as negative association), and Deception and Integrated Regulation (as negative association), as indicated by the edge weight significance test. Our findings partially contradict previous network analyses. While Gomez et al. (2022) reported that external motivation and intrinsic motivation were more associated with higher levels of gaming disorder than amotivation, we found that Amotivation, showed more stability and was associated with a higher level of gaming disorder. Integrated and Identified Regulation represent gaming that aligns with one›s life goals, potentially driving players towards gaming disorder (Mills et al., 2018).

By definition, amotivated gamers are unaware of any reason for engaging in video games, yet continue to play regardless (Ryan & Deci, 2017). It is possible that, although video gaming is not a highly motivating activity in terms of the amount or level of need satisfaction experienced during play, it may still provide a level of need satisfaction that cannot be found elsewhere in one's life (Mills et al., 2018). In this context, gaming may serve as a coping mechanism, where the individual "automatically" turns to games to regulate emotions, using gaming to escape problems or negative feelings. Amotivation in this case may reflect a learned pattern of gaming behavior, where the person does not experience strong intrinsic motivation. In terms of coping mechanisms, this represents avoidance coping, where the person completely avoids addressing the problem, in contrast to emotion-focused coping, where stress is regulated through distraction via pleasurable activities, which can include video games (Kosa & Uysal, 2020). We also observed a negative association between integrated regulation and deception, and a positive association with preoccupation. While integrated and identified regulation are typically assumed to be associated with adaptive outcomes (Ryan & Deci, 2017), emerging evidence suggests they can sometimes be linked to a mild problematic style of engagement. Individuals may fully assimilate gaming into their sense of self, implying complete autonomous regulation, yet still report mild problematic gaming due to its significant role in their lives. This indicates that integrated–identified regulation does not contribute to needs frustration in day-to-day life, even though it may relate to some problematic gaming symptoms. Conversely, integrated regulation has been associated with lower levels of IGD (Wang & Chu, 2007), consistent with previous findings (Mills et al., 2018). Although these specific stable connections do not precisely match the patterns reported in prior meta-analytic and systematic review evidence (Bäcklund et al., 2022), their findings showed that introjected regulation had a large association with gaming disorder symptoms, external regulation had a moderate association, and amotivation had a small association.

4.1 Study limitations

The study has several limitations that should be acknowledged. Firstly, the network analysis conducted did not yield a completely stable and accurate network, indicating the need for

caution in interpreting the results. Additionally, the sample size was relatively small, consisting of only 300 individuals from potentially diverse cultural backgrounds, with a majority from Slovakia and the Czech Republic. This cultural homogeneity may limit the generalizability of the findings to broader or more diverse populations. Culture can significantly influence individuals' responses to symptom scales, as demonstrated by Ali et al. (2022), particularly in collectivist cultures where deviation from group norms may lead to stigma. Although we involved a wider spectrum of the gaming community in our research, future studies could focus specifically on comparing network analyses of IGD and motivation between esports professional gamers, esports amateur gamers, and casual gamers. The prevalence rates of IGD may differ among these players, as well as the motivations related to gaming. Furthermore, while the study provides statistical insights into central and peripheral criteria, these findings may not fully reflect the clinical presentation of gaming disorder, where psychologists and psychiatrists typically rely on comprehensive interviews alongside diagnostic criteria. Additionally, the GAMS scale used in the study showed low reliability for items related to intrinsic motivation and amotivation, which could bias the results. In future research, this scale should be psychometrically validated within the target population. Also the literature on COVID-19 has shown that restrictive measures (implemented to contain the pandemic) amplified negative psychological effects in both the general and clinical populations, including increased symptoms of anxiety, depression, posttraumatic stress disorder, and stress, as well as a general tendency toward risky health behaviors such as disrupted sleep, dysfunctional eating, and increased substance abuse (Kaiser Family Foundation, 2020). Additionally, a systematic review by Salerno et al. (2023) found that individuals with IGD experienced distress in multiple areas (loneliness, boredom, quality of life, sleep quality, self-control, etc.) during the pandemic. In our case, there may also have been a change in motivation to play related to gaming disorder.

5 CONCLUSION

Despite the limitations of our study, our findings provide valuable insights that can inform future clinical practice in the diagnosis and treatment of a gaming disorder. By examining casual players, amateur esports players, and professional esports players, we have identified potential central symptoms or criteria that could be prioritized in screening for gaming disorder. As the correlation stability coefficient for centrality fell below the recommended threshold, the present findings, especially regarding node strength, should be interpreted cautiously. However, further research is needed to better understand which criteria are central and peripheral. Standardizing tools for measuring gaming disorder would be beneficial in reducing ambiguity and improving the conceptualization of individual criteria. Qualitative analyses could complement quantitative findings, contributing to a more cohesive and unified understanding of gaming disorder. Moreover, our results suggest the importance of developing preventive and intervention programs that focus on Integrated Regulations and Amotivation. Interventions could target the most central criteria, continued play despite problems, withdrawal, and tolerance, as key mechanisms maintaining gaming disorder. The link between amotivation and escape may reflect avoidance coping, suggesting that promoting healthier emotion regulation strategies could reduce problematic gaming. Moreover, strengthening integrated motivation may act as a protective factor, helping players maintain balanced gaming behavior. By targeting this aspect of gaming behavior, we may be able to mitigate the risk of gaming disorder and promote healthier gaming habits. In addition, future research could expand the application of network analysis to other substance and non-substance addictions. Comparing the network structures of different addictive behaviors could reveal shared and addiction-specific mechanisms, offering deeper insights into transdiagnostic factors and helping to refine diagnostic systems and intervention strategies.

Ethical Approval: The data are based on a bachelor thesis that was defended and reviewed by experts in psychology. Informed consent was obtained from all participants, who were informed about the research purpose. Although this study was not specifically reviewed by an ethics committee, we adhere to the ethical principles of the Declaration of Helsinki 1964 and are committed to protecting the rights and privacy of all participants.

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https://osf.io/edwc6/
https://osf.io/ns4ma/files

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