

DOI: <https://doi.org/10.17816/nb629858>

# Risk groups of internet addiction disorder

Alexey A. Sidorov<sup>1</sup>, Victor A. Soldatkin<sup>1</sup>, Alexander O. Kibitov<sup>2, 3</sup><sup>1</sup> Rostov State Medical University, Rostov-on-Don, Russia;<sup>2</sup> V.M. Bekhterev National Medical Research Center of Psychiatry and Neurology, St. Petersburg, Russia;<sup>3</sup> Pavlov First Saint Petersburg State Medical University, St. Petersburg, Russia

## ABSTRACT

**BACKGROUND:** Since publications on the differences of gaming addiction (GA) cohorts are scarce and primarily discuss the factors of only one type (gambling or gaming), it appears relevant to study personal, psychological, morphofunctional, genetic and other traits of patients by comparing different GA types to develop targeted prevention programs. A thorough approach to studying the specific traits of patients with the developed GA or at risk of GA contributes to the development of effective social and psychological, and psychological and educational preventive programs, and improvement of psychotherapeutic approaches to such patients.

**AIM:** This study develops an algorithm for differentiated assessment of the Internet addiction disorder risk.

**MATERIALS AND METHODS:** The study of clinical psychopathology, clinical dynamics, psychology, psychometrics, and risk factors of Internet addiction disorder included an open study of 69 gaming addiction (GA) patients, including 39 Pure GA patients and 30 Gambling GA patients. The control group (CG) consisted of 40 healthy volunteers. Basic study included clinical, psychological and psychometric techniques, and the genetic method as an additional tool. Statistics were processed using the Shapiro–Wilk test, Kolmogorov–Smirnov test, Student's t-test, Welch's t-test, and Mann–Whitney U-test.

**RESULTS:** For the first time, two key gaming addiction (GA) types (Pure GA and Gambling GA) were compared by analyzing the personality traits, morphofunctional and gender attributes of GA patients. The identified traits and attributes were considered in terms of the addiction risk (both in general and differentially) in relation to various Internet addiction types. The data analysis allowed to develop mathematical models to assess the Internet addiction risk in general and its specific types, identify risk groups and refine preventive actions.

**CONCLUSION:** The algorithm for differentiated assessment of the Internet addiction disorder risk was developed.

**Keywords:** internet addiction; gaming addiction; gambling addiction; risk factors; risk groups.

## To cite this article:

Sidorov AA, Soldatkin VA, Kibitov AO. Risk groups of internet addiction disorder. *Neurological Bulletin*. 2024;56(4):355–367. DOI: <https://doi.org/10.17816/nb629858>

DOI: <https://doi.org/10.17816/nb629858>

# Группы риска развития интернет-зависимости

А.А. Сидоров<sup>1</sup>, В.А. Солдаткин<sup>1</sup>, А.О. Кибитов<sup>2,3</sup><sup>1</sup> Ростовский государственный медицинский университет, Ростов-на-Дону, Россия;<sup>2</sup> Национальный медицинский исследовательский центр психиатрии и неврологии им. В.М. Бехтерева, Санкт-Петербург, Россия;<sup>3</sup> Первый Санкт-Петербургский государственный медицинский университет им. И.П. Павлова, Санкт-Петербург, Россия

## АННОТАЦИЯ

**Обоснование.** С учётом редкости литературных данных об отличиях групп игровой зависимости (ИЗ) и преимущественного рассмотрения их особенностей лишь в ключе одной из форм (азартной или игровой) представляется актуальным исследование личностных, психологических, морфофункциональных, генетических и других особенностей пациентов в контексте сравнения форм ИЗ для разработки адресных программ профилактики. Результатом тщательного подхода к изучению конкретных свойств пациентов со сформированной ИЗ или с риском формирования ИЗ является создание эффективных социально-психологических, психолого-педагогических превентивных программ, а также совершенствование психотерапевтических подходов в работе с такими категориями пациентов.

**Цель.** Создание алгоритма дифференцированной оценки риска формирования интернет-зависимости.

**Материалы и методы.** Изучение клинико-психопатологических, клинико-динамических, психологических, психометрических особенностей и факторов риска развития интернет-зависимости проводилось в рамках открытого исследования 69 пациентов с ИЗ: из них у 39 была игровая форма (ИЗ-ИФ), у 30 — азартная (ИЗ-АФ). Контрольная группа (КГ) представлена 40 условно-здоровыми добровольцами. В качестве основных методов исследования применяли клинический, психологический и психометрический, в качестве дополнительного — генетический. Статистическую обработку данных проводили с использованием критериев Шапиро–Уилка, Колмогорова–Смирнова, t-критерия Стьюдента, t-критерия Уэлча, U-критерия Манна–Уитни.

**Результаты.** Впервые в контексте сравнения двух ключевых форм ИЗ (ИЗ-ИФ и ИЗ-АФ) проанализированы данные о личностных, морфофункциональных и половых особенностях пациентов с ИЗ. Выявленные характеристики рассмотрены с точки зрения риска развития зависимости как в целом, так и дифференцированно, в отношении различных форм интернет-аддикции. На основе анализа полученных данных разработаны математические модели, оценивающие риск развития интернет-зависимости в целом и её отдельных форм, что позволяет определить группы риска и уточнить профилактические мероприятия.

**Заключение.** Создан алгоритм дифференцированной оценки риска формирования интернет-зависимости.

**Ключевые слова:** интернет-зависимость; игровая форма игровой зависимости; азартная форма игровой зависимости; факторы риска развития; группы риска.

## Как цитировать:

Сидоров А.А., Солдаткин В.А., Кибитов А.О. Группы риска развития интернет-зависимости // Неврологический вестник. 2024. Т. 56, № 4. С. 355–367.  
DOI: <https://doi.org/10.17816/nb629858>

DOI: <https://doi.org/10.17816/nb629858>

# Интернет-бәйлелек үсеше куркынычы төркемнәре

А.А. Сидоров<sup>1</sup>, В.А. Солдаткин<sup>1</sup>, А.О. Кибитов<sup>2,3</sup><sup>1</sup> Ростов дәүләт медицина университеты, Ростов-на-Дону, Рәсәй;<sup>2</sup> В.М. Бехтерев исемендәге психиатрия һәм неврология Милли медицина тикшеренү үзәге, Санкт-Петербург, Рәсәй;<sup>3</sup> И.П. Павлов исемендәге Беренче Санкт-Петербург дәүләт медицина университеты, Санкт-Петербург, Рәсәй

## АННОТАЦИЯ

**Нигезләмә.** Уенга бәйлелек төркемнәренең (ИЗ) аермалары турындагы әдәби мәгълүматларның сирәклеге һәм аларның үзенчәлекләрен бары тик бер форма (азартлы яки уенлы) төшенчәсендә генә өстенлекле карауны исәпкә алып, профилактиканың адреслы программаларын эшләү өчен формаларны чагыштыру контекстында пациентларның шәхес, психологик, морфофункциональ, генетик һәм башка үзенчәлекләрен тикшерү актуаль булып күренә. Формалаштырылган яки Формалаштыру куркынычы булган пациентларның конкрет үзлекләрен җентекләп өйрәнүнең нәтижәсе булып нәтижәле социаль-психологик, психологик-педагогик превентив программалар төзү, шулай ук мондый категориядәге пациентлар белән эшләүдә психотерапевтик алымнарны камилләштерү тора.

**Максат.** Интернет-бәйлелек барлыкка килү куркынычын дифференциациялә бәяләү алгоритмын булдыру.

**Материаллар һәм методлар.** Интернетка бәйлелек үсешенең клиник-психопатологик, клиник-динамик, психологик, психометрик үзенчәлекләрен һәм куркыныч факторларын өйрәнү 69 пациентны ачык тикшерү кысаларында үткәрелде: аларның 39 сының уен формасы (Иф), 30 сының азарт формасы (Иф). Контроль төркем (КГ) шартлы рәвештә сәламәт булган 40 ирекле хезмәткәрдән тора. Төп тикшеренү методлары сыйфатында клиник, психологик һәм психометрик, өстәмә метод буларак — генетик методлар кулланганнар. Мәгълүматларны статистик эшкәртүне Шапиро–Уилк, Колмогоров–Смирнов, студентның t-критерие, уэлчның t-критерие, Маннның U-критерие–Уитни критерийларын кулланып башкарганнар.

**Нәтижә.** Беренче тапкыр ике төп форманы чагыштыру контекстында (ИЗФ һәм ИЗФФ) пациентларның шәхси, морфофункциональ һәм җенси үзенчәлекләре турында мәгълүматлар анализланды. Ачыкланган характеристикалар интернет-аддикциянең төрле формаларына карата бәйлелек үсеше куркынычы күзлегеннән каралды. Алынган мәгълүматларны анализлау нигезендә тулаем интернет-бәйлелек һәм аның аерым формалары үсеше куркынычын бәяләүче математик модельләр эшләнде, бу куркыныч төркемнәрен билгеләргә һәм профилактик чараларны ачыкларга мөмкинлек бирә.

**Нәтижә.** Интернет-бәйлелек формалаштыру куркынычын дифференциациялә бәяләү алгоритмы төзелде.

**Төп сүзләр:** интернет-бәйлелек; уен бәйлелегенең уен формасы; уен бәйлелегенең азартлы (комарлы) формасы; үсеш куркынычы факторлары; куркынычлылык төркемнәре.

## Өземтәләр ясау өчен:

Сидоров А.А., Солдаткин В.А., Кибитов А.О. Интернет-бәйлелек үсеше куркынычы төркемнәре // Неврология хәбәрләре. 2024. Т. 56, № 4. 355–367 б.

DOI: <https://doi.org/10.17816/nb629858>

## BACKGROUND

The rapid development of the digital environment is associated with numerous opportunities, new hobbies and ways of spending time, and new internet-based professions [1]. Considering the trends for global development and the massive spread of internet-based technologies, close attention of researchers to the development of internet addiction disorder as a type of behavioral addiction is justified and relevant. Today, socialization is facilitated and affected by developing digital technologies, representing technological and sociocultural changes in the modern world, a new information culture, which has various consequences, both positive and negative [2–5].

Searching for ways and means of overcoming frustration and resolving conflicts and liberation from painful experiences of psychosocial maladjustment, a person can choose one of three ways: constructive, sublimation-creative, or illusory-compensatory. Agreeing with Korolenko et al. [5], Bukhanovsky et al. [3], and Soldatkin et al. [6], we should recognize that the third way is the easiest and associated with the development of addiction. Personality-related, biological (neurophysiological, gender-related), psychological, social, and other (predisposing) characteristics form the basis for “choosing” internet addiction. Given the ongoing development of the digital environment and the problems that follow this process, one of which is the risk of developing internet addiction, it is justified to study predisposing factors for this disorder. Considering the scarce literature on the differences between the types of internet addiction (IA) and their predominant consideration only as one of the forms (gambling or gaming addiction), it seems relevant to study personality-related, psychological, morphofunctional, genetic, and other characteristics of patients in the context of comparing IA types to develop targeted prevention programs. We assessed these two forms of IA because they have the highest prevalence and medical and social significance [6–8]. A thorough assessment of characteristics of patients diagnosed with IA or at risk of developing IA can be used to develop effective sociopsychological and psychopedagogical preventive programs and improve psychotherapeutic approaches for such categories of patients. Detailed clinical evaluation of various factors that promote internet addiction may contribute to a holistic view of this disorder and allow for a better understanding of all its aspects. It is important to study those predisposing factors that will allow expanding the range of preventive interventions and adjust therapeutic objectives.

Study objectives:

- 1) To study morphofunctional predisposition to internet addiction (IA), comparing internet gaming addiction (IGA) and online gambling addiction (OGA).
- 2) To study personality-related predisposition to IA, comparing IGA and OGA.
- 3) To study gender-related predisposition to IA, comparing IGA and OGA.
- 4) To develop a mathematical model for differential risk assessment for developing IA.

## MATERIALS AND METHODS

Clinical psychopathological, clinical dynamic, psychological, and psychometric characteristics and risk factors for the development of IA were assessed in an open-label study in 69 patients with IA. The control group included 40 apparently healthy volunteers. The study criteria are shown in Table 1.

The overall study design with study procedures at study stages A and B is shown in Table 2.

Patients who sought help at the Department of Psychiatry and Narcology of Rostov State Medical University due to internet abuse were invited to participate in the study. After their eligibility was established by the inclusion and exclusion criteria, 69 patients were included in the main group (patients with IA), with 50 men and 19 women. Patients of the main group were distributed to two subgroups, OGA and IGA. The OGA subgroup included 30 men; the IGA subgroup included 20 men and 19 women. The age of patients with IGA and OGA was 21 (Me;  $Q_1$ – $Q_3$ =16–24) and 26 (Me;  $Q_1$ – $Q_3$ =24–28), respectively. Patients who had reached the age of 15 provided information independently, and, if necessary, data were clarified with their legal representatives; for patients under the age of 15, information was obtained from their legal representatives.

The control group included gender-matched and age-matched volunteers who presented no complaints or history of psychiatric disorders. They underwent MINI testing, and absence of history of psychiatric disorders was verified, after which they were included in the control group for the study. The control group included 27 men and 13 women (age: Me=22,  $Q_1$ – $Q_3$ =20–24).

After stage B, the clinical diagnosis was established for the patients received, and they were assigned to subgroups of the main group as follows:

- IGA: F63.8 Other habit and impulse disorders;
- OGA: F63.0 Pathological gambling.

The following psychometric scales were used as psychological testing tools: Chen Internet Addiction Scale (CIAS); Alcohol Use Disorders Identification Test (AUDIT); Symptom Checklist-90-Revised (SCL-90-R); Beck Depression Inventory (BDI); Hospital Anxiety and Depression Scale (HADS); Prodromal Questionnaire-16 (PQ-16); Childhood Trauma Questionnaire (CTQ); Adverse Childhood Experiences International Questionnaire (ACE-IQ); Cloninger Temperament Character Inventory (TCI-125); Barratt Impulsiveness Scale (BIS); Buss-Perry Aggression Questionnaire (BPAQ); Ten-Item Personality Inventory (TIPI-RU) of the five-factor model; Positive and Negative Affect Schedule (PANAS); Gross and John Emotion Regulation Questionnaire (ERQ); Liebowitz Social Anxiety Scale; Fear of Negative Evaluation Scale; Columbia Suicide Severity Scale (C-SSRS); Dissociative Experience Scale (DES); Toronto Alexithymia Scale (TAS-26); Ways of Coping Questionnaire (WCQ).

Table 1. Criteria

Group	Eligibility criteria	Withdrawal criteria
Pure GA (n=39)	1. Diagnosed with GA (Other habit and impulse disorders, ICD-10 F63.8), age: 14 to 30, both sexes. The diagnosis was verified by checking the clinical findings to meet: a) Psychophysical addiction and altered reactivity syndrome (Pyatnitskaya, 2004); b) Brown-Griffiths criteria. 2. CIAS score is higher than 65.	
Gambling GA (n=30)	1. Diagnosed with GA (Pathological gambling, ICD-10 F63.0), age: 14–30, both sexes. The diagnosis was verified by checking the clinical findings to meet: a) Psychophysical addiction and altered reactivity syndrome (Pyatnitskaya, 2004); b) Brown-Griffiths criteria. 2. CIAS score is higher than 65.	A decompensated somatoneurological and/or (or, for CG) mental illness
CG (n=40)	Healthy males and females aged 14–30 who have not sought medical advice for mental illness, and consider themselves mentally and physically healthy	

Note. GA — gaming addiction; Pure GA — gaming type of GA; Gambling GA — gambling type of GA; CG — control group.

Table 2. Study design

Stage	Steps
A	Signing the patient’s informed consent form
	Assessment of eligibility criteria, including the diagnosis of the addiction and altered reactivity syndrome, its verification using Brown-Griffiths criteria, comparison with general ICD-10 criteria (Habit and impulse disorders)
	Assessment of withdrawal criteria
	Ruling in/ruling out the Internet addiction. If it is confirmed, inclusion of the patient in the study group (Pure GA or Gambling GA)
B	Past history ( <i>Anamnesis vitae</i> ): <ul style="list-style-type: none"><li>• Hereditary burden;</li><li>• Course of pregnancy and birth;</li><li>• Infancy, childhood, and adolescence aspects;</li><li>• Family relationship and upbringing;</li><li>• Social / professional status.</li></ul>
	Past medical history ( <i>Anamnesis morbi</i> )
	Concomitant treatment
	Substance abuse and addiction history
	GAS investigation and its classification by severity
	Determining the degree of progression
	MINI Structured Interview
	Sexual constitution assessment using Vasilchenko Scale
	Brain dominance type assessment
	Saliva sampling for genetic testing
	Psychometric test (by a doctor)

Note. GA — gaming addiction; Pure GA — gaming type of GA; Gambling GA — gambling type of GA; CG — control group; GAS — General Addiction Syndrome.

As an additional research method, we chose genetic testing. It was carried out in the Molecular Genetics Laboratory of the Narcology National Research Center, a branch of V.P. Serbsky National Medical Research Center of Psychiatry and Narcology (Moscow), funded as part of research project No. 18-29-22079 by a grant from the Russian Foundation for Basic Research.

Quantitative parameters were assessed for normal distribution using the Shapiro–Wilk and Kolmogorov–Smirnov

tests. Quantitative parameters with normal distribution were described using arithmetic mean (M) and standard deviation (SD) and boundaries of the 95% confidence interval (95% CI). Non-normally distributed quantitative parameters were described with median (Me) and lower and upper quartiles (Q1–Q3).

Categorical data were described using absolute values and percentages. Quantitative parameters with normal distribution were compared using the Student’s t-test (with

equal variances) or Welch's t-test (with unequal variances). Quantitative parameters with non-normal distribution were compared between the groups using the Mann–Whitney U test.

Comparison of percentages in the analysis of 2×2 contingency tables was performed using the Pearson's chi-squared test and Fisher's exact test. The direction and strength of the correlation between two quantitative parameters were assessed using Pearson correlation coefficient. A prognostic model to characterize the dependence of a quantitative variable on factors was developed using the linear regression method.

The power of the study (at least 80%) was calculated considering statistical recommendations [8, 9]. The required sample size was determined using a nomogram to obtain a study power of 80%. The study sample was sufficient to conduct the study.

## RESULTS AND DISCUSSION

Each component of the predisposition to IA was considered in the context of comparison of IGA and OGA.

### A. Morphofunctional component of predisposition to internet addiction

It was defined as a set of various characteristics identified in the study subjects using clinical psychopathological and additional methods (i.e. genetic testing and functional brain asymmetry profiling) (Table 3).

A review of clinical characteristics showed statistically significant differences between the groups in a history of traumatic brain injury (TBI). In the OGA group, TBI was more frequent than in the control group ( $p_{2-3}=0.045283$ ). Also, history of various surgery types performed under inhalation/non-inhalation anesthesia were more frequent in the OGA

**Table 3.** Past history of patients in the study group and respondents in the control group

Indicators	Category	Study groups			<i>p</i>
		Pure GA ( <i>n</i> =39)	Gambling GA ( <i>n</i> =30)	CG ( <i>n</i> =40)	
Prior brain injur	No	34 (87.2)	22 (73.3)	37 (92.5)	$p_{1-2}=0.214766$
	Yes	5 (12.8)	8 (26.7)	3 (7.5)	$p_{1-3}=0.711466$ $p_{2-3}=0.045283^*$
Surgeries	No	27 (69.2)	17 (56.7)	33 (82.5)	$p_{1-2}=0.281772$
	Yes	12 (30.8)	13 (43.3)	7 (17.5)	$p_{1-3}=0.291361$ $p_{2-3}=0.017901^*$
Prior infections and intoxications	No	29 (74.4)	29 (96.7)	37 (92.5)	$p_{1-2}=0.017862^*$
	Yes	10 (25.6)	1 (3.3)	3 (7.5)	$p_{1-3}=0.065422$ $p_{2-3}=0.629947$
Birth	At term	34 (87.2)	28 (93.3)	38 (95.0)	$p_{1-2}=0.690481$
	Pre-term	5 (12.8)	2 (6.7)	2 (5.0)	$p_{1-3}=0.430946$ $p_{2-3}=1.0$
Pregnancy	Normal	34 (87.2)	28 (93.3)	38 (95.0)	$p_{1-2}=0.690481$
	At-risk	5 (12.8)	2 (6.7)	2 (5.0)	$p_{1-3}=0.430946$ $p_{2-3}=1.0$
Maternal illnesses during pregnancy	None	38 (97.4)	30 (100.0)	40 (100.0)	$p_{1-2}=1.0$
	Medical condition	1 (2.6)	0 (0.0)	0 (0.0)	$p_{1-3}=1.0$ $p_{2-3}=1.0$
Birth complications	No	37 (94.9)	29 (96.7)	39 (97.5)	$p_{1-2}=1.0$
	Yes	2 (5.1)	1 (3.3)	1 (2.5)	$p_{1-3}=1.0$ $p_{2-3}=1.0$
Infancy	Normal	37 (94.9)	27 (90.0)	37 (94.9)	$p_{1-2}=0.646264$
	Developmental arrest	2 (5.1)	3 (10.0)	2 (5.1)	$p_{1-3}=1.0$ $p_{2-3}=0.646264$
Childhood	Normal	35 (89.7)	27 (90.0)	38 (95.0)	$p_{1-2}=1.0$
	Developmental arrest	4 (10.3)	3 (10.0)	2 (5.0)	$p_{1-3}=0.674827$ $p_{2-3}=0.644898$
Puberty	Normal	22 (56.4)	21 (70.0)	37 (92.5)	$p_{1-2}=0.248171$
	Adolescent crisis	17 (43.6)	9 (30.0)	3 (7.5)	$p_{1-3}=0.000120^*$ $p_{2-3}=0.022747^*$

Note. GA — gaming addiction; Pure GA — gaming type of GA; Gambling GA — gambling type of GA; CG — control group; \* Differences in indicators are significant ( $p < 0.05$ ), method: Pearson's chi-squared test.



group ( $p_{2-3}=0.017901$ ). However, no such differences were observed between the subgroups of the main group.

Compared with the control group, adolescence crisis, e.g., maladjustment in the family, affective reactions such as irritability and oppositional behavior, was more common in patients with IA ( $p_{1-3}=0.000120$ ;  $p_{2-3}=0.022747$ ). It was observed in 30.0% of patients with OGA and in 43.6% of patients with IGA. According to medical history data, puberty was associated with the sharpening of character traits and a slight increase in aggressiveness towards others only in 7.5% of respondents in the control group ( $n=3$ ).

Tobacco smoking was another characteristic that different in the study groups and main subgroups. Smoking was more frequent in patients with OGA, with odds differences between the IGA and OGA subgroups: patients with OGA were 4.8 times more likely to smoke tobacco (95% CI: 1.559–14.860).

The results demonstrated a combination of chemical and non-chemical addictions, confirming the concept of universal addictive behavior disorder. The morphofunctional predisposition was studied using genetic testing, which demonstrated statistically significant differences in frequencies of genotypes and alleles for polymorphic variants of genes between the main and control groups:

1) *SLC6A3* gene (*DAT1*), 40 bp VNTR exon 3 polymorphism (*DAT40*): differences between IGA and OGA subgroups were found in genotype subtypes [ $\chi^2_3(p)=7.3$  (0.026)] and allele frequencies [ $\chi^2_3(p)=5.45$  (0.019)].

2) Dopamine receptor D2 (*DRD2*) (rs6277), rs6277 polymorphism (*C957T*, *DRD2* 957): differences in genotypes were found between IGA and OGA subgroups, with  $\chi^2_3(p)=6.18$  (0.045). Its possible role can be explained by neurotransmitter processes common to different types of addiction (chemical and non-chemical), which reflect the influence of the reward system (dopaminergic neurotransmission). Also, it could be determined, in the form of a trend to significant differences, by the influence of the neurotrophin and GABA-glutamate systems on dopaminergic neurotransmission (although the latter requires further study and clarification), which can contribute to theoretical assumptions about dopaminergic neurotransmission and other systems as a common stage in the development of both chemical and non-chemical addiction, including IA.

Identified genetically determined features of the neurotransmission systems are represented by the following differences:

1) When alleles and genotypes of the *SLC6A3* (*DAT1*) gene were compared for 40 bp VNTR exon 3 (*DAT40*) polymorphism, differences were found in genotype and allele frequencies, demonstrating an association of the polymorphism with OGA.

2) When alleles and genotypes of the dopamine receptor D2 gene (*DRD2*) (rs6277) were compared for rs6277 polymorphism (*C957T*, *DRD2* 957), differences were found in genotype frequencies, demonstrating an association of the polymorphism with IGA (Table 4).

These genetic features form a predisposing basis for the patterns identified in patients of the main group during adolescence, such as adolescence crisis (maladjustment in the family, affective reactions such as irritability and oppositional behavior). In our opinion, nicotine addiction, which was more common in patients of the main group, is associated with the genetic patterns identified in the dopaminergic neurotransmission systems, GABA-glutamate system, and opioid system.

Data on the active involvement of the brain reward system in the pathogenesis of IA manifesting as particular functioning patterns of dopaminergic neurotransmission and it being a genetic IA risk marker were consistent and, therefore, confirmed. These genetic features may be considered a basis for identified individual features of adolescence and alcohol and tobacco use, which, in the context of the study, determines a relationship between various forms of addiction, both chemical and non-chemical.

## B. Gender-related component of predisposition to internet addiction

Based on the comparative study of gender-related predisposition, statistically significant differences were found between men and women in the Vasilchenko sexual constitution score (the overall score was higher in men) and clinical severity of IA based on the overall score of major substance addiction syndrome and Brown-Griffiths score. Results of our study are consistent with previous data on the role of the gender factor as a predisposing component of IA. Weak sexual constitution is a significant predisposing factor for IGA (Me=4; Q<sub>1</sub>–Q<sub>3</sub>=4–5). In the OGA group, “somewhat weak” sexual constitution was detected more often (Me=5; Q<sub>1</sub>–Q<sub>3</sub>=5–6). Differences in the subgroups were statistically significant ( $p=0.0001$ ).

## C. Personality-related component of predisposition to IA

The comprehensive review of predisposing factors for IA development also included personality-related and psychological characteristics, which were evaluated using a combination of methods such as clinical (medical history collection and analysis) and psychometric ones (psychometric scales and questionnaires).

We identified several individual social and communicative characteristics that were typical of patients in the main group and that differed in the subgroups (IGA and OGA).

Patients with IGA more often ( $p=0.005$ ) than respondents in the control group described their family relationships as “tense” (“tension” and “extreme tension” were parameters indicative of subjective assessment of intra-family relationships characterized by conflicts between family members, i.e. parents and children), with “emotional rejection” identified as a parenting style (7 subjects, 15.6%). The vast majority of patients with IGA were brought up with

**Table 4.** Genotype and allele frequencies for polymorphic variants of genes

Gene, genotype, allele	Study groups				
	CG, abs. (%)	Pure GA, abs (%)	$\chi^2_1(p)$	Gambling GA, abs. (%)	$\chi^2_1(p)$
<i>DAT VNTR 40 bp</i>					
10/10	17 (47.2)	22 (66.7)		5 (27.8)	
10/9	17 (47.2)	10 (30.3)	2.66 (0.26)	11 (61.1)	1.19 (0.13)
9/9	2 (5.6)	1 (3.0)		2 (11.1)	
Allele 10	0.71	0.81	—	0.58	—
Allele 9	0.29	0.19	—	0.42	—
$\chi^2_2(p)$	—	1.72 (0.19)	—	1.17 (0.28)	—
$\chi^2_3(p)$	—	Genotypes: 7.3 (0.026)*		Alleles: 5.45 (0.019)*	
<i>TH rs6356</i>					
CC	15 (38.5)	8 (21.0)		4 (22.2)	
CT	14 (35.9)	24 (63.2)	5.75 (0.056)**	11 (61.1)	3.19 (0.2)
TT	10 (25.6)	6 (15.8)		3 (16.7)	
Allele C	0.56	0.53	—	0.53	—
Allele T	0.44	0.47	—	0.47	—
$\chi^2_2(p)$	—	0.09 (0.76)	—	0.03 (0.87)	—
$\chi^2_3(p)$	—	Genotypes: 0.02 (0.99)		Alleles: 0 (0.99)	
<i>DRD2 rs6277</i>					
GG	13 (32.5)	9 (23.7)		7 (36.8)	
GA	19 (47.5)	19 (50.0)	0.894 (0.63)	12 (63.2)	4.47 (0.11)
AA	8 (20.0)	10 (26.3)		0 (0.0)	
Allele G	0.56	0.49	—	0.68	—
Allele A	0.44	0.51	—	0.32	—
$\chi^2_2(p)$	—	0.62 (0.43)	—	1.12 (0.29)	—
$\chi^2_3(p)$	—	Genotypes: 6.18 (0.045)*		Alleles: 3.23 (0.07)**	
<i>GABRA6 rs3219151</i>					
TT	10 (26.3)	13 (34.2)		11 (57.9)	
TC	20 (52.6)	18 (47.4)	0.56 (0.75)	6 (31.6)	5.46 (0.065)**
CC	8 (21.1)	7 (18.4)		2 (10.5)	
Allele T	0.53	0.58	—	0.74	—
Allele C	0.47	0.42	—	0.26	—
$\chi^2_2(p)$	—	0.24 (0.62)	—	3.83 (0.0503)**	—
$\chi^2_3(p)$	—	Genotypes: 2.94 (0.23)		Alleles: 2.08 (0.15)	
<i>OPRK1 rs6473797</i>					
TT	20 (51.3)	17 (43.6)		14 (70.0)	
TC	15 (38.5)	19 (48.7)	0.86 (0.65)	6 (30.0)	3.12 (0.21)
CC	4 (10.2)	3 (7.7)		0 (0.0)	
Allele T	0.71	0.68	—	0.85	—
Allele C	0.29	0.32	—	0.15	—
$\chi^2_2(p)$	—	0.03 (0.86)	—	2.26 (0.13)	—
$\chi^2_3(p)$	—	Genotypes: 4.39 (0.11)		Alleles: 3.14 (0.077)**	

Note. Pure GA — gaming type of GA; Gambling GA — gambling type of GA; CG — control group; \* Differences in indicators are significant ( $p < 0.05$ ), method: Hardy–Weinberg equilibrium test; \*\*  $p$  values tend to be significant, method: Hardy–Weinberg equilibrium test;  $\chi^2_1$ , genotype frequencies compared with the CG;  $\chi^2_2$ , allele frequencies compared with the CG;  $\chi^2_3$ , comparison of Pure GA and Gambling GA groups.



underprotective parenting (15 subjects, 33.3%) or indulging overprotective parenting (14 subjects, 31.1%). During their school years, 17.9% of patients in the IGA group were bullied.

Personality characteristics were represented by introversion (33 subjects, 84.6%); the predominant type of character accentuation was schizoid (11 subjects, 28.2%) and psychasthenic (8 subjects, 20.5%).

According to the CIAS scores, the most common psychological characteristics in patients with IGA were negative emotionality, fear of negative evaluation, risk of developing psychotic states (PQ scale), subclinical depression, and dissociation.

Most patients with OGA described their family relationships as normal (24 subjects, 80.0%). In the families of patients with OGA, the predominant parenting style was underprotection (10 subjects, 34.5%) and indulgent overprotection (10 subjects, 34.5%), with no emotional rejection as a parenting style in any patient.

Personality characteristics were represented by extraversion (24 subjects, 80.0%); the predominant type of character accentuation was hyperthymic (10 subjects, 33.3%), unstable (6 subjects, 20.0%), and conformist (6 subjects, 20.0%).

In patients with OGA, the most common psychological characteristics included greater severity of tolerance symptoms, more pronounced and intense intrapersonal and health problems, more pronounced key symptoms of IA (CIAS scores), suppression of expression, impulse control disorder, and physical aggression.

Summarizing results the psychological and psychometric tests, we should highlight several individual characteristics of patients with IA that distinguish them from the respondents of the control group. The results are demonstrated in comparative Table 5.

Our data on predisposition components to IA (i.e. morphological, gender-related, personality-related, and psychological components) allows us to conclude that IA has common patterns and features with other types of chemical and non-chemical addiction.

The differences are shown in Fig. 1.

The analysis of the parameters allows us to identify a number of genetic, personality-related, and psychological characteristics of patients with IA, as well as differences between the IGA and OGA subgroups.

It seems reasonable to integrate our data in line with the concept of Aleksandrovsky [10] on the mental adaptation barrier: biological (morphofunctional) predisposition to IA development, which is determined by the significance of the gender-related and genetic components, together with the personality-related and psychological component is a significant factor for changes in the functioning of the mental adaptation barrier.

The genetic component is central in the development of the biological basis for the mental adaptation barrier. Key parameters of homeostatic mechanisms in humans complete their development in the first period of postnatal ontogenesis. After that, in the absence of painful interventions, they do not tend to undergo dramatic changes, although quite pronounced shifts may occur in the functional activity of various biological mechanisms during critical age periods (such as puberty or sexual involution).

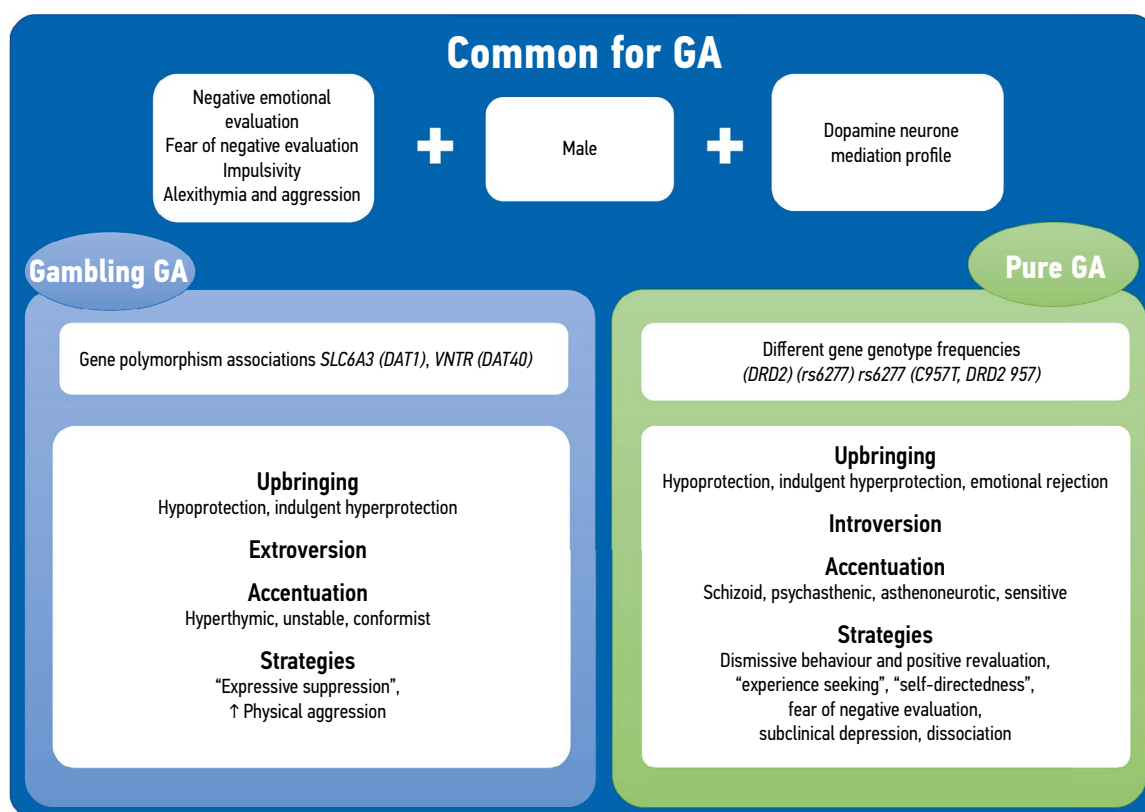
Agreeing with the author's position that the biological basis of the adaptation barrier merely creates natural opportunities for its functional activity, we believe that this barrier cannot be formed and exist without its second basis (i.e. social one); we should highlight the influence of the second component on the development of both forms of IA (IGA and OGA).

The social factor includes social interaction aspects — for patients with IA it is associated with problems in social interaction or interpersonal relationships — and individual personality traits. For patients with IGA, this includes subjective “tension” of intra-family relationships; introversion; prevalence of underprotection and indulgent overprotection as parenting styles, with emotional rejection in some respondents; bullying by peers during school years; schizoid, psychasthenic, asthenoneurotic, and sensitive types of character accentuation; “openness” as

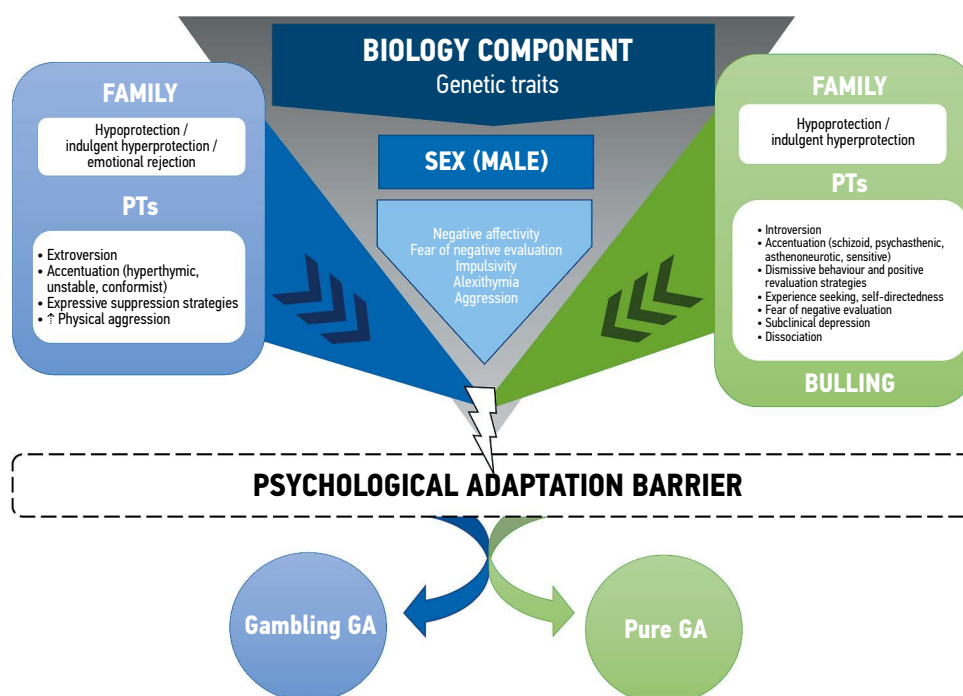
**Table 5.** Personality and psychological components of predisposition to gaming addiction

Indicators	Study subpopulations	
	Gambling GA (n=30)	Pure GA (n=39)
Common for GA Group (n=69)	Signs of alexithymia; increased impulsivity, impulse control issues; psychopathological symptoms and psychosis risk; increased hostility, physical aggression and anger; detectable negative affectivity; personality traits, including experience seeking and transcendentality; fear of negative evaluation; social interaction and interpersonal relationship issues	
Personality	Extroversion	Introversion
Upbringing	Hypoprotection, indulgent hyperprotection	Hypoprotection, indulgent hyperprotection, emotional rejection
Accentuation	Hyperthymic, unstable, conformist	Schizoid, psychasthenic, asthenoneurotic, sensitive
Strategies	Expressive suppression	Dismissive behaviour, positive revaluation
Additional	↑ Physical aggression	Subclinical anxiety, dissociation, fear of negative evaluation, experience seeking, self-directedness

Note. GA — gaming addiction; Pure GA — gaming type of GA; Gambling GA — gambling type of GA; ↑ — increased score.



**Fig. 1.** Pure GA and Gambling GA predisposition factors: GA — gaming addiction; Pure GA — gaming type of GA; Gambling GA — gambling type of GA.



**Fig. 2.** Gambling addiction (GA) predisposition components: Pure GA — gaming type of GA; Gambling GA — gambling type of GA; PTs — personality traits.

one of the personality characteristics, “self-directedness” as a characterological trait; fear of negative evaluation; prevalence of distancing strategies and positive reappraisal; subclinical depression; dissociation. For patients with OGA this includes extraversion; predominance of hyperthymic,

unstable, and conformist types of character accentuation; more frequent use of the “suppression of expression” strategy; higher rates of physical aggression.

Long-term and especially sharp increases in functional activity of the mental adaptation barrier can lead to distress.

This is manifested by pre-neurotic conditions, which are characterized by minor disturbances such as increased sensitivity to common irritants, anxiety, restlessness, inhibition or fussiness in behavior, insomnia, and other symptoms. They do not change the purposefulness of behavior and the adequacy of affect and are rather temporary and local.

If the pressure on the mental adaptation barrier continues to increase and its reserve capacity is exhausted, a “breakthrough” of the barrier occurs, disrupting its integrity. Functional activity continues to be determined by previous parameters but the disrupted integrity reduces the capabilities of mental adaptation. This mechanism allows us to understand the role of identified non-fatal predisposition factors, which can lead to the mental adaptation barrier overstrain and, as a result, its breakdown. Timely identification of the factors allows determining IA risk groups and preventing the influence of maladjustment on the mental adaptation barrier. The resulting barrier maladjustment is a stage in the AI development. The predisposition components that lead to the “breakdown” of the mental adaptation barrier are clearly demonstrated in Fig. 2.

Further mathematical analysis of the parameters that demonstrated statistical differences between the IGA and OGA subgroups allowed us to select risk factors such as temperament parameters (introversion/extraversion), the age of onset of binge gambling and the total score of the altered reactivity syndrome (model 1, which demonstrated overall high statistical significance: chi-squared test 60.9;  $p < 0.000001$ ) or the total score of the Brown–Griffiths scale (model 2, which demonstrated overall high statistical significance: chi-squared test 54.2;  $p < 0.000001$ ). Based on the mathematical analysis, two models of differentiated classification of patients with IA into IGA and OGA subgroups were developed and tested.

## CONCLUSION

1. Morphofunctional predisposition to IA includes genetic aspects related primarily to dopamine neurotransmission. Differences between IGA and OGA include polymorphism when comparing gene alleles and genotypes *SLC6A3* (*DAT1*), *VNTR* (*DAT40*). For IGA, differences were found in the frequencies of the dopamine receptor D2 gene genotypes (*DRD2*) (*rs6277*), i.e. *rs6277* (*C957T*, *DRD2 957*) polymorphism.

2. Personality-related and psychological predisposition is characterized by the following:

a: Personality-related predisposition to IA is a combination of such factors as relationships in the family (“tense” according to the subjective assessment of respondents), parenting style (predominance of underprotection, indulgent overprotection, with emotional rejection in some respondents; indulgent overprotection and underprotection in patients with OGA), history of bullying, problems with intrasocial interaction;

b: Psychological predisposition is represented by negative emotionality, fear of negative evaluation, alexithymia (possible or obvious), impulsivity;

c: Differences in subgroups were demonstrated in temperament features (extraversion for OGA and introversion for IGA). Patients with IGA had schizoid and psychasthenic types of character accentuation, preferred distancing ( $M \pm SD = 53 \pm 15$ ) and positive reappraisal ( $M \pm SD = 48 \pm 10$ ) as coping strategies, and demonstrated subclinical depression and dissociation ( $Me = 54$ ). Patients with OGA had hyperthymic, unstable, and conformist types, greater severity of tolerance symptoms, intrapersonal problems and health problems; physical aggression ( $Me = 22$ );

3. Gender-related predisposition to IA, namely, male gender and “somewhat weak” sexual constitution in patients with IGA ( $Me = 4$ ), “moderate” sexual constitution in patients with OGA ( $Me = 5$ );

4. Highly sensitive and specific mathematical models were developed, allowing screening with a wide coverage of respondents and differentiating patients diagnosed with IA into two the OGA and IGA subgroups.

## ADDITIONAL INFORMATION

**Funding source.** The study has been supported by Russian Foundation for Basic Research within the framework of scientific project No. 18-29-22079.

**Competing interests.** The authors declare that there is no conflict of interest.

**Authors’ contribution.** Thereby, all authors confirm that their authorship complies with the international ICMJE criteria (all authors have made a significant contribution to the development of the concept, research, and preparation of the article, as well as read and approved the final version before its publication).

**Ethics approval.** The protocol of the study was approved by the local Ethics Committee of the Rostov State Medical University No. 16/19 at 17/10/2019.

**Consent for publication.** Written consent was obtained from the patients for publication of relevant medical information and all accompanying images within the manuscript.

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## AUTHORS' INFO

### \* Alexey A. Sidorov;

address: 29 Nakhichevansky Ave., 344022 Rostov-on-Don, Russia;  
ORCID: 0000-0001-6039-4089;  
eLibrary SPIN: 9655-6360;  
e-mail: alexe7890@mail.ru

### Victor A. Soldatkin, MD, Dr. Sci. (Medicine);

ORCID: 0000-0002-0222-3414;  
eLibrary SPIN: 8608-9020;  
e-mail: sva-rostov@mail.ru

### Alexander O. Kibitov, MD, Dr. Sci. (Medicine);

ORCID: 0000-0002-8771-625X;  
eLibrary SPIN: 3718-6729;  
e-mail: druggen@mail.ru

## ОБ АВТОРАХ

### \* Алексей Алексеевич Сидоров;

адрес: Россия, 344022, Ростов-на-Дону, пер. Нахичеванский, д. 29;  
ORCID: 0000-0001-6039-4089;  
eLibrary SPIN: 9655-6360;  
e-mail: alexe7890@mail.ru

### Виктор Александрович Солдаткин, д-р мед. наук;

ORCID: 0000-0002-0222-3414;  
eLibrary SPIN: 8608-9020;  
e-mail: sva-rostov@mail.ru

### Александр Олегович Кибитов, д-р мед. наук;

ORCID: 0000-0002-8771-625X;  
eLibrary SPIN: 3718-6729;  
e-mail: druggen@mail.ru

\* Corresponding author / Автор, ответственный за переписку