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Article

Internet addiction and sleep problems among Russian adolescents: a field school-based study

Sergey Tereshchenko [1,*], Edward Kasparov [1], Marina Smolnikova [1], Margarita Shubina [1], Nina Gorbacheva [1] and Olga Moskalenko [1]

[1] Federal Research Center "Krasnoyarsk Science Center of the Siberian Branch of the Russian Academy of Sciences", Research Institute of Medical Problems of the North, Krasnoyarsk, Russian Federation; impn@imppn.ru

* Correspondence: legise@mail.ru; Tel.: +7(391)228-06-62

Abstract: This study aims to establish a link between disturbances in the night sleep habitus, quality of sleep, and daytime sleepiness in adolescents with Internet addiction and different types of content consumed. Methods: This is a cross-sectional observational study of a school sample in three large cities in Central Siberia. 4,615 schoolchildren of 12–18 years old were examined. The Russian-language versions of the Chen Internet Addiction Scale, the Game Addiction Scale for Adolescents, and the Social Media Disorder Scale were used to identify Internet addiction. Questions from the Pittsburgh Sleep Quality Index questionnaire were used to assess nighttime sleep. Daytime sleepiness was assessed using the Pediatric Daytime Sleepiness Scale questionnaire. Results: Adolescents with Internet addiction go to bed and wake up late; they are characterized by a decrease in the duration of nighttime sleep, an increase in sleep onset latency, and frequent nighttime awakenings, as well as more pronounced daytime sleepiness. Among the sleep parameters studied, the indicators of daytime sleepiness and night awakening scales have the highest effect size in Internet-addicted adolescents, regardless of the media consumed. Conclusion: Internet-addicted adolescents are characterized by significant disturbances in the quality of nighttime sleep and excessive daytime sleepiness, which requires appropriate psychological correction.

Keywords: adolescents; Internet addiction; game addiction; social media addiction; sleep problems; daytime sleepiness

1. Introduction

The last two decades have been characterized by an avalanche-like increase in the prevalence of Internet use in all social groups, especially among adolescents and young adults [1]. In Russia, 80.9% of the population use the Internet, which is 16% of European users – the highest value among all European countries [2]. Moreover, over the past 10 years, the number of users has almost doubled – in 2010, the penetration of the Internet into the Russian population was only 42.8% [2]. A certain number of Internet users, mainly adolescents and young adults, develop Internet addiction (IA) or "pathological/compulsive use of the Internet", characterized by a loss of control over the time spent online, an obsessive craving for various types of Internet activities, which often becomes the catalyst for the formation of a wide range of psychosocial and psychosomatic problems.

In recent years, it has become apparent that excessive human interaction with information and communication technologies is becoming a major public health problem. In particular, it has been shown that IA in adolescents is associated with serious psychological disorders and social difficulties. A large number of studies have convincingly shown pronounced comorbidity of IA with a wide range of psychopathological conditions: impulsivity, depression, anxiety disorders, obsessive-compulsive disorder, social phobia, and aggressive behavior [3-5].

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Besides, there is growing evidence of a link between IA and various types of sleep disorders. In modern industrial society, filled with information flows and gadgets, IA is becoming one of the leading causes of the development and increase in the severity of sleep disorders [6], including among adolescents [7]. A large number of studies show a pronounced mutual influence of IA and sleep disorders. Thus, excessive time spent online reduces the required night sleep of schoolchildren [8], is associated with going to bed later [9], various night sleep problems [6,10], including insomnia [11], as well as weakness [12] and sleepiness during the day [13]. It has been shown that exposure to light from monitors, especially the blue spectrum, is related to the suppression of melatonin secretion and, probably, associated difficulties in falling asleep, which may exacerbate the pathological effect of excessive online time on night sleep [14,15].

Chen and Gau in their longitudinal study of schoolchildren based on the parental Sleep Habit Questionnaire showed an association of IA with insomnia, especially at the beginning and middle of nighttime sleep, with subsequent disturbance of the circadian rhythm [16]. It seems interesting that the authors established bi-directionality in the interaction of IA and night sleep disorders: initially, dyssomnia is a risk factor for addiction, and later, the already developed IA leads to a disruption of circadian rhythm. Kawabe et al. recorded the fact of going to sleep later and awakening later, a decrease in total sleep duration, and an increased general index of sleep problems according to the Child and Adolescent Sleep Checklist in adolescents with IA [7]. A large number of studies show a significant decrease in the quality of night sleep, verified using the Pittsburgh Sleep Quality Index (PSQI) questionnaire [17-21]. Besides, daytime sleepiness was increased in adolescents with IA [17-20].

There is a systematic review and pooled meta-analysis of studies on the relationship between IA and sleep disorders. In 2014, Lam, in his systematic review, demonstrated a significant amount of convincing evidence for the association of IA with sleep impairment and insomnia [10]. A recent (2019) meta-analysis of 23 studies in this direction, carried out by Alimoradi et al., quantitatively assessed the strength of such associations and showed a significant risk of dyssomnia in the case of IA (OR = 2.20; 1.77–2.74), as well as a significant reduction in night sleep [6].

The general prevalence of IA and its structure depending on the media consumed (dependence on video games/social networks), as well as the psychosomatic consequences of such dependence in Siberian adolescents, was previously presented by the authors in a series of publications [22-24]. It was shown that the prevalence of IA, verified by the Chen Internet Addiction Scale (CIAS) questionnaire, in adolescents from Krasnoyarsk was 6.8%, game addiction was more common in males, and addiction to social networks – in females. An association of IA with adolescent psychosocial problems was established and then verified using the Strengths and Difficulties Questionnaire developed by Goodman et al. A pronounced comorbidity of IA with recurrent cephalalgia, dorsalgia, and recurrent abdominal pain was demonstrated.

This study aims to establish a link between disturbances in the nightly sleep schedule, quality of sleep, and daytime sleepiness in adolescents with Internet addiction and different types of media consumed.

2. Materials and Methods

This is a single-point cross-sectional observational study unbiased school sample in three large cities in Siberia. The research subjects were adolescents aged 12–18 years old (46.2% were male and 53.8% were female, the average age – 14.58 ± 0.02 years old) – students of 10 general education schools in Krasnoyarsk (n=3084), 4 general education institutions in Abakan (n=1314), and 2 general education schools in Kyzyl (n=217). The study was approved by the Ethics Committee of the Federal Research Center "Krasnoyarsk Science Center of the Siberian Branch of the Russian Academy of Sciences".

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The internationally accepted CIAS scale [25], adapted by Malygin and Feklisov [26] was used to study the presence of Internet-addictive behavior. The CIAS covers five symptomatic criteria for addictive behavior, which include compulsive symptoms, withdrawal symptoms, signs of tolerance, psychological or physical problems, and difficulty in time management. The questionnaire includes 26 statements, each of which is assessed on the 4-Point Likert's Scale: "Not Suitable At All" (1 point), "Poorly Suitable" (2 points), "Partially Suitable" (3 points), and "Completely Suitable" (4 points). An overall CIAS score of 27 to 42 was assessed as adaptive Internet use; 43–64 points – maladaptive Internet use; 65 points and above – IA.

The analysis of the structure of content consumed by adolescents with IA was carried out using the Russian-language version of the questionnaire for assessing game addiction, "Game Addiction Scale for Adolescents" (GASA) [27] and the questionnaire of social network addiction, "The Social Media Disorder Scale" (SMDS) [28]. The questionnaire for assessing game addiction consists of 7 questions concerning behavioral disorders in adolescents caused by excessive interest in Internet games. Each of the questions is rated on the 5-Point Likert's Scale: "never" (0 points), "rarely" (1 point), "sometimes" (2 points), "often" (3 points), "very often" (4 points). A diagnosis of game addiction was made when the total score of 3–5 scales of the questionnaire was 12 points or more. The Social Media Addiction Questionnaire consists of 9 questions regarding behavioral disorders caused by the overuse of social media. Each question has two possible answers: "no" and "yes". For each "Yes" answer, 1 point is assigned. An overall score of 5 or more points indicates an addiction to social media.

To assess the quantitative and qualitative characteristics of night sleep, the authors used questions from the PSQI questionnaire. [29]. The adolescents were asked the following questions:

1. What time did you usually go to bed during the last month on school days (excluding weekends)?
2. How much time (how many minutes) did it usually take you to fall asleep (during the last month)?
3. What time did you usually wake up during the last month on school days (excluding weekends)?
4. During the past month, how often have you had trouble sleeping because you woke up in the middle of the night or in the morning?

The last question was estimated in points, the points were summed up to quantify the frequency of night awakenings:

- Not once within the last month – 0 points
- Less than once a week – 1 point
- Once or twice a week – 2 points
- Three or more times a week – 3 points.

To assess the degree of daytime sleepiness, the "Pediatric Daytime Sleepiness Scale" (PDSS) questionnaire developed by Drake et al. [30] was used. The questionnaire consists of 8 questions concerning daytime sleepiness. Each of the questions is evaluated on the 5-Point Likert Scale: "never" (0 points), "rarely" (1 point), "sometimes" (2 points), "often" (3 points), "very often" (4 points). The points of all questions, except the third one, are summed up with the direct score, the third question is scored in reverse. Higher values of the total score correspond to greater severity of daytime sleepiness.

Statistical analysis: The statistical analysis of the results obtained was carried out with the use of Statistica v.12.5 (Stat Soft Inc., USA). The distribution type was determined using the Shapiro-Wilk test. Student's t-test was used in the case of normal distribution in the comparison groups. In the absence of signs of normal distribution, the nonparametric Kruskal–Wallis H (for three comparison groups) and Mann–Whitney U (for pairwise comparison) tests were used to assess the differences in the groups. Effect size (Cohen's d) for Kruskal–Wallis H and Mann–Whitney U tests were calculated according to recommendations Fritz, Morris & Richler [31] with the public domain software

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https://www.psychometrica.de/effect_size.html. The comparison of groups by the qualitative binary feature was performed using the Pearson $\chi 2$ test. The data are presented as "arithmetic mean ± mean error" in the case of using parametric criteria and the median (25 quartile – 75 quartile) – in the case of using nonparametric criteria.

3. Results

The demographic characteristics for the sample of adolescents in this study and the main statistics of the IA parameters and sleep scores used in the study are presented in Table 1.

Prevalence IA according to CIAS assessment in our total sample was 7.1% with a higher rate in girls (p boys vs. girls < 0.001). Prevalences of Internet game addiction assessed by GASA and Social media addiction assessed by SMDS were 10.4% and 7.7%, respectively. Internet game addiction was more typical for boys than girls (15.6% vs. 5.9%, respectively, p<0.001) while Social media addiction was more typical for girls than boys (11.5% vs. 3.3%, respectively, p<0.001).

Since both the features of sleep schedule and the IA phenomenon have characteristic distinctive features depending on the age and sex of respondents in our and other samples [7, 16, 23], we carried out a separate analysis of sleep parameters in the groups of younger (12–14 years old) and older (15–18 years old) adolescents with additional sex stratification.

The results of the analysis of the relationship between the parameters of night sleep and daytime sleepiness with the general IA (undifferentiated by consumed content), verified by the CIAS questionnaire, are presented in Table 2. The data obtained indicate that adolescents with IA have pronounced features of qualitative and quantitative sleep characteristics for all the parameters selected for the analysis and in all age–sex groups.

Internet-addicted adolescents went to bed later and woke up later, but their total duration of nighttime sleep was significantly lower than that of adolescents with adaptive Internet use. At the same time, it was more difficult for adolescents with IA to fall asleep – sleep onset latency was statistically significantly increased in all analyzed groups. Moreover, they clearly showed symptoms of late insomnia – they woke up more often in the middle of the night and in the morning, which was recorded using the higher values of the night awakenings. These features of nighttime sleep in adolescents with IA were obviously accompanied by higher values of the daytime sleepiness scale calculated using the PDSS questionnaire.

Among sleep characteristics, the highest effect size exhibited the PDSS score with Cohen's d 0.7–0.8 in all age–sex groups. The second significant parameter was weekdays bedtime with Cohen's d 0.4–0.7, although an increase in the time of going to bed was accompanied by reductions in the total duration of night sleep with moderate Cohen's d (0.3–0.4) only in older adolescents.

Data on the relationship between sleep parameters and verified addictions to computer games and social networks are presented in Tables 3 and 4, respectively.

As in the case of using the CIAS questionnaire, the addiction had the greatest effect on the severity of daytime sleepiness, both for Internet game addiction (GASA questionnaire) and social media addiction (SMDS questionnaire). The presence of Internet game addiction had a greater impact on sleep parameters for boys, especially younger ones, with low-to-moderate Cohen's d (0.2–0.6). For example, the increase in the frequency of night awakenings was typical only for boys, but not for girls with Internet game addiction. Among Internet game overusers sleep onset latency increased only in younger (12–14 years old) adolescents, both in boys and girls. Social media addiction had practically no effect on the quantitative parameters of nighttime sleep in all age-sex groups and had a very weak effect on the qualitative characteristics of nighttime sleep. Among social media overusers the frequency of night awakenings increased in almost all age–sex groups with low Cohen's d (0.2); sleep onset latency was slightly increased only in girls but not in boys.

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Table 1. Descriptive statistics for major study variables.

Variables	All participants	Boys	Girls	p (Boys vs. Girls)
Age 12–14	2228	1009 (45.3%)	1219 (54.7%)	—
Age 15–18	2387	1125 (47.1 %)	1262 (52.9%)	—
Total	4615	2134 (46.2%)	2481 (53.8%)	—
		CIAS results (n=4615)		
Adaptive Internet use	2390 (51.8%)	1234 (57.8%)	1156 (46.6%)	<0.001
Maladaptive Internet use	1896 (41.1%)	788 (36.9%)	1108 (44.7%)	<0.001
Internet addiction	329 (7.1%)	112 (5.3%)	217 (8.8%)	<0.001
		GASA and SMDS results (n=4549)		
Internet game addiction	472 (10.4%)	328 (15.6%)	144 (5.9%)	<0.001
Social media addiction	352 (7.7%)	70 (3.3%)	282 (11.5%)	<0.001
		Sleep behavior characteristics		
Bedtime weekdays (in hours)	23.12±0.02	23.09±0.03	23.14±0.02	0.258
Waking up weekdays (in hours)	7.05±0.02	7.14±0.03	7.00±0.03	<0.001
Total sleep weekdays (in hours)	7.74±0.02	7.90±0.03	6.97±0.03	<0.001
Sleep onset latency (in minutes)	17.3±0.2	16.1±0.4	18.3±0.3	<0.001
Frequency of night awakenings (in points)	0.90±0.02	0.75±0.02	1.04±0.02	<0.001
PDSS score (in points)	12.0±0.08	10.7±0.12	13.2±0.11	<0.001

Note: Data are presented as n (%) and Mean ± SEM. Pearson's chi-squared and Student's t tests were used.

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Table 2. Sleep characteristics in adolescents with IA verified with Chen Internet Addiction Scale (CIAS).

	Age 12–14								Age 15–18							
	Boys (n=1009)				Girls (n=1219)				Boys (n=1125)				Girls (n=1262)			
	AIU n=575	MIU n=376	IA n=58	p d	AIU n=593	MIU n=534	IA n=92	p d	AIU n=659	MIU n=412	IA n=54	p d	AIU n=563	MIU n=574	IA n=125	p d
Bedtime weekdays, hr	23 (22–23)	23 (22–24)	23.5 (23–25)	<0.001 0.478	23 (22–23)	23 (23–24)	23 (22–24)	<0.001 0.411	23 (22–23)	23 (23–24)	24 (23–01)	<0.001 0.571	23 (22–24)	23 (23–24)	23 (23–01)	<0.001 0.705
Waking up weekdays, hr	7 (7–8)	7 (7–9)	8 (7–9)	0.008 0.176	7 (6–8)	7 (6–9)	7 (6–9)	0.016 0.144	7 (6–7)	7 (6–7)	7 (6–7)	0.381 0.017	6 (6–7)	6 (6–7)	7 (6–7)	0.052 0.111
Total sleep weekdays, hr	8.5 (7.7–9.5)	8.3 (7.3–9.3)	8.3 (7.3–9.1)	0.004 0.193	8.3 (7.4–9.2)	8.0 (7.0–9.0)	7.8 (6.5–9.3)	0.003 0.179	7.8 (7.0–8.4)	7.2 (6.3–8.0)	6.7 (5.8–7.4)	<0.001 0.492	7.3 (6.7–8.0)	7.0 (6.2–7.8)	6.7 (5.3–7.8)	<0.001 0.334
Sleep onset latency, min	10 (7–20)	10 (10–30)	15 (8–30)	0.017 0.164	12 (10–20)	15 (10–30)	15 (10–30)	<0.001 0.222	10 (7–15)	10 (7–20)	10 (9–30)	0.012 0.164	10 (8–20)	15 (10–20)	15 (10–30)	0.005 0.173
Frequency of night awakenings, points	0 (0–1)	1 (0–1)	1 (0–2)	0.014 0.163	1 (0–1)	1 (0–2)	1 (0–2)	<0.001 0.368	0 (0–1)	1 (0–2)	1 (0–2)	<0.001 0.311	1 (0–1)	1 (0–2)	1 (0–2)	0.002 0.218
PDSS score, points	8 (5–12)	11 (8–15)	14 (10–18)	<0.001 0.696	10 (7–14)	14 (10–17)	17 (14–20)	<0.001 0.752	9 (6–13)	13 (9–16)	18 (11–22)	<0.001 0.808	11 (8–15)	15 (11–18)	18 (14–21)	<0.001 0.800

Note: Time is expressed in 24–hour clock time. AIU – adaptive Internet use; MIU – maladaptive Internet use; IA – Internet addiction. Data are presented as medians (25%–75% quartiles). The Kruskal–Wallis H test was used. d – effect size (Cohen's d) for Kruskal–Wallis H test calculated according to recommendations Fritz, Morris & Richler [31] with the public domain software https://www.psychometrica.de/effect_size.html.

Table 3. Sleep characteristics in adolescents with Internet game addiction (IGA) verified with Game Addiction Scale for Adolescents (GASA).

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	Age 12–14						Age 15–18					
	Boys (n=1010)			Girls (n=1217)			Boys (n=1045)			Girls (n=1258)		
	No IGA n=833	IGA n=177	p d	No IGA n=1130	IGA n=87	p d	No IGA n=985	IGA n=156	p d	No IGA n=1203	IGA n=59	p d
Bedtime weekdays, hr	23 (22-23)	23 (23-24)	<0.001 0.332	23 (22-24)	23 (23-24)	0.020 0.133	23 (22-24)	24 (23-24)	<0.001 0.260	23 (22-24)	24 (23-01)	0.002 0.177
Waking up weekdays, hr	7 (7-8)	8 (7-9)	<0.001 0.262	7 (6-8)	7 (6-9)	0.120 0.089	7 (6-7)	7 (6-7)	0.393 0.051	6 (6-7)	7 (6-7)	0.006 0.154
Total sleep weekdays, hr	8.4 (7.6-9.4)	8.3 (7.3-9.3)	0.190 0.083	8.2 (7.2-9.1)	7.9 (6.5-9.3)	0.461 0.042	7.6 (6.8-8.2)	7.0 (6.0-7.9)	<0.001 0.250	7.2 (6.4-7.9)	6.7 (5.3-8.0)	0.068 0.103
Sleep onset latency, min	10 (7-20)	15 (10-30)	0.013 0.164	15 (10-25)	20 (13.5-30)	<0.001 0.222	10 (7-20)	10 (7-20)	0.313 0.062	10 (10-20)	15 (7-30)	0.467 0.042
Frequency of night awakenings, points	0 (0-1)	1 (0-2)	0.015 0.175	1 (0-2)	1 (0-2)	0.350 0.051	0 (0-1)	1 (0-2)	<0.001 0.222	1 (0-2)	1 (0-2)	0.177 0.076
PDSS score, points	9 (6-13)	13 (10-17)	<0.001 0.561	12 (8-16)	16 (13-19)	<0.001 0.340	10 (7-14)	14 (10-18)	<0.001 0.417	13 (10-17)	17 (13-22)	<0.001 0.302

Note: Time is expressed in 24–hour clock time. Data are presented as medians (25%–75% quartiles). The Mann–Whitney U test was used. d – effect size (Cohen's d) for Mann–Whitney U test calculated according to recommendations Fritz, Morris & Richler [31] with the public domain software https://www.psychometrica.de/effect_size.html.

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Table 4. Sleep characteristics in adolescents with social media addiction (SMA) verified with the Social Media Disorder Scale (SMDS).

	Age 12-14 лет						Age 15-18 лет					
	Boys (n=1010)			Girls (n=1217)			Boys (n=1141)			Girls (n=1262)		
	No SMA n=966	SMA n=44	p d	No SMA n=1050	SMA n=167	p d	No SMA n=1113	SMA n=28	p d	No SMA n=1144	SMA n=118	p d
Bedtime weekdays, hr	23 (22-24)	23 (22-24)	0.425 0.050	23 (22-24)	23 (22-24)	0.010 0.142	23 (22-24)	24 (23-01)	0.002 0.175	23 (22-24)	23 (23-24)	0.081 0.094
Waking up weekdays, hr	7 (7-8)	7 (7-9)	0.639 0.030	7 (6-8)	7 (6-9)	0.293 0.058	7 (6-7)	7 (6-7)	0.824 0.013	6 (6-7)	6 (6-7)	0.662 0.022
Total sleep weekdays, hr	8.4 (7.5-9.4)	8.2 (7.5-9.3)	0.874 0.010	8.2 (7.2-9.1)	8.0 (7.0-9.1)	0.612 0.029	7.5 (6.7-8.2)	6.9 (5.5-7.8)	0.008 0.158	7.2 (6.3-7.9)	7.0 (5.9-7.8)	0.096 0.094
Sleep onset latency, min	10 (7-20)	15 (10-30)	0.095 0.110	15 (10-25)	15 (10-30)	0.015 0.058	10 (7-20)	10 (9-20)	0.482 0.044	10 (10-20)	15 (10-27.5)	0.053 0.111
Frequency of night awakenings, points	0 (0-1)	1 (0-2)	0.002 0.194	1 (0-2)	1 (0-2)	<0.001 0.243	0 (0-1)	1.5 (0-2)	0.004 0.140	1 (0-2)	1 (1-2)	<0.001 0.223
PDSS score, points	9 (6-13)	12 (10-17.5)	<0.001 0.251	12 (8-16)	16 (12-20)	<0.001 0.480	10 (7-15)	16 (12.5-22.5)	<0.001 0.297	13 (10-17)	17 (13-21)	<0.001 0.356

Note: Time is expressed in 24–hour clock time. Data are presented as medians (25%–75% quartiles). The Mann–Whitney U test was used. d – effect size (Cohen's d) for Mann–Whitney U test calculated according to recommendations Fritz, Morris & Richler [31] with the public domain software https://www.psychometrica.de/effect_size.html.

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4. Discussion

It is well-known that at secondary school age, for proper rest, the duration of nighttime sleep should be at least 8 hours [32,33]. Schoolchildren of 12–14 years old in the sample generally fulfilled this recommendation; among older adolescents in all age–sex groups, the duration of nighttime sleep was less than the recommended 8 hours, with the lowest values in groups with IA – 6.4±0.2 hours among males and 6.6±0.2 hours among females. It should be mentioned that even in the lack of addiction in this age group, sleep duration did not exceed 8 hours. Lack of sleep has been seen in other adolescent populations as well. For example, Norwegian schoolchildren aged 16–17 sleep on average 7 hours 36 minutes on school days [34]; sleep duration of fewer than 8 hours at this age was also recorded in Poland, Latvia, Estonia, and Greece [34]. However, in the overwhelming majority of European countries and the USA, older students sleep the recommended 8 hours or more. The revealed insufficient amount of nighttime sleep in older adolescents from Central Siberia, especially in the case of IA, should attract the attention of specialists, since the deficit of nighttime sleep is associated with several mental and somatic problems, as well as with a decrease in school performance [35,36].

It is noteworthy that non-adaptive Internet use is associated with difficulties in falling asleep – in all selected groups, sleep onset latency (the actual equivalent of early insomnia) progressively increased with an increase in the degree of IA. It was previously found, that an increase in this time in adolescents was characteristic when they had felt a large number of exciting emotions during the day – the repeated mental experience of which did not allow adolescents to fall asleep quickly [37]. Moreover, it has been shown that an increase in sleep onset latency is an indirect reflection of many psychosocial problems: depression [38], emotional and behavioral problems [39], decreased academic performance [40], weakness and sleepiness during the day [38,41].

Night awakenings, as an equivalent of late insomnia, were also significantly more frequent in the groups of adolescents with non-adaptive Internet use and IA, with a slightly higher frequency in females. The data of this study are consistent with the results of other studies in this direction. For example, in the study by Canan et al. in 16-year-old Internet-addicted adolescents, along with a decrease in the time of nighttime sleep, frequent night awakenings were also recorded [42]. A recent study of Turkish adolescents also showed a decrease in the duration of nighttime sleep, an increase in sleep onset latency, and dyssomnia, recorded by an increase in the mean score of the PSQI in adolescents with IA [21]. Similar associations using the PSQI have also recently been described for Indian adolescents [43], Turkish and Bangladeshi students [44,45]. A 3.25-fold decrease in the subjective assessment of sleep quality was found in Chinese adolescents with IA, compared with adolescents without addiction [46].

The mechanisms underlying the link between IA and sleep disorders have not been conclusively established [47]. The most probable is a multifactorial and two-sided model of mutual influence. Sleep disorders, reflecting psychosocial problems, depression, and anxiety-phobic disorders, can precede and contribute to the formation of IA [16]. On the other hand, sleep disorders such as insomnia can lead to the increased use of the Internet in the evening and at night, further exacerbating the problem, creating a "vicious circle".

It is assumed that intense emotional experiences in the evening, associated with Internet activities, prevent an adolescent from falling asleep peacefully, increasing the sleep onset latency and leading to more superficial and restless sleep. In this context, the hypothesis of the associative link between IA and dyssomnia, recently put forward by You et al. [47], is of interest. The authors suggest that mental rumination preceding falling asleep, as a psychological phenomenon of the automatic repeated mental experience of negative situations, analysis of their causes, feeling of inability to achieve desired goals, is characteristic of Internet-addicted adolescents and is simultaneously associated with difficulties in falling asleep and dyssomnia. There are also hypotheses of a direct physiologically determined effect of gadgets on brain activity that is unfavorable for the formation of a healthy sleep pattern. For example, it is assumed that the already mentioned effect of

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light from monitors on the production of melatonin, which is necessary for the formation of a healthy circadian rhythm, may underlie difficulties in falling asleep [14,15].

Disruption of a healthy night sleep pattern in Internet-addicted adolescents was accompanied in the research sample by a pronounced increase in the degree of daytime sleepiness, worsening due to an increase in the degree of IA, calculated by using the PDSS questionnaire. The possible explanations of this relation may be: (1) the higher rate of night activity among Internet overusers, (2) night sleep disturbances, such as insomnia, and (3) the presence of common pathogenic factors in IA and excessive daytime sleepiness, such as personality characteristics, depression, anxiety. Severe daytime sleepiness in adolescents with IA has been previously reported in a number of studies. Thus, Ekinci et al. showed a high frequency of complaints of daytime sleepiness and fatigue in Internet-addicted adolescents [18]. Demir et al. convincingly showed a positive association of the severity of daytime sleepiness with IA in university students [17].

The authors of this article managed to find only two studies in this direction, in which they also used a psychometric tool created specifically for children and adolescents – the PDSS scale. South Korean researchers have shown a pronounced association of daytime sleepiness, verified using the PDSS questionnaire, with smartphone addiction in 14-15-year-old adolescents [19]. Moreover, the risk of developing pronounced daytime sleepiness increased in parallel with an adolescent's sleep onset latency. In Brazilian adolescents, the PDSS scores were positively associated with the intensity of social media use and negatively – with the level of physical activity [20].

It has been previously shown that excessive daytime sleepiness in adolescents can reduce attention and school performance, affect mood and decision-making ability, reflect the presence of anxiety-depressive disorders, and even is one of the predictors of suicidal behavior [48-51]. In the authors' opinion, the pronounced association revealed between daytime sleepiness and the severity of Internet-dependent behavior in Siberian adolescents is undoubtedly one of the negative consequences of a decrease in the quality of nighttime sleep: going to bed late, difficulty in falling asleep, frequent awakenings. On the other hand, daytime sleepiness may be one of the common manifestations of depression and anxiety-phobic disorders comorbid for IA.

The analysis of literature data shows that in the overwhelming majority of studies on sleep assessment in adolescents with IA, only one psychometric tool was used to assess addiction, and general scales were most often used, which did not identify the predominant media an adolescent consumed. Thus, in a meta-analysis by Alimoradi et al., out of the 23 included studies, only Young's Internet Addiction Scale questionnaire was used to assess IA in 15, and in 4 – only the CIAS questionnaire, which was also used by the authors [6]. These questionnaires reveal only the general IA pattern without reference to the consumed content. In the authors' opinion, the undoubted advantage of this research project is the use of three tools simultaneously, which make it possible to assess not only the general, undifferentiated IA but also to identify the predominant media of addiction.

The presented data show that the parameters, with the highest effect size IA, regardless of the content, were indicators of daytime sleepiness and the scale of night awakenings. Daytime sleepiness was increased in all age and sex groups when using data from all three tools used to assess the IA, regardless of the presence or absence of disturbance in the night sleep pattern. These data once again confirm the above hypothesis about excessive daytime sleepiness, as a reflection of not only disturbances in the nighttime sleep schedule but also psychosocial problems comorbid for IA. Emotional problems can also reflect an increase in the average score of the nighttime awakening scale, recorded in all groups, except girls with addiction to video games. On the other hand, light and restless sleep can be caused by the emotionally charged use of the Internet just before bedtime, as evidenced by an increase in sleep onset latency, especially in boys with game addiction and girls with addiction to social networks.

Regarding the nighttime sleep schedule, despite the fact of going to bed late, which was observed in both types of addiction in almost all age and sex groups, the reduction in the total time of nighttime sleep was more typical for older adolescents. Apparently, this

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is due to the schedule opportunity for younger schoolchildren to get up later, while at an older age, with increased responsibility and changes in the school schedule/the emergence of new household duties, there is no such opportunity, and when an adolescent goes to bed late, the duration of nighttime sleep is reduced.

According to research data, the greatest effect on the quality of sleep was recorded in 12- 14-year-olds boys with game addiction – in this group, five of the six sleep parameters used in the study were changed. The least effect on sleep was recorded in the same group in case of addiction to social media – only frequent night awakenings and daytime sleepiness were recorded; the nightly sleep schedule was not disturbed.

This study has some limitations. The study was not anonymous; the questionnaires were completed not individually, but in class groups. The study design was based on voluntary consent. It can be assumed that some of the adolescents with psychological problems could not answer the questions truthfully and/or explicitly or implicitly evaded the survey. The results of this study are presented without taking into account the ethnicity of adolescents (Russians, Khakass, Tuvans), which did not allow for assessing the effect of the ethnocultural factor on both the IA indicators and a sleep pattern. Such analysis is planned for the near future.

5. Conclusions

Thus, the following has been revealed in adolescents with IA: a habit of going to bed late and waking up late, a decrease in the duration of nighttime sleep, an increase in sleep onset latency, and frequent night awakenings, as well as more pronounced daytime sleepiness. We suppose that sleep disturbances in Internet-addicted adolescents may be explained by the higher rate of night activity, and common pathogenic factors, such as personality characteristics, depression, anxiety. Among the sleep parameters studied, the indicators of daytime sleepiness and night awakening scales have the highest effect size in Internet-addicted adolescents, regardless of the media consumed. Regarding differences in consumed content, the greatest effect on sleep habitus and quality was recorded in 12-14-year-old males with addiction to Internet video games. The data obtained is advisable to use when planning psychological and pedagogical activities to normalize the sleep schedule in adolescents according to the available recommendations.

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Abbreviations:

IA	Internet addiction
CIAS	Chen Internet Addiction Scale
GASA	Game Addiction Scale for Adolescents
SMDS	The Social Media Disorder Scale
PSQI	Pittsburgh Sleep Quality Index
PDSS	Pediatric Daytime Sleepiness Scale
IGA	Internet game addiction
SMA	social media addiction
SEM	standard error of mean

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