

Internet, video game and mobile phone addiction in children and adolescents: A case-control study

Adicción a Internet, videojuegos y teléfonos móviles en niños y adolescentes: Un estudio de casos y controles

A. MENÉNDEZ-GARCÍA*, A. JIMÉNEZ-ARROYO*, M. RODRIGO-YANGUAS*,**, M. MARÍN-VILA**, F. SÁNCHEZ-SÁNCHEZ***, E. ROMAN-RIECHMANN****, H. BLASCO-FONTECILLA*,**,*****.

* Universidad Autónoma de Madrid (UAM), Madrid, Spain.

** Departamento de Psiquiatría, IDIPHIPSA-Hospital Universitario Puerta de Hierro, Majadahonda, Spain.

*** Departamento I+D+I, TEA Ediciones, Madrid, Spain.

**** Departamento de Pediatría, IDIPHIPSA-Hospital Universitario Puerta de Hierro, Majadahonda, Spain.

***** Centro de Investigación Biomédica en Red Salud Mental (CIBERSAM), Madrid, Spain.

***** ITA Salud Mental, Madrid, Spain.

Abstract

The use of new technologies has become widespread worldwide. There is increasing concern about “Internet addiction disorder” (IAD), “Internet gaming disorder” (IGD), and “Mobile phone addiction” (MPA). Attention Deficit Hyperactivity Disorder (ADHD) has been associated with IAD and IGD. However, evidence is lacking about the relationship between ADHD and MPA. Naturalistic case-control study. 112 patients (51 children with and 61 children without ADHD) between 7 and 17 years old were compared regarding IAD, IGD, and MPA. We used the TEA questionnaire for the assessment of executive function and ADHD (ATENTO), and the ADITEC questionnaire to get gender-differentiated information for IAD, IGD, and MPA. Female children scored higher on MPA (Mean \pm Standard Deviation, $M \pm SD$) (25.93 ± 17.64 vs. 14.77 ± 19.43 , $p=0.03$), while male children scored higher on IGD (30.09 ± 21.65 vs. 12.51 ± 16.61 , $p<10^{-3}$). Severity of hyperactivity/impulsivity and IGD were moderately correlated ($r=0.349$, $p=0.013$), but the correlation disappeared after controlling for the impact on the social domain as measured by the ATENTO questionnaire ($r=0.171$, $p=0.250$). Most parents are concerned that their children may be addicted to IAD/IGD/MPA. Female gender is associated with MPA, while male gender is associated with IGD. ADHD is a risk factor for developing IAD and IGD. Combined type and predominantly hyperactive/impulsive ADHD are each associated with IGD. Good social adjustment protects against developing IGD. There are gender vulnerabilities for IAD/IGD/MPA. ADHD is a risk factor for IGD, but good social adjustment buffers this association.

Keywords: ADHD; Internet addiction disorder; Internet gaming disorder; mobile phone addiction.

Resumen

El uso de las nuevas tecnologías se ha generalizado a nivel mundial. Hay una creciente preocupación respecto del «trastorno de adicción a Internet» (TAI), el «trastorno de juego en Internet» (TJI) y la «adicción al teléfono móvil» (ATM). El trastorno por déficit de atención con hiperactividad (TDAH) se ha asociado con el TAI y el TJI. Sin embargo, falta evidencia sobre la relación entre el TDAH y la ATM. Estudio naturalista de casos y controles. Comparación de 112 pacientes (51 niños con el TDAH y 61 niños sin el TDAH) con edades entre 7-17 años respecto del TAI, el TJI y la ATM. Utilizamos el cuestionario de TEA para evaluar la función ejecutiva y el TDAH (ATENTO) y el cuestionario ADITEC para obtener información diferenciada por género para el TAI, el TJI y la ATM. Las niñas obtuvieron puntuaciones más altas en la ATM (desviación típica \pm media, $DT \pm M$) ($25,93 \pm 17,64$ vs. $14,77 \pm 19,43$, $p = ,03$), mientras que los niños obtuvieron puntuaciones más altas en el TJI ($30,09 \pm 21,65$ vs. $12,51 \pm 16,61$, $p < 10^{-3}$). Hubo una correlación moderada entre la gravedad de hiperactividad/impulsividad y el TJI ($r = ,349$, $p = ,013$), pero la correlación desapareció después de controlar por el impacto en el ámbito social según las mediciones del cuestionario ATENTO ($r = 0,171$, $p = ,250$). A la mayoría de los padres les preocupa que sus hijos puedan tener el TAI, el TJI o la ATM. El género femenino está asociado con la ATM, mientras que el género masculino está asociado con el TJI. El TDAH es un factor de riesgo para el desarrollo del TAI y el TJI. El TDAH del tipo combinado y de predominio de hiperactividad/impulsividad están asociados con el TJI. Un buen ajuste social protege contra el desarrollo del TJI. Hay vulnerabilidades de género para el TAI, el TJI y la ATM. El TDAH es un factor de riesgo para el TJI, pero un buen ajuste social amortigua esta asociación.

Palabras clave: TDAH; trastorno por adicción a Internet; trastorno de juego en Internet; adicción al teléfono móvil.

Received: January 2020; Accepted: May 2020.

Send correspondence to:

Hilario Blasco-Fontecilla M.D., Ph.D. Departamento de Psiquiatría, Hospital Universitario Puerta de Hierro-IDIPHIPSA. Manuel de Falla s/n. Majadahonda (Madrid), Spain. Tel: (+34) 91 191 6134. Email: hmbiasco@yahoo.es

The use of new technologies (NT) (Internet, mobile phones, or video games) has become widespread worldwide. NT are useful tools that facilitate communication and information-sharing and can be used for recreational purposes. However, excessive use of NT is increasingly becoming a matter of concern (Marín Vila, Carballo Crespo & Coloma Carmona, 2018). For instance, 25% of young people spend more than three hours a day watching TV or using the Internet, and 15% spend more than three hours playing video games on a school day (Weiss, Baer, Allan, Saran & Schibuk, 2011). Even if it's controversial (Weinstein, Yacov, Manning, Danon & Weizman, 2015), there is increasing evidence that "Internet addiction disorder" (IAD), "Internet gaming disorder" (IGD), and "Mobile phone addiction" (MPA) are behavioral addictions (Chóliz, 2010; Osborne et al., 2016; Rehbein, Kliem, Baier, Mossle & Petry, 2015). Indeed, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) included "addiction to gambling with money on the Internet" in the chapter *Disorders related to substances and addictive disorders*. Furthermore, IAD and IGD were included as conditions for further study in Section 3 (Chen, Chen & Gau, 2015; Rehbein et al., 2015).

These are several risk factors for IAD, IGD and MPA. For instance, certain characteristics such as extraversion, disinhibition, narcissism, neuroticism, social anxiety, anxious attachment, and low self-esteem are associated with an increased risk of IAD (Peris, Maganto & Garaigordobil, 2018). IGD is associated with male gender (Schou Andreassen et al., 2016). MPA has been related to low self-esteem, social anxiety and interpersonal sensitivity (You, Zhang, Zhang, Xu & Chen, 2019).

Attention Deficit Hyperactivity Disorder (ADHD), the most frequent disorder in childhood and adolescence with a prevalence of 5.29% (range: 0.2%-27%) worldwide (Polanczyk, de Lima, Horta, Biederman & Rohde, 2007), has been associated with IAD (Dalbudak & Evren, 2014) and IGD (Weinstein & Weizman, 2012). Some studies reported no significant differences in the amount of time or frequency of play between children with and without ADHD, but rather a more severe addiction to IGD in children with ADHD (Bioulac, Arfi & Bouvard, 2008). However, there is less evidence concerning the relationship between ADHD and MPA.

The main aim of this study is to explore the relationship between ADHD and IAD, IGD, and MPA in children and adolescents. Our study has three specific objectives: first, to compare the pattern of NT use (Internet, video games, and mobile phone) among children and adolescents with and without ADHD; second, to study the relationship between ADHD, and IAD, IGD, and MPA; and third, to explore whether or not social skills mediate the relationship between ADHD, and IAD, IGD, and MPA.

Methods

Participants

Our study is a descriptive naturalistic case-control study. The sample was recruited at the Puerta de Hierro University Hospital in Majadahonda (HUPH-M). One hundred twelve patients between 7 and 17 years old were recruited: 51 children and adolescents diagnosed with ADHD (cases), and 61 children and adolescents who attended outpatient pediatrics consultations in the same hospital for a medical reason and without a diagnosis of ADHD (controls). Most controls were patients either for digestive or respiratory reasons. Neither the cases nor the controls presented comorbidity with mental retardation, generalized developmental disorders or other neurological or psychiatric alterations that could compromise the cognitive functioning of the participant.

Measures and procedure

The cases and controls were evaluated using semi-structured diagnostic interviews, including parent interviews, and a protocol including sociodemographic and clinical data; the ADHD criteria of the Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (DSM-IV); and some scales for assessing ADHD, and IAD, IGD, and MPA.

According to these criteria, cases were divided into the following groups: combined type (ADHD/C), predominantly hyperactive/impulsive type (ADHD/HI), and predominantly inattentive type (ADHD/I). To evaluate the main ADHD symptoms (impulsivity, hyperactivity and inattention) and the underlying executive processes altered, we used the *TEA questionnaire for the assessment of executive function and ADHD (ATENTO)*, which evaluates the following aspects: attention control, behavioral regulation, emotional regulation, flexibility, working memory, planning and organization, temporal orientation, behavioral problems, sleep-related problems, as well as the level of affectation or impact of symptoms in family, social and school contexts (Sánchez-Sánchez & Luque, 2020).

We evaluated the use of NT by using information provided by the parents and children. Participating parents filled out an ad hoc 12-item (yes/no) questionnaire based on an adapted version of the criteria used for the evaluation of behavioral addictions (Blasco-Fontecilla et al., 2014) (see supplementary material, SM). This strategy has been used elsewhere (Kourosh, Harrington & Adinoff, 2010). We used the first question of the ad hoc questionnaire evaluating the use of NT (*Do you think your child has an addiction to any of the following technologies?*). If the parent responded "yes" to three or more questions (items 2 to 12), we considered it a "screening diagnosis" for addiction to NT. Regarding children and adolescents, we used the ADITEC questionnaire (ADITEC. Assessment and Prevention of Internet, Mobile and Video Game Addiction, Choóiz, Marco & Chóliz, 2016) to diagnose IAD, IGD, and/or

MPA. The ADITEC questionnaire provides gender-differentiated information for IAD, IGD, and MPA, including a total score and the following subscale scores: 1) Internet (ADITEC-I): abuse, abstinence, disturbance and absence of control, and escape; 2) Video games (ADITEC-V): compulsive gambling, abstinence, tolerance and interference with other activities, and associated problems and escape; and 3) Mobile phone (ADITEC-M): tolerance and abstinence, difficulty controlling impulse, problems derived from economic expenditure and abuse (Chóliz, Marco & Chóliz, 2016).

Statistical Analyses

For Objective 1, we performed descriptive analyses of sociodemographic and clinical variables and the frequency of addiction to NT in the case and control groups, using χ^2 and the odds ratio (OR) for ordinal and internal variables. We also used the *t* test for independent samples associated with the Levene statistic for equality of variances to compare quantitative variables (cases vs. controls, and ADHD/HI vs. ADHD/I). To assess group differences regarding IAD, IGD, and MPA, the bifactorial ANOVA procedure was conducted by differentiating two age groups: 7-11 years old and 12-17 years old. Therefore, we considered group (case-control) as a between-subjects factor, and IAD/IGD/MPA, as a within-subject factor. This strategy allowed us to extract information between groups, types of addiction to NT (IAD, IGD, and MPA), and the inter-

action between ADHD and IAD/IGD/MPA. For Objective 2, we performed bivariate correlation analyses comparing the scores of the three subscales of the ADITEC questionnaire (Mobile phone, Video games and Internet) and the scores of inattention and hyperactivity-impulsivity as measured by the ATENTO questionnaire. For Objective 3, we performed the same bivariate correlation analyses but controlled for the subscale Affectation of the Social Context from the ATENTO questionnaire. The level of statistical significance was established at $p < 0.05$. We used the SPSS software (v20 for Mac) for all analyses.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The local Institutional Review Board approved the study (February 12, 2018; n° 03.18). Before entering the study, the study was explained to parents (or legal guardians) and children. Informed Consent (IC) was obtained from both. Both the parents (or legal guardians) and the children were fully informed and agreed to participate voluntarily.

Results

Table 1 displays the participants' sociodemographic and educational characteristics, and some clinical and familial antecedents.

Table 1. Patient sociodemographic and clinical characteristics.

	Cases n = 51 %	Controls n = 61 %	OR [95% CI]	Significance
Gender (female)	21.6	49.2	0.48 [0.28-0.82]	FET* p = .003
Adopted (Yes)	15.7	0.0	2.42 [1.92-3.04]	FET p = .001
Repeating at least one school year	28	9.8	1.77 [1.20-2.60]	FET p = .024
Teaching support at school (Yes)	37.5	13.1	1.92 [1.31-2.81]	FET p = .006
Adapting early childhood curriculum at school (Yes)	31.2	9.8	1.91 [1.30-2.79]	FET p = .007
Teaching support at home (Yes)	39.6	24.6		FET p = .101
Problems during pregnancy (Yes)	23.8	18		FET p = .619
Childbirth (weeks)				FET p = .841
< 37 o > 42	34.6	31.1		
37-42	65.4	68.9		
Problems during childbirth (Yes)	20.9	29.5		FET p = .370
Speech Acquisition (> 2 years old)	48.1	29.5	1.52 [1.02-2.22]	FET p = .053
Sphincter control (> 6 years old)	25	6.6	1,88 [1.32-2.69]	FET p = .008
Familial antecedents of mental disorders	47.1	11.7	2.17 [1.59-3.33]	FET p < 10-3

Note. * FET (Fisher Exact Test)

Objective 1: To compare the pattern of NT (internet, video games and mobile phone) use in cases versus controls

The first question of the ad hoc questionnaire evaluating the use of NT (*Do you think your child has an addiction to any of the following technologies?*) was affirmatively answered by 75.6% and 73% of the parents of cases and controls, respectively. Even if we did not find statistically significant differences regarding the use of internet/videogames/mobile phone, parents of children and adolescents with ADHD seemed particularly worried about Internet use, whereas the parents of controls expressed their concerns about mobile phone use (see Table 1-SM).

When using the operational diagnosis of addiction to NT (3 or more affirmative responses to questions 2-12), 66.7% and 29.7% of the parents of ADHD and control cases, respectively, met the diagnostic criteria [OR(95%) = 2(1.28-3.12), Fisher Exact Test (FET) p = 0.002] (see Figure 1-SM and Table 2-SM).

Figure 1 graphically displays the prevalence of at least one addiction to NT (IAD/IGD/MPA). The prevalence ranges between the 29.7% among pediatric controls and the 100% of the predominantly ADHD/HI subtype (OR = 3.42 [1.23-9.55], FET p = 0.003).

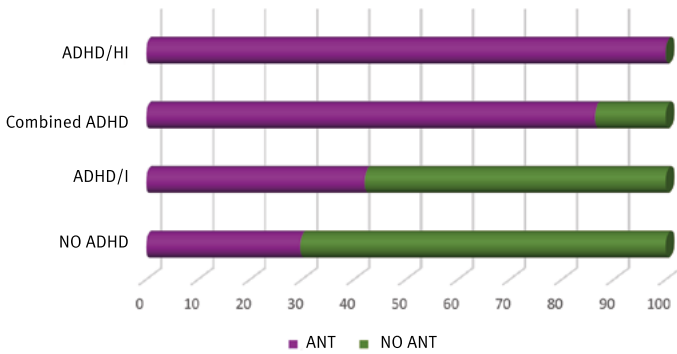


Figure 1. Prevalence of at least one "addiction to NT" (ANT): IAD/IGD/MPA.

ADHD was associated with IAD and IGD, but not with MPA (see Table 2).

Table 2. Comparison between cases and controls regarding IAD, IGD, and MPA (as measured by the ADITEC).

	Cases (n = 51)	Controls (n = 61)	Levene	t Test
	M ± DT	M ± DT		
ATM	18.86 ± 19.20	19.15 ± 19.77	0.794	p = .939
TJI	32.10 ± 23.70	16.79 ± 16.89	0.001	p < .001
TAI	26.94 ± 21.18	17.70 ± 17.23	0.079	p = .013

Figure 2 shows the quantitative differences among IAD/IGD/MPA (as measured by the direct responses on the ADITEC) regarding gender. Female children scored higher on MPA (Mean Standard Deviation, M SD) (25.93 17.64 vs. 14.77 19.43, p = 0.03) and IAD (23.59 18.72 vs. 20.68

20.22, p = 0.45), while male children scored higher on IGD (30.09 21.65 vs. 12.51 16.61, p < 10⁻³).

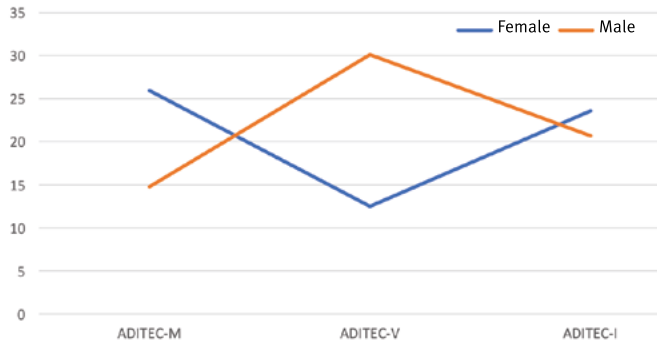


Figure 2. Type of ANT (as measured by the ADITEC*): IAD/IGD/MPA by gender.

Note. *ADITEC-M (Mobile); ADITEC-V (Video games); ADITEC-I (Internet).

Objective 2: To study the relationship between ADHD and ANT

Table 3 displays the relationship between the various subtypes of ADHD and IAD/IGD/MPA.

Table 3. Subtypes of ADHD (DSM-IV) and IAD/IGD/MPA (as measured by the ADITEC*).

	TDAH/I (n = 24)	TDAH/HI o el TDAH/C (n = 26)	Levene	t Test
	M ± DT	M ± DT		
ATM	22.75 ± 19.25	14.73 ± 18.88	0.794	p = .144
TJI	22.79 ± 18.91	40.31 ± 25.25	0.201	p = .008
TAI	27.13 ± 22.33	26.75 ± 20.91	0.865	p = .952

We found a positive correlation between the severity of impulsivity and IGD (see Table 4). Accordingly, we explored which of the IGD subscales were involved. We found that the severity of H/I correlated with both the abstinence and the associated problems and escape subscales (see Table 5).

Table 4. Correlations between ADHD dimensions (as measured by ATENTO) and IAD/IGD/MPA (as measured by the ADITEC).

		ATM	TJI	TAI
Inattention	Pearson r	-.145	.219	.007
	Significance	.316	.127	.961
Hyperactivity/Impulsivity	r de Pearson	-.079	.349	.066
	Significance	.586	.013	.657

Table 5. Correlations between ADHD dimensions (as measured by ATENTO) and IGD's subscales.

		Compulsive gambling	Abstinence	Tolerance & interference	Associated problems & escape
Inattention	Pearson r	.164	.219	.211	.239
	Significance	.254	.126	.142	.095
Hyperactivity/Impulsivity	Pearson r	.273	.373	.257	.405
	Significance	.056	.008	.072	.004

Objective 3: To test the influence of the social context on the ANT

After controlling for the impact of the social domain as measured by the ATENTO questionnaire, the correlations displayed in Table 6 were lower than those displayed in Table 4 and were no longer statistically significant.

Table 6. Correlations between ADHD and IAD/IGD/MPA controlling by the subscale Affection of the Social Context (ATENTO).

		ADITEC-M	ADITEC-V	ADITEC-I
Inattention	Pearson r	.005	-.074	-.184
	Significance	.972	.619	.217
Hyperactivity/ Impulsivity	Pearson r	.051	.171	-.063
	Significance	.734	.250	.674

Discussion

In keeping with the literature, our study confirmed that addiction to NT (IAD/IGD/MPA) is highly prevalent among children and adolescents with and without ADHD. We also found that ADHD is associated with IAD/IGD/MPA in a Spanish population of children and adolescents. The association between ADHD and IAD/IGD/MPA has been convincingly demonstrated in several Asian countries (Lee et al., 2018), but evidence is lacking in other countries worldwide. Furthermore, we expanded on some information about the relationship between ADHD and IAD/IGD/MPA. For instance, we found that ADHD/C and ADHD/HI were associated with IGD, whereas ADHD/I was related to MPA. However, the most relevant finding was that good social adjustment buffered the relationship between ADHD/C or ADHD/HI, and IGD in children and adolescents with ADHD.

When using our ad hoc criteria for diagnosing an addiction to NT, we found that most of the parents of children and adolescents with or without ADHD feared that they might have at least one addiction to NT (IAD/IGD/MPA). These elevated percentages may suggest that the threshold used (3 items) was too low for using these criteria as a screening tool. In any case, the probability of presenting with IAD/IGD/MPA is very high. Thus, IAD ranges from 1.4% to 17.9% of adolescents (Chen et al., 2015), rising to 21.6% in Korea (Lee et al., 2018). Furthermore, 8% of people aged 17 or younger are diagnosed with IGD (Stockdale et al., 2018); 36.6% of adults with ADHD and 23% of controls without ADHD had at least one addiction to NT (Bielefeld et al., 2017).

On the other hand, we found a significant statistical difference between cases and controls concerning gender, as male gender was overrepresented among the ADHD group. Indeed, we found a male:female ratio of 3:1, which is the male:female ratio accepted in the literature (Lange, Reichl, Lange, Tucha & Tucha, 2010). It is important to stress this gender difference, as it may affect our results. Indeed, female and male gender were associated with MPA

and IGD, respectively (Haghbin, Shaterian, Hosseinzadeh & Griffiths, 2013; Schou Andreassen et al., 2016). These gender differences may reflect the propensity for males to engage in competitive and aggressive entertainment and for females to participate in cooperative and social activities (Griffiths, Kuss & Pontes, 2016).

In accordance with the literature, we found that ADHD is a risk factor for IAD (Dalbudak & Evren, 2014) and IGD (Weinstein & Weizman, 2012), but not MPA. Our findings are particularly interesting, because IAD was not associated with any particular subtype of ADHD, but IGD was clearly associated with ADHD/C and ADHD/HI. Most authors have reported that impulsivity is core to the addiction to NT. In a study, the most relevant predictor of developing IAD was impulsivity (Metin et al., 2015). These authors stressed that children most likely to present with IAD share a preference for quick response stimuli and short-term rewards, disinhibition and lack of self-control, and impulsivity. This opinion, paired with the evidence that individuals with IAD have deficits in inhibiting responses to stimuli under experimental conditions (Cao, Su, Liu & Gao, 2007), has led some authors to propose IAD as an impulse control disorder (Cao et al., 2007; Metin et al., 2015). Furthermore, a recent meta-analysis concluded that impulsivity mediated the relationship between ADHD and the addiction to media (Nikkelen, Valkenburg, Huizinga & Bushman, 2014).

Our finding that ADHD/HI and ADHD/C are the subtypes more closely associated with IGD is consistent with a study postulating that impulsivity explains the relationship between self-control, ADHD, and IGD (Haghbin et al., 2013). Indeed, individuals with IGD have similar neurocognitive and social cognitive dysfunctions as methamphetamine-dependent patients (Jiang, Li, Zhou & Zhou, 2020). Moreover, video games provide quick, immediate rewards and an artificial living environment where children and adolescents can escape from problems and fulfill their fantasies (Gentile, Swing, Lim & Khoo, 2012). Furthermore, severity of H/I is correlated with both abstinence and the associated problems and escape subscales. This finding is relevant because it points to specific areas of addiction that could be specifically targeted for treatment if our findings are replicated. We have not found any literature on this subject. We also found a trend of a clinically relevant association between ADHD/I and MPA. This finding is similar to the one reported in a study carried out with ADHD/I Chinese adolescents, who were particularly vulnerable to developing MPA if the mobile phone was switched on during sleep (Zheng et al., 2014).

However, the most important finding is that good social adjustment buffered the relationship between ADHD/C or ADHD/HI. This finding is important because research on the impact of computer and video game use on the development of children and adolescent social skills is scarce (Tran & Subrahmanyam, 2013). Thus, we must face the chicken

and egg dilemma: Does IGD worsen social skills? Or do people with poor social skills tend to use video games? Or can both hypotheses be true? In a case-control study, students with IGD had poorer social skills than students without IGD (Zamani, Kheradmand, Cheshmi, Abedi & Hedayati, 2010). In a longitudinal study, a two-year follow-up of 251 toddlers measured the impact of screen time (television/video, video/computer games) and physical activity on the development of social skills. They reported that screen time was negatively associated with express (e.g., joins play) and comply (e.g., cooperates) scores and positively associated with disrupt scores (e.g., teases) (Carson et al., 2019). In a similar vein, in another study the authors reported an inverse relationship between physical activity (fitness and bodybuilding) and video gaming-related self-regulation problems (Cardol, Escamilla, Gebhardt & Perales, 2019).

On the other hand, the self-medication hypothesis may help to explain why people lacking social skills make massive use of video games. In a study with 62 children, drug-naive, diagnosed with ADHD, and Internet video game players, the authors reported that after eight weeks of treatment with methylphenidate, the children not only improved their ADHD symptoms but also reduced the time spent on Internet video gaming activities (Han et al., 2009). The authors reminded that both stimulants -such as methylphenidate- given to treat ADHD, and video game play increase synaptic dopamine, and suggested that “Internet video game playing might be a means of self-medication for children with ADHD”. Indeed, although the influence on children’s mental health is usually negatively perceived, a recent study with 3195 children aged 6-11 years old from six European countries reported that high video game use was related to 1.75 times the odds of high intellectual functioning, and a decreased risk of peer relationship problems and prosocial deficits [OR 0.41 (0.2-0.86) and 0.23 (0.07, 0.81), respectively] (Kovess-Masfety et al., 2016). In a randomized trial with 69 children aged 7-11 years with poor social skills, 33 were assigned to treatment with an interactive online adventure game for nine weeks, and 36 to a waitlist. The treatment group improved significantly more than the controls “in social literacy, social anxiety, bullying victimization, and social satisfaction” (Sánchez, Brown, Kocher & DeRosier, 2017). The authors concluded that video games may be useful in improving the mental health of children with poor social skills. Accordingly, they could be helpful in children and adolescents with or without ADHD who struggle with poor social skills.

Some limitations should be mentioned. Firstly, our study is retrospective. Accordingly, remember that bias may affect our results and that establishing causal links is not possible. Secondly, our sample size meant that some clinically significant results (e.g., the trend for parents of children with ADHD to be more worried about Internet use than parents of controls) did not reach statistical significance. Another limitation is that the control group was extracted from pa-

tients attending a pediatric consultation. Thus, the epidemiological results may not be representative of the general population of children and adolescents in our country. Another limitation is that we used an ad hoc questionnaire with parents to evaluate the perception of use of NT by their children; the questionnaire was based on modified DSM-IV-TR criteria for substance dependence. However, this strategy has been used for evaluating other behavioral addictions, such as suicidal behavior or tanning (Blasco-Fontecilla et al., 2014; Kourosch et al., 2010). Finally, we used brand-new questionnaires only available in Spanish for evaluating the severity of ADHD and the addiction to NT (ATENTO and ADITEC, respectively). However, the ATENTO questionnaire is particularly interesting because it evaluates not only the core ADHD clinical symptoms but also executive function and the impact of ADHD symptoms in several domains, including the social area. Despite being novel, the ADITEC questionnaire expands on information regarding various aspects of addictive behaviors and may help in expanding our knowledge of specific areas (e.g., impulsivity, tolerance) that are altered in IAD, IGD, and MPA. Furthermore, the ADITEC comprehensively evaluates IAD, IGD, and MPA in a single questionnaire.

Conclusions

Most parents are concerned that their children may be addicted to NT (IAD/IGD/MPA). Female gender is associated with MPA, while male gender is associated with IGD. ADHD is a risk factor for developing IAD and IGD. ADHD/C and ADHD/HI are each associated with IGD. Good social adjustment protects against developing IGD. Future directions for research may include, among others: 1) the study of good social adjustment as a protective factor against developing an IGD; 2) testing if either the use of sports or some video games may be protective for developing an IGD; and 3) the study of how some characteristics of the video games (i.e., the amount of time, frequency of play, presence or absence of violence, etc.) interact with the personality characteristics and gender of children and adolescents (López-Fernández, Mezquita, Griffiths, Ortet & Ibáñez, 2021), so we can develop preventive rules aimed at protecting vulnerable children and adolescents.

Acknowledgements

The authors thank Lorraine Maw, MA, for editorial assistance.

Conflict of interests

In the last 24 months, Hilario Blasco-Fontecilla received lecture fees from Shire. He is Principal Investigator (PI) of an iPFIIS research contract (www.isciii.es; IFI16/00039) and

co-PI of a MINECO research grant (RTI2018-101857-B-I00); recipient of: 1) a FIPSE Grant, and 2) an IDIPHIPSA intensification Grant; involved in two clinical trials (MENSIA KOALA, NEWROFEED Study; ESKETSUI2002); member of the Advisory Board of ITA Salud Mental. Fernando Sánchez Sánchez is an employee of *TEA ediciones*. Maria Rodrigo Yanguas is the recipient of an iPFS research contract (www.isciii.es). The remaining authors do not have any conflict of interest regarding the publication of this manuscript.

Funding sources

Neither financial support nor indirect sponsorship was received for this study.

Authors' contributions

All authors have participated sufficiently in the work to take public responsibility for the content. The corresponding author affirms that he had access to all data from the study, both what is reported and what is unreported, and also had complete freedom to direct its analysis and reporting.

H.B.F. conceived and designed the study. A.M. and A.J.A. gathered all clinical and protocol data. M.R.Y. designed the database and entered most of the data.

H.B.F. and A.M. are responsible for data analyses, literature searches, draft and revision of the manuscript's initial versions.

F.S.S., E.R.R., and M.M.V. reviewed the manuscript and provided conceptual guidance for improving the study.

All authors read, critically revised and approved the final version of the manuscript; no other potential authors have been omitted from authorship.

Ethics

The Institutional Review Board of the Puerta de Hierro University Hospital-Majadahonda approved the study (February 12, 2018; n° 03.18).

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Supplementary material (SM)

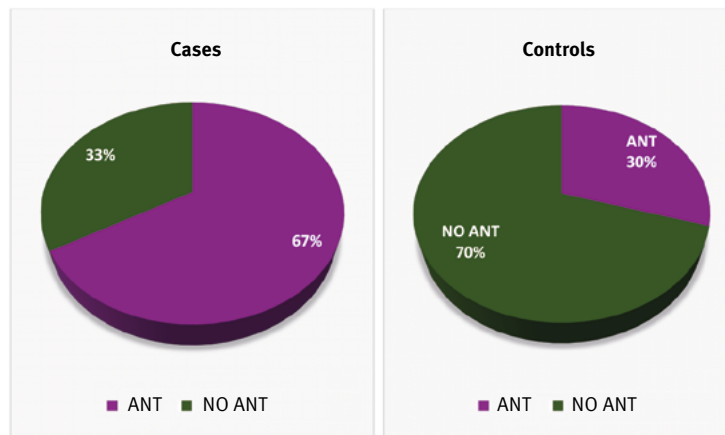


Figure 1-SM. Prevalence of an addiction to new technology (ANT: IAD, IGD, and/or MPA) among cases and controls.

Table 1-SM. Perception of an ANT by parents (responses to question 1 of the ad hoc questionnaire).

	No	Mobile	Video games	Internet	Several	Global
Cases	11 (24.4%)	6 (13.1%)	14 (31.1%)	12 (26.7%)	2 (4.4%)	45 (100%)
Controls	10 (27%)	9 (24.3%)	12 (32.4%)	5 (13.5%)	1 (2.7%)	37 (100%)
Global	21 (25.6%)	15 (18.3%)	26 (31.7%)	17 (20.7%)	3 (3.7%)	82 (100%)

Table 2-SM. Ad hoc questionnaire about a putative ANT (parents).

Item	Cases (%)	Controls (%)	Significance
1. Do you think your child has an addiction to any of the following technologies?			ns
2. Has your child got the urge to use new technologies (mobile, video games, or the Internet) to relieve tension, relax, or decrease psychological distress in the past year?			ns
3. Has your child been using new technologies more frequently or longer lasting than initially planned?			ns
4. Does your child have a persistent desire to quit the use of new technologies, but is unable to stop?			ns
5. Has your child ever missed or reduced a social engagement, work, school, or other recreational activities because he/she was involved in activities related to new technologies?	46.7	21.6	p = .018
6. Does your child continue using new technologies despite knowing the problems related to its use?			ns
7. Has your child tried to stop using new technologies, but is unable to do so or it took him/her a lot of effort?			ns
8. Do you feel that your child needs to spend more and more time on new technologies in order to feel good, less anxious, or emotionally fine?	44.4	2.7	p < .05
9. Does your child feel a strong desire to use new technologies even without any particular reason?	64.4	16.2	p < .05
10. Has your child gotten into trouble at school/work/home due to new technologies?	42.2	0	p < .05
11. Does your child use new technologies in situations in which it is physically hazardous? (i.e., crossing a road while using mobile phone)	22.2	0	p < .05
12. Does your child feel bad, anxious or annoyed when he/she wishes to use new technologies but cannot do so at the time?			ns

