Comorbidity of Internet use disorder and attention deficit hyperactivity disorder: Two adult case–control studies

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Objectives: There is good scientific evidence that attention deficit hyperactivity disorder (ADHD) is both a predictor and a comorbidity of addictive disorders in adulthood. These associations not only focus on substance-related addictions but also on behavioral addictions like gambling disorder and Internet use disorder (IUD). For IUD, systematic reviews have identified ADHD as one of the most prevalent comorbidities besides depressive and anxiety disorders. Yet, there is a need to further understand the connections between both disorders to derive implications for specific treatment and prevention. This is especially the case in adult clinical populations where little is known about these relations so far. This study was meant to further investigate this issue in more detail based on the general hypothesis that there is a decisive intersection of psychopathology and etiology between IUD and ADHD. *Methods:* Two case–control samples were examined at a university hospital. Adult ADHD and IUD patients ran through a comprehensive clinical and psychometrical workup. *Results:* We found support for the hypothesis that ADHD and IUD share psychopathological features. Among patients of each group, we found substantial prevalence rates of a comorbid ADHD in IUD and vice versa. Furthermore, ADHD symptoms were positively associated with media use times and symptoms of Internet addiction in both samples. *Discussion:* Clinical practitioners should be aware of the close relationships between the two disorders both diagnostically and therapeutically. When it comes to regain control over one's Internet use throughout treatment and rehabilitation, a potential shift of addiction must be kept in mind on side of practitioners and patients.

Keywords: attention deficit hyperactivity disorder, online addiction, Internet use disorder

INTRODUCTION

There is a robust body of scientific evidence that attention deficit hyperactivity disorder (ADHD) is both a predictor (Biederman et al., 1995) and a characteristic comorbidity for many addictive disorders (Gillberg et al., 2004). Within a large European sample of patients with substance use disorder, 13.9% were identified with adult ADHD (van Emmerik-van Oortmerssen et al., 2014) with large variability due to the country and the primary substance used (van de Glind et al., 2014). ADHD is a mental disorder that characteristically goes along with difficulties in paying attention and concentrating, excessive activity, and problems with controlling a behavior, which is inappropriate for an individual's age. Especially, but not exclusively, when ADHD persists throughout adolescence and adulthood, which is the case in about 36.3% of cases (Kessler et al., 2005), the risk to develop an addiction to alcohol (Biederman et al., 1995), nicotine (Wilens et al., 2008), or even illegal drugs such as cocaine (Carroll & Rounsaville, 1993) is high. Since stimulants like methylphenidate (MPH) serve as an effective medication (Van der Oord, Prins, Oosterlaan, & Emmelkamp, 2008), substance use and abuse in ADHD patients have also been interpreted as a way of self-medication (Han et al., 2009). Moreover, high levels of impulsivity are characteristic for both patients with ADHD (Winstanley, Eagle, & Robbins, 2006) and with substance use disorders (De Wit, 2009).

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ADHD is also a characteristic comorbidity for pathological gambling, which according to ICD-10 (World Health Organization, 1992) is still to be categorized as an impulse control disorder. By contrast, in 2013, the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) established a common ground for substance and non-substance use disorders. Within the chapter "Substance-Related and Addictive Disorders" the now called "Gambling Disorder" yet is the only recognized behavioral addiction. However, within Section III of DSM-5, Internet gaming disorder (IGD) is first mentioned as a condition warranting more clinical research and experience before it might be fully recognized as a distinct disorder (Petry & O'Brien, 2013). IGD indeed is the one specific variant of Internet addiction that has been studied the most (Young, 1996) and shown the highest prevalence (Rehbein, Kliem, Baier, Mößle, & Petry, 2015). This development does not come as a surprise, not least because online gaming and online gambling increasingly share common features.

Independently from the Internet, video game addiction has already been linked to ADHD psychopathology in several ways (Arfi & Bouvard, 2008; Yen et al., 2017). Systematic reviews have identified ADHD as a typical predictor (Weiss, Baer, Allan, Saran, & Schibuk, 2011) and comorbidity (Weinstein & Weizman, 2012) for IGD especially in children and adolescents. In addition, on a subclinical-level hyperactivity, impulsivity, inattention, deficits in focusing, and concentrating on cognitive tasks have been shown to correlate with the excessive use of video games, both offline and online (Swing, Gentile, Anderson, & Walsh, 2010). Similar findings have been found earlier for excessive TV use (Miller et al., 2007), contributing to an ongoing discussion about whether excessive use of screen media in general and video gaming in particular may not only be a symptom *of* but also a risk factor *for* the development of ADHD (Weiss et al., 2011).

The relationships between the excessive use of certain online applications and ADHD are not fully understood. Yet, it is supposed that online activities, such as gaming etc., provide a continuous stream of stimulation and immediate rewards, which, in turn, is highly appreciated by individuals with ADHD, who tend to be easily bored (Castellanos & Tannock, 2002) and aversive toward delayed gratifications (Diamond, 2005). Other studies hypothesized that this link might be explained by impaired working memory function in ADHD that has been identified as a crucial endophenotype of ADHD (Castellanos & Tannock, 2002). Referring to this, online applications like multiplayer online games provide an on-hand assistance through display of mission objectives to overcome this impairment and therefore overcome frustration and poor performance in real life. Consequently, individuals with ADHD might favor complex online games applications, which make them more vulnerable to develop a pathological media use (Yen, Yen, Chen, Tang, & Ko, 2008). Interestingly, Koepp et al. (1998) reported that video gaming leads to a striatal dopamine release possibly resulting in better concentration and performance, which might be perceived as a relief by individuals whose cognitive skills are impaired in real life. This fits in with the application of specifically designed *serious*

games for the offline treatment of patients with ADHD including neurofeedback applications (Lau, Smit, Fleming, & Riper, 2017). Nowadays, video games are predominantly played on online devices and in online modes. Moreover, online games progressively integrate aspects of gambling, shopping, and social networking (Gainsbury, Hing, Delfabbro, & King, 2014), which contain further addictive features. Analogous behavioral addictions, such as gambling disorder, pathological buying, and hypersexual disorder, which have been linked to ADHD as well (Blankenship & Laaser, 2004; Brook, Chenshu, Brook, & Leukefeld, 2016), manifest themselves more and more online and in this gain a new dynamic and phenomenology (Dittmar, Long, & Bond, 2007; Young, 2008). Considering these continuous developments in terms of digital transfer and merger, it is important to keep an eye on other specific and general forms of excessive or addicted Internet use beyond IGD. Recently, experts tend to apply the term Internet use disorder (IUD; American Psychiatric Association, 2013), which refers to an uncontrollable excessive Internet use that negatively interferes with daily life. In fact, IUD already has been associated with ADHD too. Next to depression and anxiety disorders, it has been found to be a characteristic comorbidity of IUDs in general (Ko, Yen, Yen, Chen, & Chen, 2012). Moreover, patients suffering from both ADHD and IUD seem to have a higher risk to develop another form addiction. In a clinical context, this is a noteworthy finding, since these patients require a distinct awareness concerning a potential shift in addiction pathology throughout withdrawal and rehabilitation. However, little is known about the overlaps and links between IUD and ADHD especially in adult clinical populations. Therefore, it makes sense to further investigate the relationships between ADHD and IUD from a clinical perspective. There have been several studies with large cohorts dealing with these issues mostly on a subclinical level (Yen et al., 2008). Yet, only few studies have been performed with clinical samples consisting either of ADHD (Han et al., 2009) or problematic Internet use (PIU) patients (Bernardi & Pallanti, 2009). To our knowledge, this is the first study to compare a group of adult ADHD patients with a group of adult IUD patients not only with controls but also with each other to further investigate their commonalities and differences. The study stems from the hypothesis that there is a decisive intersection of psychopathology that needs to be addressed distinctively both in therapeutic and preventive medicine. More precisely, we expect that measures of ADHD correlate with measures of Internet addiction to a substantial degree.

METHODS

Two clinical groups (ADHD and IUD) and two control groups were recruited at Hannover Medical School (MHH). Consisting of 25 participants each, this procedure allowed to compare each clinical group with their respective control group and both clinical groups with each other. Within a first appointment, patients with an intention to be treated were thoroughly assessed with a diagnostic interview. Those who fulfilled the criteria of ADHD or IUD, respectively, were

invited to participate in the study being performed at a second appointment.

ADHD group and its control group

The participants of the ADHD group were recruited exclusively from the adult ADHD outpatient clinic of MHH. Patients received a thorough diagnostic assessment regarding their ADHD symptoms and comorbidities. Within the diagnostic process, individuals were invited for the diagnostic main instrument, the clinical interview Conners' Adult ADHD Diagnostic Interview for DSM-IV (CAADID; Epstein, Johnson, & Conners, 2001). Here, the 18 DSM-IV criteria of ADHD subdivided into the two clinical domains of inattention (nine items) and hyperactivity/impulsivity (6/3 items) concerning both childhood and adulthood were assessed by thorough exploration. ADHD was only diagnosed if DSM-IV criteria were fulfilled, that means at least six of nine symptoms had to be present in one or both domains for childhood and adulthood. The assessment was complemented by self-report questionnaires (see below). Over the time span of 1.5 years, 50 survey kits were distributed to the patients who were diagnosed with ADHD, aged between 18 and 65 years and showed an average verbal intelligence level [multiple-choice vocabulary intelligence test (MWT-B) IQ of 100 ± 15]. A total of 25 patients returned their surveys, which equals a response rate of 50%. In the same period of time, the control group was recruited through notices within the MHH matching in terms of distribution of sex, age, and school education. The inclusion criteria for the control group were: average verbal intelligence level and absence of a history of mental disease. Controls were screened for ADHD and IUD.

IUD group and its control group

The IUD group was recruited within the MHH's outpatient clinic for media-associated disorders, specializing in Internet addiction. The inclusion criteria were: diagnosis of IUD according to the criteria of Young (1996) and Beard (Beard & Wolf, 2001) (Table 1) and an intention to treat, age between 18 and 65, and average verbal intelligence level. If inclusion criteria were fulfilled, participants were invited to a clinical interview that contained the collection of anamnestic information. The participants of the control group were recruited within the MHH and were matched for a corresponding distribution of sex, age, and school education. The inclusion criteria for the control group were: average verbal intelligence level and absence of a history of mental disease. Controls were screened for ADHD and IUD. In total, 25 participants with IUD and 25 controls were recruited and consequently included into the study.

The participants of all four groups were informed about the confidential handling of their data and the purpose of the study. Table 2 provides an overview about the demographic data of the samples.

Questionnaires

General questionnaire. The general questionnaire was specifically designed for the studies. The first part included

Table 1. Diagnostic criteria for Internet use disorder

All the following (1–5) must be present:
1. Is preoccupied with the Internet (think about previous online activity or anticipate next online session).
2. Needs to use the Internet with increased amount of time to achieve satisfaction.
3. Has made unsuccessful efforts to control, cut back, or stop Internet use.
4. Is restless, moody, depressed, or irritable when attempting to cut down or stop Internet use.
5. Has stayed online longer than originally intended.

At least one of the following:
1. Has jeopardized or risked the loss of a significant relationship, job, educational, or career opportunity.
2. Has lied to family members, therapist, or others to conceal the extent of involvement with the Internet.
3. Uses the Internet as a way of escaping from problems or of relieving a dysphoric mood (e.g., feelings of helplessness, guilt, anxiety, and depression).

Note. Adapted from Young (1996) and Beard and Wolf (2001).

questions related to demographic information concerning partnership, education, and profession. In addition to that, participants were asked to report preexisting illnesses and former treatments. The second part was designed to assess the media-use behavior. Here, participants could specify their media use in terms of content, frequency, and duration. Furthermore, they were asked about motivational and appetitive aspects concerning their media use and if they eventually perceived themselves as being addicted to a specific media use.

DSM-IV Self-rating Scale for ADHD. The DSM-IV list of symptoms is a retrospective instrument for the diagnosis of ADHD in childhood and adolescence. Basically, it is an adaptation of the diagnostic criteria of the DSM-IV (American Psychiatric Association, 2000). It is composed of 18 items subdivided into the clinical domains of inattention (nine items), hyperactivity (six items), and impulsivity (three items). The tool allows to diagnose the mixed, mainly inattentive or mainly hyperactive subtype of ADHD. To diagnose ADHD, at least six of nine symptoms are consistently present for 6 months in the age span of 6–12 years. With being a direct adaptation of the DSM-IV criteria, this instrument shows high-criterion validity.

Wender Utah Rating Scale (WURS-k). The Wender Utah Rating Scale (WURS) is a popular tool for the retrospective dimensional assessment of ADHD in childhood for adults and has widely been used in this context. Retz-Junginger et al. (2002) developed a German short version (WURS-k) of the WURS containing 25 items representing an economic retrospective assessment of ADHD symptoms in childhood. Participants receive a list of statements from which they are asked to assess how strong a described behavior, attribute, or problem was pronounced within the age between 8 and 10 (e.g., *As a child between 8 and 10 I had problems to concentrate or was easily distractible*). Here, responses can be given on a 5-point Likert scale ranging from [0] does

Table 2. Clinical measures. Mean value (SD)

	ADHD group (n = 25)	Control group (n = 25)	Statistics	IUD group (n = 25)	Control group (n = 25)	Statistics	Statistics (ADHD vs. IUD)
ISS	36.36 (17.45)	23.00 (4.34)	$U = 117.0^{**}$	53.28 (12.99)	24.88 (6.62)	$U = 28.0^{**}$	$U = 135.0^{*}$
Loss of control	9.68 (4.09)	4.84 (1.41)	$U = 72.0^{**}$	11.92 (3.49)	5.28 (2.01)	$U = 41.0^{**}$	$U = 216.0$, n.s.
Withdrawal symptoms	6.56 (3.66)	4.24 (0.72)	$U = 72.0^{*}$	10.12 (3.27)	4.28 (0.74)	$U = 34.0^{**}$	$U = 140.50^{*}$
Development of tolerance	7.92 (4.06)	5.72 (2.51)	$U = 208.0$, n.s.	12.64 (3.29)	6.56 (2.95)	$U = 64.0^{**}$	$U = 114.50^{**}$
Social relationships	6.32 (3.73)	4.12 (0.44)	$U = 192.0^{*}$	10.28 (3.61)	4.36 (1.08)	$U = 50.0^{**}$	$U = 137.50^{*}$
Impact on work performance	5.88 (3.66)	4.08 (0.40)	$U = 221.50$, n.s.	8.32 (3.57)	4.40 (1.44)	$U = 76.0^{**}$	$U = 164.50^{*}$
WURS-k	41.68 (16.52)	10.20 (9.97)	$U = 26.0^{**}$	27.29 (17.30)	13.84 (11.35)	$U = 131.50$, n.s.	$U = 125.0$, n.s.
CAARS (mean T values)							
Inattention/memory problem	80.05 (11.82)	46.56 (8.91)	$U = 2.50^{**}$	61.77 (13.55)	45.08 (8.36)	$U = 67.50^{**}$	$U = 69.50^{**}$
Hyperactivity/restlessness	69.86 (18.19)	48.32 (10.68)	$U = 93.00^{**}$	49.77 (13.81)	49.38 (10.13)	$U = 254.50$, n.s.	$U = 93.00^{*}$
Impulsivity/emotional lability	77.29 (14.21)	47.36 (10.96)	$U = 33.00^{**}$	58.48 (16.55)	48.13 (10.44)	$U = 153.00$, n.s.	$U = 84.00^{**}$
Problems with self-concept	67.14 (12.11)	44.40 (10.80)	$U = 44.00^{*}$	58.68 (13.93)	43.13 (9.82)	$U = 95.50^{**}$	$U = 146.00$, n.s.
DSM-IV: inattentive	80.43 (11.91)	45.16 (7.48)	$U = 4.50^{**}$	57.41 (14.69)	43.79 (7.47)	$U = 112.00^{**}$	$U = 53.00^{**}$
DSM-IV: hyperactive–impulsive	73.29 (14.34)	50.48 (8.90)	$U = 50.00^{**}$	53.14 (14.96)	51.21 (8.83)	$U = 255.00$, n.s.	$U = 76.50^{**}$
DSM-IV: ADHD symptoms	80.29 (12.95)	47.76 (8.51)	$U = 17.50^{**}$	56.27 (14.51)	47.42 (8.40)	$U = 161.00$, n.s.	$U = 56.00^{**}$
ADHD Index	82.00 (10.19)	47.56 (9.92)	$U = 13.00^{**}$	61.09 (15.47)	48.08 (10.95)	$U = 127.50^{*}$	$U = 60.00^{**}$
DSM-IV Self-rating Scale for ADHD							
Combined	9 (36%)	–	$\chi^2 (3) = 31.28^{**}$	3 (12%)	2 (8%)	$\chi^2 (3) = 4.03$, n.s.	$\chi^2 (3) = 14.05^{*}$
Inattentive	8 (38%)	–		2 (8%)	2 (8%)		
Hyperactive–impulsive	1 (4%)	1 (4%)		2 (8%)	2 (8%)		
No	3 (12%)	23 (92%)		15 (60%)	15 (60%)		
BDI	16.96 (9.91)	2.76 (3.66)	$U = 46.50^{**}$	18.54 (8.40)	2.92 (3.42)	$U = 16.50^{**}$	$U = 277.0$, n.s.
SCL-90-R/correlation T value							
GSI	0.94 (0.50)/63	0.23 (0.35)/49	$U = 61.0^{**}$	0.88 (0.45)/62	0.25 (0.36)/50	$U = 74.0^{**}$	$U = 269.00$, n.s.
PST	42.20 (16.92)/59	14.28 (15.78)/48	$U = 70.0^{**}$	40.68 (19.48)/59	15.40 (16.23)/48	$U = 99.50^{**}$	$U = 301.0$, n.s.
PSDI	1.89 (0.43)/63	1.19 (0.33)/49	$U = 59.50^{**}$	1.82 (0.43)/62	1.25 (0.31)/52	$U = 63.50^{**}$	$U = 258.0$, n.s.
MWT-B	29.71 (3.54)	29.40 (3.49)	$U = 287.50$, n.s.	28.65 (3.66)	26.84 (4.39)	$U = 236.50$, n.s.	$U = 236.0$, n.s.

Note. Included data sets within the ADHD group reach from n = 20–25 and in its control group from n = 24–25. Within the IUD group, included data sets reach from n = 20–25 and in its control group from 24 to 25. The gray-shaded areas represent the statistical comparison between the respective clinical and control group. The last column represents the statistical comparison between both clinical groups. ADHD: attention deficit hyperactivity disorder; IUD: Internet use disorder; ISS: Internetsuchtskala; WURS-k: Wender Utah Rating Scale; CAARS: Conners' Adult ADHD Rating Scales; BDI: Beck Depression Inventory; SCL-90-R: Symptom-checklist-90 – Revised; GSI: Global Severity Index; PST: Positive Symptom Total; MWT-B: multiple-choice vocabulary intelligence test; SD: standard deviation; n.s.: not significant.
*p < .01. **p < .001.

not apply to [4] strongly pronounced. For the general score, a cut-off of 30 points indicates a preexisting ADHD in childhood. The short version showed satisfactory psychometrical properties in terms of factor structure, reliability (split-half: $r12 = .85$) and internal consistency ($\alpha = 0.91$) (Retz-Junginger et al., 2003).

Conners' Adult ADHD Rating Scales (CAARS). Developed in 1999 by Conners [see Macey (2003) for a detailed discription], the CAARS have become one of the best-validated instruments to diagnose and assess ADHD symptomatology in adulthood. Here, in the presented studies, the self-report's long version with 66 items has been applied. Respondents are asked to assess, how much, or often a given statement (e.g., *I am frustrated easily*) applies to their personal experience. Answers are given on a 4-point Likert scale ranging [0] not at all/never, [1] little/ sometimes, [2] strong/often, and [3] very strong/very often. The long version of the self-report allows a division into eight subscales, e.g., for inattention, hyperactivity/impulsi- vity, and overall ADHD symptomatology based on the DSM-IV criteria for ADHD. The German adaptation of Christiansen, Hirsch, Abdel-Hamid, and Kis (2014) has demonstrated good reliability and validity.

Criteria for IUD. As IUD is a relatively new pheno- menon and because of the yet pending phenomenological classification as an impulse control disorder or a behavioral addiction, it is not yet fully recognized as a clinical entity within ICD-10 and/or DSM-IV. Nevertheless, a growing body of research shows that the criteria for substance-related disorders can also be applied to Internet addiction. One approach in line with this research comes from Young (1996) who developed eight criteria from which at least five have to be present to diagnose Internet addiction. Beard and Wolf (2001) provided a modification of the use of the eight criteria. According to their definition, the presence of the first five items, focusing on the primary addictive behavior, is obligatory to diagnose Internet addiction. And, at least one out of the three last criteria has to be present, which rather describe the impairment in daily functioning due to the addictive behavior. Within the study, the stricter criteria as proposed by Beard and Wolf were applied (Table 1).

Internetsuchtskala (ISS). Within German-speaking coun- tries, the ISS [free translation: Internet Addiction Scale, not to be mistaken with the Internet Addiction Scale (IAS) of Griffiths (1998)] by Hahn and Jerusalem (2003) is a fairly well-validated instrument to assess IUD. Twenty items cover five aspects of IUD: loss of control (e.g., *I spend more time on the Internet as originally intended*), withdrawal symptoms (e.g., *When I cannot be online, I feel irritated and discontent*), development of tolerance (e.g., *My everyday life gets increas- ingly dominated by the Internet*), negative impact on work performance (e.g., *My performance within school or work is negatively affected by my Internet use*), and negative impact on social relationships (e.g., *Since I discovered the Internet, I undertake less activities with others*). Every subscale consists of four items. Responses are made on a 4-point Likert scale ranging [1] does not apply, [2] does barely apply, [3] does rather apply, and [4] does exactly apply. The cut-off score to identify IUD has been set to >59 (mean response of 3), whereas a score between 50 and 59 (mean response of

2, 5) indicates a misuse and a risk to develop IUD. The ISS showed satisfactory psychometrical properties in terms of internal consistency of $\alpha = 0.93$ for the overall score and $\alpha = 0.80$ for the five subscales as well as the validity with external criteria, e.g., impulsivity (for a review, see Hahn & Jerusalem, 2010).

Beck Depression Inventory (BDI). The DSM-based BDI (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) is one of the most common instruments for measuring depression both in clinical research and practice. Its excellent psychometrical properties allow a reliable and valid assessment of depression severity. The German adaptation (Hautzinger, Keller, & Kühner, 2006) consists of 21 items allowing to calculate an overall score. Responses are made on a 4-point Likert scale. Values from 0 to 13 represent no depression, values from 14 to 19 code a mild depression, values from 20 to 28 indicate a moderate depression, and values above 28 indicate a severe depression. The German adaptation of the BDI has shown a high reliability and criterion validity (Kühner, Bürger, Keller, & Hautzinger, 2007).

Symptom-checklist-90 – Revised (SCL-90-R). The SCL-90-R (Derogatis, 1977) measures the subjective impairment by physical and psychological symptoms within the past 7 days. The questionnaire consists of 90 items from which 83 items cover nine symptom areas: somatization, obsessive–compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The total of nine items add up to several global indices (see below). The respondents are asked to indicate how strongly they suffered under a distinct symptom within the past 7 days. Responses are made on a 5-point Likert scale. The inventory allows to form three global indices: Global Severity Index, Positive Symptom Total, and Positive Symptom Distress Index. The German adaptation of Franke (2016) showed high internal consis- tencies for the global scale and all subscales as well as good convergent validities (Schmitz et al., 2000).

Multiple-choice vocabulary intelligence test (MWT-B). The MWT-B by Lehrl, Triebig, and Fischer (1995) is an inventory assessing the general intelligence level in terms of crystalline verbal intelligence among adults from age 20 to 64. It consists of 37 items from which respondents are asked to find and mark the only German word in a row of five words that actually exists. It is a very economic tool as completion normally takes only 5 min. The raw score (number of correct answers) can be transformed into an IQ value by considering the person's age.

Data Analysis

To investigate whether the data allow parametric methods of analysis, a mixed approach was chosen. First, signifi- cance tests (Kolmogorov–Smirnov and Shapiro–Wilk tests) were used to investigate the normality of the dis- tributions. In addition, graphical (histograms, Q–Q plots, and P–P plots) and numerical approaches, which include the calculation of skew and kurtosis of the distributions, were used to analyze the normality of the data. For the analysis of the clinical measures, simple comparisons of means were chosen. Where parametric approaches were suitable, independent samples *t*-tests were carried out. For

non-parametric approaches, Mann–Whitney U tests were performed. Missing data sets are highlighted in the footnotes of the tables. For categorical variables, χ^2 tests were computed. Due to the small sample sizes and the multiple comparisons within the samples, the significance level was set to 0.01 (two-tailed) for all analysis. Therefore, the presented statistics represent a conservative analysis approach.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki and according to requirements of all applicable local and international ethical standards. The institutional ethics committee [Hannover Medical School] approved the study. All subjects were informed about the study and all provided informed consent and were not compensated for their participation.

RESULTS

Clinical measures

All ADHD patients were diagnosed on the basis of the CAADID that was conducted by experienced clinical specialists. Application of questionnaires was an additional supplement. It has to be considered that a diagnosis mostly based on the structured clinical interview does not necessarily mean that all individuals reach the distinct cut-off in the questionnaires (Table 3).

DSM-IV Self-rating Scale for ADHD. About 18 of 25 ADHD patients (72%) reached the cut-off in this self-rating scale. This group mainly fulfilled the criteria for the combined subtype (36%) directly followed by the inattentive subtype (32%). In one case, a hyperactive–impulsive subtype was found (4%) and three participants did not reach the cut-off (12%). Four data sets concerning information of DSM criteria were missing (16%).

About 7 of 25 IUD patients (28%) tested positive for ADHD in the DSM criteria. Here, the combined subtype was most prevalent (12%). Two cases were tested positive for the inattentive subtype (8%) and the hyperactive–impulsive subtype (8%). In 15 cases (60%), the psychometrical cut-off for ADHD was not reached and three data sets (12%) were missing. There was no significant difference between the IUD group and their controls regarding the DSM criteria. Finally, both clinical groups significantly differed from each other with regard to the distribution of the combined and inattentive subtype in favor of the ADHD group. No significant difference was found concerning the hyperactive–impulsive subtype.

WURS-k. The results on the WURS-k indicate a preexisting ADHD for the ADHD group on the basis of the mean score ($M = 41.68$, $SD = 16.52$). On an individual level, 18 (72%) participants showed a value equal or above the cut-off of 30. In total, the ADHD group significantly differed from their controls ($U = 26.00$, $p < .001$). Considering the mean score, the IUD group showed a high value on the WURS-k being close to the proposed cut-off indicating an elevated ADHD symptomatology in childhood ($M = 27.29$, $SD = 17.30$). On

Table 3. Sample demographics

	ADHD group (n = 25)	Statistics	Control group (n = 25)	IUD group (n = 25)	Statistics	Control group (n = 25)	Statistics (ADHD vs. IUD)
Sex (male/female)	14/11		14/11	19/6		19/6	
Age [mean in years (SD)]	38.8 (10.22)	$U = 301.0$, n.s.	38.16 (10.84)	29.36 (10.76)	$U = 302.0$, n.s.	29.48 (9.96)	$U = 158.5$, n.s.
IQ [mean (SD)]	109.92 (14.43)	$U = 289.50$, n.s	108.36 (11.22)	106.61 (13.11)	$U = 236.50$, n.s.	101.72 (10.10)	$U = 236.0$, n.s.
School education (%)							
School student	–		5 (20%)	1 (4%)		1 (4%)	
Secondary modern school	8 (32%)	$\chi^2(2) = 2.03$, n.s.		2 (8%)	$\chi^2(3) = 0.36$, n.s.	2 (8%)	$\chi^2(3) = 5.92$, n.s.
Middle school	10 (40%)		15 (60%)	10 (40%)		12 (48%)	
High school/grammar school	7 (28%)		5 (20%)	12(48%)		10 (40%)	
Professional education (%)							
None	4 (16%)		2 (8%)	9 (36%)		4 (16%)	
In education (apprenticeship)	–		–	3 (12%)		–	
Finished apprenticeship	14 (56%)	$\chi^2(5) = 3.47$, n.s	16 (64%)	6 (24%)	$\chi^2(6) = 13.61$, n.s.	11 (44%)	$\chi^2(6) = 12.92$, n.s.
Technical college	4 (16%)		2 (8%)	1 (4%)		2 (8%)	
University degree	2 (8%)		4 (16%)	5 (20%)		5 (20%)	
Other	–		–	–		3 (12%)	

(Continued)

Table 3. (Continued)

	ADHD group (n = 25)	Control group (n = 25)	Statistics	IUD group (n = 25)	Control group (n = 25)	Statistics	Statistics (ADHD vs. IUD)
Occupational status/work (%)							
Yes, learned	9 (36%)	16 (64%)	$\chi^2(5) = 5.00$, n.s.	9 (36%)	15 (60%)	$\chi^2(6) = 12.41$, n.s.	$\chi^2(7) = 10.29$, n.s.
Yes, other	6 (24%)	5 (20%)		2 (8%)	3 (12%)		
Yes, protected	1 (4%)	–		–	–		
No, family break	2 (8%)	1 (4%)		–	2 (8%)		
No, without job	5 (20%)	2 (8%)		6 (24%)	1 (4%)		
No, permanent sick leave	–	–		4 (16%)	–		
No, in pension	–	–		1 (4%)	–		
No, other	2 (8%)	1 (4%)		3 (12%)	4 (16%)		
Partnership (%)							
Single	6 (24%)	4 (16%)	$\chi^2(3) = 3.09$, n.s.	11 (44%)	9 (36%)	$\chi^2(4) = 8.38$, n.s.	$\chi^2(4) = 12.77$, n.s.
In partnership	7 (28%)	6 (24%)		12 (48%)	10 (40%)		
Married	8 (32%)	14 (56%)		–	6 (24%)		
Separated/divorced	3 (12%)	1 (4%)		1 (4%)	–		
Widowed	–	–		1 (4%)	–		
Preexisting illnesses [n (%)]							
Depression	14 (56%)	0%	–	12 (48%)	0%	–	$\chi^2(1) = 0.32$, n.s.
Anxiety disorder	7 (28%)	0%	–	6 (24%)	0%	–	$\chi^2(1) = 0.10$, n.s.
OCD	1 (4%)	0%	–	1 (4%)	0%	–	$\chi^2(1) = 0$, n.s.
Eating disorder	4 (16%)	0%	–	2 (8%)	0%	–	$\chi^2(1) = 0.76$, n.s.
Adaptive disorder	1 (4%)	0%	–	–	0%	–	$\chi^2(1) = 1.02$, n.s.
Somatization disorder	1 (4%)	0%	–	–	0%	–	$\chi^2(1) = 1.02$, n.s.
Psychosomatic disorder	5 (20%)	0%	–	3 (12%)	0%	–	$\chi^2(1) = 0.60$, n.s.
PTSD	2 (8%)	0%	–	–	0%	–	–
Dissociative identity disorder	–	0%	–	2 (8%)	0%	–	–
Borderline personality	1 (4%)	0%	–	–	0%	–	–
Other personality disorder	1 (4%)	0%	–	2 (8%)	0%	–	$\chi^2(1) = 0.36$, n.s.
Addictive disorder	3 (12%)	0%	–	1 (4%)	0%	–	$\chi^2(1) = 1.09$, n.s.
Schizophrenia	1 (4%)	0%	–	1 (4%)	0%	–	$\chi^2(1) = 0$, n.s.
ADHD	10 (40%)	0%	–	0 (0%)	0%	–	$\chi^2(1) = 12.50*$
Other	0 (0%)	0%	–	4 (16%)	0%	–	$\chi^2(1) = 4.35$

Note. The gray-shaded areas represent the statistical comparison between the respective clinical and control group. The final column represents the statistical comparison between both clinical groups.
SD: standard deviation; IUD: Internet use disorder; ADHD: attention deficit hyperactivity disorder; OCD: obsessive compulsive disorder; PTSD: posttraumatic stress disorder.
Four data sets missing, one data set missing, three data sets missing.
*$p < .01$. **$p < .001$.

the individual level, eight IUD cases (32%) reached a value, which was equal or above the cut-off. Both clinical groups did not differ significantly from each other with regard to their self-reported ADHD symptomatology in childhood.

CAARS. As the CAARS do not provide a cut-off on the basis of raw scores and only have sex-specific norms, *t*-scores of the manual by Christiansen et al. (2014) are reported to assess the dimensions of current ADHD symptomatology. Here, *t*-scores equal or above 65 are rated as clinically relevant. The *t*-scores between 60 and 65 imply an elevated symptomatology, which is above the normal level and marked as borderline to the clinical relevant dimensions. The ADHD group showed highly elevated and clinically relevant scores on all dimensions of the CAARS and differed significantly from their controls. On the individual level, 19 individuals (76%) of the ADHD group showed clinical relevant levels on the DSM-IV implying an ongoing ADHD in the majority of cases. The IUD group showed slightly to moderate elevated scores on the CAARS. They significantly differed from their controls on several dimensions except the subscales hyperactivity, impulsivity, DSM-IV hyperactive–impulsive, and DSM-IV ADHD symptoms. On the individual level, five cases (20%) fulfilled the criteria on the CAARS DSM-IV ADHD measure. In direct comparison between both clinical groups, the ADHD group significantly differed on the vast majority of the CAARS dimension except the problems with self-concept measure from the IUD group.

ISS. Overall, the ADHD patients showed a significantly higher total ISS score as compared with their controls [($M = 36.36$, $SD = 17.45$) vs. ($M = 23.00$, $SD = 4.34$)], whereas the mean did not reach the cut-off for problematic or pathological Internet use. On the subscale level, the ADHD group significantly showed higher levels for loss of control ($M = 9.68$, $SD = 4.09$), withdrawal symptoms ($M = 6.56$, $SD = 3.66$), and negative impact on social relationships ($M = 6.32$, $SD = 3.73$) compared with their controls. On the individual level, five patients (20%) showed scores equal or above the cut-off for the risk to develop an Internet addiction. Three patients (12%) actually showed values that were equal or above the cut-off for addiction. Within the IUD group, the ISS indicated a problematic use for four patients (16%) and a pathological Internet use for 10 patients (40%). On the subscale level, the IUD group showed a significant higher loss of control ($M = 11.92$, $SD = 3.49$), withdrawal symptoms ($M = 10.12$, $SD = 3.27$), development of tolerance ($M = 12.64$, $SD = 3.29$), negative impact on social relationships ($M = 10.28$, $SD = 3.61$), and work performance ($M = 8.32$, $SD = 4.40$) compared with their controls. In direct comparison, the IUD group exceeded the ADHD group significantly on any dimension of the ISS except the *loss of control* subscale.

BDI and SCL-90-R. Overall, the ADHD patients showed values indicative for a mild depression ($M = 16.96$, $SD = 9.91$). Furthermore, they significantly differed from their controls. Among the ADHD patients, 13 (52%) were assessed as being clinically depressed. The IUD group showed a slightly more severe depression symptomatology, which was still mild in terms of the BDI ($M = 18.54$, $SD = 8.40$). Here, 15 patients (60%) were assessed as being clinically depressed. Again, this group significantly differed from their controls. There was no significant difference

between both clinical groups. With regard to the SCL-90-R, both clinical groups significantly differed from their controls on all indices. In direct comparison, both clinical groups did not show significant differences but showed elevated scores, which were formally on the edge to be clinical relevant. Overall, both clinical groups showed an elevated symptom load indicating a relevant level of strain.

Sociodemographic variables

Briefly, the analysis revealed that in the majority of cases, no normal distribution of the data could be assumed (see Table 4). Only a small number of variables showed to be normally distributed, but as a non-parametric approach (e.g., Mann–Whitney *U* tests) can also be applied to these cases, a non-parametric approach was chosen for the whole data set.

ADHD group versus control group. The analysis revealed no significant difference in terms of sex, age, education, occupational status, and partnership between the ADHD group and its control group. Most notably, in line with the inclusion criteria, the ADHD group differed from its control group in terms of reported preexisting illnesses. Here, depression and anxiety disorders were the most frequent conditions. To a lesser extent, eating and psychosomatic disorders were reported within the ADHD group.

IUD group versus control group. The analysis revealed no significant differences concerning the demographic variables between the IUD and its control group. The IUD group reported more preexisting illnesses as their controls. Again, depression and anxiety disorders were the most frequent conditions.

ADHD versus IUD. On the vast majority of the sociodemographic variables, no significant differences between both clinical groups could be found. As expected, the ADHD group reported a preexisting ADHD significantly more frequently.

Media use

ADHD group versus control group. There were no significant differences between the variables of Internet use between the ADHD group and their controls. Same accounts for the variables for video games. Concerning the motivation to use video games, there was one notable pattern. ADHD patients reported to use video games to stimulate, to overcome loneliness, and/or for socialization needs, whereas none of the controls did so. Another major motivation to use video games among ADHD patients was for relaxation. The motive to use the Internet among individuals within the ADHD group was mainly due to interest. The ADHD group significantly reported more often as compared with their controls to perceive themselves as being addicted from video games [11 vs. 0, $\chi^2 (1) = 12.76$, $p < .001$].

IUD versus control group. The IUD group used video games significantly more frequently in comparison with their controls [21 vs. 10, $\chi^2 (1) = 11.89$, $p < .001$]. There was also a significant difference concerning the hours spent per day with video games in favor of the IUD group [($M = 6.47$, $SD = 5.41$) vs. ($M = 1.94$, $SD = 0.95$), $U = 18.00$,

Table 4. Media use. Mean (SD)

	ADHD group (n = 25)	Control group (n = 25)	Statistics	IUD group (n = 25)	Control group (n = 25)	Statistics	Statistics (ADHD vs. IUD)
Video games [n (%)]	15 (60)	9 (36)	χ^2 (1) = 2.89, n.s.	21 (87.5)[a]	10 (40)	χ^2 (1) = 11.89**	χ^2 (1) = 4.75, n.s.
Video games use since (years)	9.3 (5.95)	13.3 (6.98)	U = 47.0, n.s.	13.15 (6.26)	12.9 (6.15)	U = 93.00, n.s.	U = 99.00, n.s.
Video games use (days/week)	4.61 (2.34)	2.31 (2.05)	U = 55.0, n.s.	5.90 (2.02)	2.75 (2.53)	U = 240.00, n.s.	U = 88.50*
Video games use (hours/day)	3.69 (3.12)	1.81 (1.31)	U = 32.50, n.s.	6.47 (5.41)	1.94 (0.95)	U = 18.00**	U = 81.50, n.s.
Motivation to play video games [n (%)]							
Interest	7 (46.7)	4 (44.4)		10 (47.6)	5 (50)		
Entertainment	10 (66.7)	7 (77.8)		16 (76.2)	9 (90)		
Boredom	5 (33.3)	3 (33.3)		14 (66.7)	4 (40)		
Relaxation	7 (46.7)	1 (11.1)		5 (23.8)	1 (90)		
Stimulation	1 (6.7)	0 (0)		1 (4.8)	0 (0)		
Loneliness	3 (20)	0 (0)		3 (14.3)	0 (0)		
Socialization	1 (6.7)	0 (0)		5 (23.8)	0 (0)		
Self-perceived addiction [n (%)]	11 (73.3)	0 (0)	χ^2 (1) = 12.76**	12 (57.1)	1 (10)	χ^2 (1) = 7.60*	χ^2 (1) = 0.52, n.s.
Internet [n (%)]	24 (96)	21 (84)	χ^2 (1) = 2.00, n.s.	23 (95.8)	23 (92)	χ^2 (1) = 0.31, n.s.	χ^2 (1) = 0.001, n.s.
Internet use since (years)	5.08 (2.86)	5.86 (2.20)	U = 208.50, n.s.	7.43 (3.67)	5.65 (2.60)	U = 203.50, n.s.	U = 181.50, n.s.
Internet use (days/week)	4.96 (2.20)	3.48 (2.52)	U = 168.00, n.s.	6.96 (0.21)	3.96 (2.57)	U = 143.00**	U = 121.00**
Internet use (hours/day)	2.50 (2.43)	1.64 (1.97)	U = 134.50, n.s.	6.47 (4.07)[a]	2.20 (2.52)	U = 66.00**	U = 65.00**
Motivation to use Internet [n (%)]							
Interest	22 (91.7)	21 (100)		16 (69.6)	22 (95.7)		
Entertainment	10 (41.7)	4 (19)		14 (60.9)	8 (34.8)		
Boredom	5 (20.8)	2 (9.5)		14 (60.9)	4 (17.4)		
Relaxation	2 (8.3)	0 (0)		4 (17.4)	0 (0)		
Stimulation	6 (25)	7 (33.3)		5 (21.7)	6 (26.1)		
Loneliness	1 (4.2)	0 (0)		6 (26.1)	0 (0)		
Socialization	10 (41.7)	2 (9.5)		11 (47.8)	2 (8.7)		
Self-perceived addiction [n (%)]	6 (25)	2 (9.5)	χ^2 (1) = 2.02, n.s.	17 (73.9)	3 (13)	χ^2 (1) = 20.42**	χ^2 (1) = 14.03**

Note. The gray-shaded areas represent the statistical comparison between the respective clinical and control group. The last column represents the statistical comparison between both clinical groups.
SD: standard deviation; IUD: Internet use disorder; ADHD: attention deficit hyperactivity disorder; n.s.: not significant.
[a]One data set missing, four data sets missing.
*p < .01. **p < .001.

$p < .001$]. Concerning the Internet use, the IUD group spent significantly more hours per day using the Internet in comparison with their controls [($M = 6.47$, $SD = 4.07$) vs. ($M = 2.20$, $SD = 2.52$), $U = 66.0$, $p < .001$]. The distinctive motivational pattern to use video games found among ADHD patients was also found among IUD patients. The motives to use the Internet among individuals with IUD were mainly due to interest. The IUD patients reported to perceive themselves as being addicted from video games [12 vs. 1, $\chi^2 (1) = 7.60$, $p = .006$] significantly more frequently as their controls.

ADHD versus IUD. The participants of the IUD group significantly spent more days per week with playing video games [($M = 5.90$, $SD = 2.02$) vs. ($M = 4.61$, $SD = 2.34$), $U = 88.50$, $p < .05$], although they did not spend significantly more hours per day with it [($M = 6.47$, $SD = 5.41$) vs. ($M = 3.69$, $SD = 3.12$), $U = 81.50$, $p > .05$]. The motivation to use video games within the IUD group differed from the ADHD group in terms of a higher tendency to avoid boredom. In addition, social needs were a more prominent motive within the IUD group. The use of video games for relaxation was more pronounced within the ADHD group. In direct comparison of both clinical groups, there was no significant difference concerning self-perceived addiction video games. The IUD group did use the Internet for significantly more hours per day [($M = 6.47$, $SD = 4.07$) vs. ($M = 2.5$, $SD = 2.43$), $U = 65.0$, $p < .001$]. The motivation to use the Internet differed in terms of boredom, loneliness, entertainment, and relaxation in favor of the IUD group.

Comorbidities

To further explore and elucidate the converging lines and associations between both disorders, patients who reached the respective cut-offs on the measures of ADHD and IUD were separately examined. Here, patients who showed a value higher than or equal to 50 on the ISS and a T-value higher than or equal to 65 on the CAARS DSM-IV ADHD measure were included into this subgroup. This procedure resulted in eight patients stemming from both groups in equal shares. This group consisted of five males and three females with a mean age of 41.6 years ($SD = 10.23$). About 75% were employed and 62.5% had a partner. According to the WURS-k, 87.5% fulfilled the criteria for ADHD in childhood (mainly combined subtype). Consequently, this group showed a high WURS-k value ($M = 49.88$, $SD = 16.19$) also indicating preexisting ADHD in childhood. Concerning their media use, 62.5% of this group reported to play video games on average for 4.40 years ($SD = 2.07$) on 6 days/week ($SD = 1.73$) at an average of 4.60 hr ($SD = 4.22$) mainly for entertainment (60%) and relaxation (60%). The Internet was used by patients in this group on average since 7.75 years ($SD = 3.77$). Furthermore, they reported to use the Internet in the mean on 6 hr/day ($SD = 5.90$) mainly for entertainment (62.5%), interest (62.5%), and socialization (50%). Overall, the group exceeded the cut-off for addiction on the ISS ($M = 61.50$, $SD = 9.53$). The values on the CAARS DSM-IV: ADHD measure can be considered as highly clinically relevant ($M = 81.75$, $SD = 7.72$). Finally, this subgroup could be described as mildly depressed ($M = 17.13$, $SD = 7.10$).

Correlations

Overall, the used instruments showed high internal consistencies and captured the underlying constructs in a satisfactory way (Table 5). Within the ADHD group, the WURS-k and the hours of Internet use showed a strong and significant relation ($r = .630$, $p < .01$). Interestingly, this association was only weak within the IUD sample and failed to show significance ($r = .264$, n.s.). The relationship between video game use in hours and the WURS-k within the ADHD sample was high but not significant ($r = .564$, $p = .056$). Interestingly, this was not the case within the IUD sample ($r = .297$, n.s.). Within the ADHD sample, there was a moderate but non-significant correlation between ISS and Internet use in hours ($r = .472$, n.s.), which was not the case within the IUD sample ($r = .171$, n.s.). Within the IUD sample, the CAARS hyperactivity measure was associated with the Internet use in hours to a moderate, non-significant degree ($r = .453$, n.s.). Within the group of patients being diagnosed with both ADHD and IUD, there was a strong and significant correlation between the WURS-k and the ISS ($r = .884$, $p < .01$) (not displayed in Table 5).

DISCUSSION

IUD group

As expected, patients diagnosed with IUD significantly differed on all measures of Internet addiction from their controls. We found a similar pattern with regard to some measures of adult ADHD.

ADHD diagnosis within IUD. Within the patients diagnosed with IUD, we found substantial prevalence rates of ADHD. High prevalence numbers of childhood ADHD within the group of IUD patients indicate that ADHD might represent a substantial risk factor for the onset and development of IUD. Support for this notion stems, e.g., from the area of nicotine and alcohol dependence. Here, Ohlmeier et al. (2007) found that almost one fourth in a group of alcohol-dependent patients could be diagnosed with ADHD in childhood. Additional support from the area of Internet addiction comes from Dalbudak and Evren (2014). In their investigation of college students, they found a strong and significant correlation between the WURS-25 measure and the IAS. In this study, 20% of the IUD patients were identified with symptoms of adult ADHD. Taking these numbers, we see support for our notion of strong associations between both disorders. As the body of literature on this topic, especially in an adult clinical context, is still small, only Bernardi and Pallanti (2009) provide data to compare these findings. Here, they found that 20% of their adult outpatients, who were identified as addicted by the Internet in terms of Young's (1998) IAS, fulfilled the criteria for adult ADHD. As their findings matched with our results, we are confident in the validity of our data. Additional data come from Ko, Yen, Chen, Chen, and Yen (2008) who investigated psychiatric comorbidity in a sample of adult college students with Internet addiction. Here, the students ran through a psychiatric diagnostic interview and 32.2% were identified as having ADHD. Despite the non-clinical

Table 5. Scale correlations and internal consistencies (left: ADHD and right IUD) in the diagonal for the ADHD (below the diagonal) and IUD sample (above the diagonal)

Scale	1	2	3	4	5	6	7	8	9
1. WURS-k	0.919 0.907	-0.022	0.627	0.223	0.715*	0.208	0.611*	0.264	0.297
2. ISS	0.394	0.977 0.918	0.232	0.218	0.159	0.169	0.236	0.171	-0.319
3. CAARS DSM-IV: ADHD	0.509	0.364	0.932 0.929	0.891*	0.830*	-0.281	0.442	0.315	-0.147
4. CAARS DSM-IV: inattention	0.389	0.396	0.891*	0.888 0.866	0.285	-0.315	0.159	-0.017	-0.200
5. CAARS DSM-IV: hyperactive	0.523	0.271	0.919*	0.640*	0.838 0.898	-0.147	0.525	0.453	-0.077
6. BDI	-0.011	0.357	0.176	0.143	0.174	0.881 0.820	0.294	0.216	-0.050
7. SCL-90 (GSI)	-0.206	0.104	0.276	0.304	0.203	0.580*	0.962 0.945	0.298	-0.042
8. Internet use (hr)	0.630*	0.472	0.418	0.385	0.392	0.025	-0.223	–	-0.078
9. Video games use (hr)	0.564	0.418	0.313	0.231	0.342	0.209	-0.158	0.818*	–

Note. Pearson's correlations, included data sets reach from 12 to 25 (ADHD group) and 17 to 24 (IUD group). WURS-k: Wender Utah Rating Scale; ISS: Internetsuchtskala; IUD: Internet use disorder; ADHD: attention deficit hyperactivity disorder; CAARS: Conners' Adult ADHD Rating Scales; BDI: Beck Depression Inventory; SCL-90-R: Symptom-checklist-90; GSI: Global Severity Index.

*$p < .01$; p values are two-sided.

context, these results still demonstrate that ADHD and IUD show substantial associations.

IUD – Motivational aspects and correlations. With regard to the motives for using certain online applications, we found an interesting pattern within the group of patients diagnosed with IUD. As reported, video games were utilized to stimulate, to overcome loneliness, and to socialize with others within the IUD group, whereas none of their controls reported such motivation. In addition, boredom was a major motive among patients diagnosed with IUD. In a sample of university students, Skues, Williams, Oldmeadow, and Wise (2016) identified boredom proneness as a predictor of PIU. Furthermore, loneliness was both associated with boredom and PIU but was not a significant predictor in the model. They conclude that university students prone to experience boredom tend to use the Internet to seek for stimulation and satisfaction as a compensation. Based on our data, we share this view as we found boredom and entertainment to be the major motives to engage in online activities, both for video games and the Internet in general. With regard to the linear relationships, we found only weak or even negative relationships between the clinical measures and external aspects like media use times. Here, it has to be stated that media use hours are not viewed as a valid criterion to diagnose IUD. Clinical criteria such as those by Young (1996) and Beard and Wolf (2001) are gold standard including adverse effects of IUD in private and professional aspects of life. This aspect is underlined by an investigation of Hahn and Jerusalem (2010) who reported a correlation about only $r = .40$ between the ISS and the mean media use times within a week. However, it has to be stated that this investigation took place in a non-clinical sample.

ADHD group

With regard to symptoms of Internet addiction, the ADHD patients significantly differed from their controls on most measures.

IUD diagnosis within ADHD. The analysis of the ISS revealed that 20% of the patients diagnosed with ADHD showed values, which were above the cut-off for problematic and pathological Internet use. To our knowledge, this is the first study that provides data concerning media use within an adult and clinical ADHD population. Therefore, a direct comparison of these results is difficult. Han et al. (2009) investigated a sample of children diagnosed with ADHD and found 45% to be addicted to the Internet in terms of elevated levels on the IAS. Although our sample differs in terms of age and the applied instruments, we still see support for our view that IUD is a matter of concern not only in children but also in adults with ADHD. Future studies in larger clinical adult populations are needed to provide more data concerning prevalence rates. The ISS cut-offs to define a problematic or pathological media use are known to be set quite high due to the publicized norms. Therefore, it seems reasonable to suppose an even higher prevalence rate of IUD among adults diagnosed with ADHD.

ADHD – Motivational aspects and correlations. Concerning the motivational aspects of the media use within patients diagnosed with ADHD, we found a notable pattern. One major motive among ADHD patients to play video games was for relaxation. Of course, this is not pathological

in itself, but still of interest as this motive was mostly present within patients diagnosed with ADHD compared with all other groups. From a biological point of view, it is well known that ADHD is associated with low dopamine function (Friedel et al., 2007; Gold, Blum, Oscar-Berman, & Braverman, 2014; Volkow et al., 2009). As playing video games has been linked to striatal dopamine release (Koepp et al., 1998) gaming might be interpreted as a way of self-medication in terms of relaxation. The self-medication hypothesis has also been proposed to explain the elevated prevalence of substance use disorders among individuals with ADHD (for an overview, see Biederman et al., 1995). Therefore, here, the reported motive to use video games for relaxation could be interpreted as the emotional impact of dopamine release while playing. As the body of literature within adult and clinical ADHD patients is small, this idea remains speculative. On the level of correlations, we found significant associations between the WURS-k and media use times. The correlation between the WURS-k and the video games use in hours was indeed not significant but still high. Here, the small sample size and the conservative significance level might have prevented significance. Nevertheless, these elevated relations are of interest as there is some evidence that retrospectively reported ADHD symptoms relate to concrete outcome measures of addictive behaviors. In a large, population-based sample of young adults, Kollins, McClernon, and Fuemmeler (2005) found a significant linear relationship between the retrospectively reported symptoms of ADHD within the years of 5–12 and the number of cigarettes smoked per day. In more detail, the number of reported symptoms of inattention correlated positively with the number of cigarettes smoked per day. Here, we see some converging lines to our data, which might further support the self-medication hypothesis.

Double diagnosis – ADHD and IUD. Within the small subgroup of patients who showed problematic to pathological scores on the ISS and clinical significant scores on the CAARS ADHD measure, we found a strong and significant correlation between the WURS-k and the ISS. This relationship differenciated this subgroup from the clinical groups either diagnosed with ADHD or IUD, where the same relationship was only weak. This finding may further underline the significance of childhood ADHD being a predictor for the onset and development of IUD.

Strengths and limitations

This is, to our knowledge, the first study to provide a closer investigation comparing samples of patients diagnosed with ADHD and IUD (and their controls) providing further evidence for interdependencies and stimulating further research in this regard. This study used a comprehensive psychometrical and clinical approach, which worked with a broad variety of variables and well-established instruments capturing several constructs of interest thus allowing us to investigate and evaluate multiple associations. As this is a cross-sectional study, we cannot make causal inferences about the associations we found. As ADHD normally has its onset at the age of 7, it can be speculated if at least some of the found associations relate to ADHD symptoms. Nevertheless, this cannot replace a longitudinal design, which is of

essence when it comes to investigate and evaluate the developmental interferences between ADHD and IUD. Another aspect limiting our interpretations was the relatively small sample sizes partly due to missing data. Moreover, the specific clinical diagnostic workups for the ADHD and IUD patients were not applied vice versa, which is problematic since the results of the self-report questionnaires do not necessarily indicate a diagnosis. Therefore, our findings should be interpreted with caution until being replicated in larger samples. Finally, the ADHD group was older than the IUD group, although the statistical difference was insignificant. Since the use of digital media has especially increased among younger generations, the older ADHD group might not be representative in terms of their Internet use. Nevertheless, our study demonstrates that a problematic and pathological Internet use can also be found among older individuals who might not be exposed to online media from their early ages on. If early excessive media exposure should correlate positively with the development of ADHD, our results can be seen as a conservative estimation of this impact within our ADHD sample.

Clinical and scientific implications

From a clinical perspective and due to heightened comorbidity rates, patients with IUD should be tested for ADHD when symptoms of it appear. Patients with ADHD should operate a modest Internet and video game consumption as a preventive strategy. As a treatment strategy, Park, Lee, and Han (2016) could show that a 12-week medication with atomoxetine or MPH could reduce the severity of IGD, which was correlated with a reduction in impulsivity. Therefore, pharmacological and also psychotherapeutic approaches aiming at a reduction of inattention, hyperactivity, and impulsivity might be the most promising interventions so far. As patients with ADHD generally have a higher risk to develop other addictions, clinicians must be aware of a potential shift in addiction throughout treatment and beyond. On the other hand, it cannot be ruled out that excessive media consumption within childhood could be a factor among others, which could cause or intensify ADHD symptomatology.

CONCLUSIONS

We found support for the hypothesis that excessive or pathological media use among patients diagnosed with ADHD and/or IUD is indeed a common and substantial pathological facet and needs to be adequately addressed in treatment and rehabilitation. Among the patients, video games seem to serve as a selective tool in overcoming dysphoric mood states, whereas the Internet is utilized for these reasons also among healthy individuals. This is especially the case among patients with ADHD who utilize video games for relaxation to a stronger degree, which might be attributed to their deficits in dopamine function. As comorbidity rates are remarkable, future research should investigate the mechanisms between both disorders and therefore must employ longitudinal designs especially in clinical and adult populations. Clinical practitioners

should be aware of the close relationships between both disorders, both diagnostically and therapeutically. Well-established principles in the treatment of ADHD could be applicable in the treatment of IUD patients as well. Moreover, when it comes to regain control over one's Internet use throughout the treatment and rehabilitation, a potential shift of addiction must be kept in mind on side of practitioners and patients.

Authors' contribution: BTW: principal investigator; MB: data analysis and first author; MD and IP: examinations on patients with IUD; MR and MO: examinations on patients with ADHD; LB, TS, JD-H, GRS, and AM: coauthors with expertise on IUD.

Conflict of interest: The authors declare no conflict of interest.

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