Current Psychology
https://doi.org/10.1007/s12144-023-05203-x

Trait-level non-clinical ADHD symptoms in a community sample and their association with technology addictions

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Accepted: 1 September 2023

Abstract
An increasing number of studies have reported the existence of ADHD symptoms to be risk factors for technology addictions among young adults. In contrast to previous studies, the aim of the present study was to examine different dimensions of technology addiction in a community sample of adults and to examine their association with the individual trait-level ADHD symptoms of inattention and hyperactivity-impulsivity. A community sample of one hundred and fifty adults were recruited to participate in this study via convenience sampling. Participants completed the Adult ADHD Self-Report Scale Symptom Checklist, the Bergen Social Media Addiction Scale, the Smartphone Addiction Scale, Young's Internet Addiction Test, the Compulsive Online Shopping Scale, and a Demographic Information Form. Composite ADHD score, inattention and hyperactivity/impulsivity were positively associated with technology addictions (internet, social media, smartphone, and online shopping addiction). Hierarchical regression analysis revealed inattention and hyperactivity-impulsivity were predictors of social media addiction and smartphone addiction, whereas they were not for online shopping addiction. Furthermore, inattention was the only predictor of internet addiction. People with non-clinical, trait-level ADHD, especially those showing a preponderance of inattention symptoms appear to be more vulnerable to developing some forms of technology addiction.

Keywords ADHD · Hyperactivity · Impulsivity · Inattention · Technology addiction

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the neurodevelopmental and behavioral disorders that has childhood onset and usually perseveres into adulthood (Sedgwick-Müller et al., 2022). Several of the symptoms and characteristics of ADHD can also be seen in healthy people. For example, Li et al. (2019), reported that almost 60% of the general population experience symptom of inattention, and/or hyperactivity, and impulsivity. It was proposed that clinically diagnosed ADHD should be understood as being the extreme end of a continuum of ADHD symptoms in the general population, in contrast to being a categorically distinct disorder whose definition is based on the number of symptoms described by patients and/or their parents (Li et al., 2019). A large-scale twin study (Levy et al., 1997), genetic studies (Larsson et al., 2012; Martin et al., 2014; Stergiakouli et al., 2015), and neurobiology and neuropsychology studies (McLennan, 2016) supported the notion that ADHD is a disorder at the extreme end of a continuum of ADHD symptoms in the general population.

People with ADHD have inhibition and cognitive control problems (Panagiotidi & Overton, 2018; Wang et al., 2017), exhibit a reduced ability to react to punishment (Kandre et al., 2020) and tend to seek immediate rewards (Wang et al., 2017). Furthermore, they display sensation-seeking personality traits, a need for new, varied, and complicated experiences and sensations, as well as a readiness to take risks to fulfil this need (Panagiotidi & Overton, 2018). Therefore, they are more vulnerable to risk-taking behaviors and have a greater risk of developing addiction (Karaca et al., 2017; Romo et al., 2018).

Behavioral addictions such as internet addiction (IA) (Bağcı & Horzum, 2022), smartphone addiction (Masalimova et al., 2022), social media addiction and online shopping addiction (OSA) are forms of the broader concept of Technology Addiction (TA) (Savci and Aysan, 2017). TA is any behavioral addiction enacted through an information

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Published online: 13 September 2023

technology device (Serenko & Turel, 2020) and it is defined as involving immoderate and unrestrained use of technology. TA includes the behavioral symptoms of salience (Turel et al., 2011a, 2011b), mood modification (Serenko & Turel, 2022), tolerance (Jamir et al., 2019), withdrawal (Serenko & Turel, 2020), conflict (Osman, 2022), and relapse (Amudhan et al., 2022). Upon examining the occurrence of TAs within the general population, it becomes evident that their prevalence varies. According to the results of a recently published systematic review and meta-analysis study, the estimated global pooled prevalence for internet addiction, smartphone addiction, social media addiction and shopping addiction was 14.22%, 26.99%, 17.42% and 7.2%, respectively (Alimoradi et al., 2022; Meng et al., 2022).

When the DSM-4 was revised to DSM-5, "Substance-related and Addictive Disorders" was changed to "Substance-related Disorders", and "Non-substance Disorders" are under the sub-title of "Substance Addiction and Addictive Disorders". Although behavioral addictions such as sex, exercise and shopping were considered, inadequate scientific evidence to develop the diagnostic criteria for other behavioral addictions meant that they are not included in DSM-5 (Potenza, 2014). Therefore, the diagnostic criteria of IA, smartphone addiction, social media addiction and OSA are not listed in DSM-5 (Savci & Aysan, 2017). Smartphone addiction, social media addiction and OSA can all be regarded as addictions where the addictive substance is the internet (Savci & Aysan, 2017). Griffiths and Szabo (2014) proposed they should be examined under different headings such as IA, OSA, and social media addiction, as in substance addictions, instead of dealing with them under "internet addiction".

A recent systematic review indicated that 5.8% to 88.3% of individuals with behavioral addictions have comorbid ADHD and 5.9% to 71.8% of individuals with ADHD have comorbid behavioral addictions. It was therefore concluded that there is a considerable degree of overlap between behavioral addictions and ADHD (Karaca et al., 2017). Whilst studies have reported a relationship between ADHD and forms of TA (e.g., Andreassen et al., 2016; Hussain & Griffiths, 2021; Hussain & Wegmann, 2021), it is notable that only a few studies have considered how the core symptoms of ADHD are associated with the different forms of TA among adults. Research with university students revealed that both inattention and hyperactivity/impulsivity predict IA (Evren et al., 2018) in line with other studies (Kim et al., 2017; Panagiotidi & Overton, 2018). A systematic review and meta-analysis noted that inattention is most strongly correlated with internet addiction among adults with ADHD (Wang et al., 2017). In contrast, Dalbudak and Evren (2014) reported that hyperactivity/impulsivity were the symptoms most correlated with internet addiction among adults. However, it has also been found that there is publication bias in the severity of hyperactivity/impulsivity (Wang et al., 2017), which might be a reason for the conflicting findings. Another reason can be sample differences. In Wang et al. (2017) the studies focus on the relationship between ADHD and internet addiction among adolescents and adults whose mean age ranged from 11.1 to 23.34. However, in Dalbudak and Evren (2014) the participant pool consisted of only university students whose mean age was not reported.

It is known that ADHD is a risk factor to developing social networking site (social media) addiction (Settanni et al., 2018) and Facebook overuse among adolescents, and this has been linked to higher attentional impulsivity (Gul et al., 2018). Further, it has been reported that impulsivity (Grant et al., 2019) and inattention (Panagiotidi & Overton, 2020) were most strongly related to smartphone addiction among adults as in ADHD (Dey et al., 2019; Kim & Park, 2015; Li et al., 2021; Selçuk & Ayhan, 2019). Whilst a relationship between compulsive buying and ADHD has been reported (Brook et al., 2015; Eroğlu et al., 2019; Tavolacci et al., 2017), there is no research reporting relationships between ADHD symptoms and OSA among adults.

Given the limited number and contradictory nature of studies examining the relationship between the individual core symptoms of ADHD and forms of TA, the aim of the current study was to explore this issue further. In this study we asked a community sample of non-clinically assessed adults to complete a questionnaire assessing their experiences of ADHD symptoms, and questionnaires assessing their levels of social media addiction, internet addiction, smartphone addiction, and OSA, making it one of the few studies exploring many types of technology addictions and their relationships to the core symptoms of inattention and hyperactivity-impulsivity in the general population. Our overall aim was to identify technology addictions that are specific to the symptom of inattention to better understand whether those with inattention symptoms are likely to experience general or specific issues with technology addictions.

Method

Participants

Data were collected from 150 community sample of adults between March 2022 and June 2022. Previous studies showing a relationship between ADHD and a technology addiction produced large effect sizes ($R^2 > 0.35, f^2 = 0.59$) with fewer than 80 participants in both clinical and non-clinical populations (e.g., Kim et al., 2017; Kocyigit, et al., 2021). A post-hoc power calculation using G*Power based on the average observed R^2 value returned a power value of 0.99 for the present study. Participants were recruited through Prolific or opportunity sampling. Advertisement of the study was published on the researcher`s social media account and the

university`s Psychology Volunteers Newsletter. Participants under 18 years old and non-fluent English speakers were excluded based on the inclusion criteria of being above 18 years old and fluent in English. Recruited participants were aged between 19 and 58 years old ($M = 28.64$, $SD = 7.81$). There were 56 male ($M = 28.25$, $SD = 8.65$) and 94 female ($M = 28.87$, $SD = 7.31$) participants. Participants ($n = 87$) from Prolific received £4 for their involvement while the remaining participants did not receive any compensation. All experimental protocols were approved by a University Ethics Committee. All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013 ("World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects," 2013). Informed consent was obtained from all participants for being included in the study.

Experimental procedure and measures

Initially, the Participant Information Sheet and Participant Agreement Form were distributed to all participants. Once consent was given, participants were asked to complete the Demographic Information Form, the ASRS-v1.1 Symptom Checklist, BSMAS, SAS, the Internet Addiction Test, and COSS online, anonymously using any appropriate technological device. The presentation order of the scales across all participants was the same. It took between 20–30 min for the participants to complete the study.

The Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist is an instrument consistent with the DSM-IV-TR eighteen criteria. It is constituted of 2 subscales: Inattention (questions 1–4, 7–11) and Hyperactivity-impulsivity (questions 5–6, 12–18). The first six questions (Part A) have been determined to be the most accurate predictors of the disorder and are the best for use as screening instruments (Adler et al., 2013). The World Health Organization developed this self-administered, internationally validated adult ADHD screening instrument (Valsecchi et al., 2022). T

The value for Cronbach's Alpha for ASRS Screener was $\alpha = 0.85$ in this study. Nine of the 18 items are related to attention deficit symptoms (e.g., How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?), while nine are related to hyperactivity/impulsivity symptoms (e.g., How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?). Patients rate the frequency of occurrence of each item on a scale of 0 (never) to 4 (very often) (Valsecchi et al., 2022), resulting in a composite score ranging from 0 to 72. The composite score reflects higher degrees of ADHD symptoms.

The Bergen Social Media Addiction Scale (BSMAS) is a modified version of the Bergen Facebook Addiction Scale (BFAS). It has six items (e.g., You spend a lot of time thinking about social media or planning how to use it.) that represent the main characteristics of addiction (i.e., salience, conflict, mood modification, withdrawal, tolerance, and relapse). It is a 5-point Likert scale ranging from very rarely (1) to very often (5) and resulting in a composite score ranging from 6 to 30 (Andreassen et al., 2016). The value for Cronbach's Alpha for BSMAS was $\alpha = 0.82$ in this study. The higher composite score reflects a high degree of social media addiction.

The Smartphone Addiction Scale (SAS) is a self-diagnostic scale of smartphone addiction that has internal consistency and concurrent validity (Cronbach's alpha = 0.967) and contains 33 questions (e.g., Missing planned work due to smartphone use.). Each item is rated on a 6-point Likert scale ranging from strongly disagree (1) to strongly agree (6) (Kwon et al., 2013) and resulting in a composite score ranging from 33 to 198. The value for Cronbach's Alpha for SAS was $\alpha = 0.95$ in this study. The higher composite score indicates higher dependence on smartphone addiction.

Young's Internet Addiction Test (IAT) was created to assess the presence and severity of adult internet and technology addiction (Cronbach's alpha range 0.60–0.72) (Young, 2009). It contains 20 questions (e.g., How often do you find that you stay online longer than you intended?) rated on a 6-point Likert scale ranging from "not applicable" (0) to "always" (5) and resulting in a composite score ranging from 0 to 100. Composite scores between 0 and 30 points are thought to represent normal internet usage; scores between 31 and 49 indicate a mild level of internet addiction; scores between 50 and 79 reflect a moderate level; and scores between 80 and 100 indicate a severe reliance on the internet. The value for Cronbach's Alpha for IAT was $\alpha = 0.93$ in this study.

The Compulsive Online Shopping Scale (COSS) is adapted from The Bergen Shopping Addiction Scale. It consists of 28 questions (e.g., Online shopping/buying is the most important thing in my life.) that represent salience, conflict, mood modification, withdrawal, tolerance, relapse, and problems. Each question is rated on a 4-point scale ranging from strongly disagree (0) to strongly agree (4) (Manchiraju et al., 2017) and resulting in a composite score ranging from 0 to 112. The continuous COSS's internal consistency reliability is 0.97 in this study. High scores reveal a high degree of compulsive online shopping.

Statistical analysis

All analyses were conducted using SPSS 28.0. Descriptive statistics included mean, standard deviations of scales, the ASRS-v1.1 Symptom Checklist score, BSMAS score, SAS score, the Internet Addiction Test score, and COSS score. Cook`s distance was examined to control the normality of the distribution of scores. A Skewness and Kurtosis value

between + 1.5 and -1.5 was accepted as normally distributed (Tabachnick et al., 2013). Pearson correlations were used to measure the correlations among ADHD symptoms and technology addictions. Hierarchical regression analyses were used to measure the variance of ADHD symptoms in technology addiction. The assumption of homoscedasticity was assessed based on visual inspection of the plot of the Z Residuals vs Z predictors. Multicollinearity was assessed with tolerance and VIF values. VIF ≥ 5 was taken as evidence that there is multicollinearity (Hair et al., 2011). There was no multicollinearity among the predictors. Effect size was evaluated as small (0.02), medium (0.13), and large (0.26) (Cohen et al., 2013).

Results

The relationship between the composite ADHD score and all self-rated addictions was assessed. A Pearson's Correlation indicated a moderately strong, positive, significant relationship for social media addiction, $r(148) = 0.519$, $R^2 = 0.27$, $p < 0.001$; for smartphone addiction, $r(148) = 0.424$, $R^2 = 0.18$, $p < 0.001$; and for internet addiction, $r(148) = 0.431$, $R^2 = 0.19$, $p < 0.001$. The relationship between inattention and all self-rated addictions was assessed. A Pearson's Correlation indicated a moderately strong, positive, significant relationship for social media addiction, $r(148) = 0.508$, $R^2 = 0.26$, $p < 0.001$ and for internet addiction, $r(148) = 0.437$, $R^2 = 0.19$, $p < 0.001$. The relationship between hyperactivity/impulsivity symptoms and all self-rated addictions was assessed. A Pearson's Correlation indicated a moderately strong, positive, significant relationship for social media addiction, $r(148) = 0.456$, $R^2 = 0.21$, $p < 0.001$ (see Table 1).

Table 2 presents a summary of the regression model for inattention, hyperactivity, and impulsivity scores from the ASRS-v1.1 Symptom Checklist scores on technology addiction.

Four two-model hierarchical multiple regressions were conducted with social networking site (SNS) addiction, smartphone addiction, internet addiction and online shopping addiction as the dependent variables. In each regression, the first nested model (Stage 1) used only inattention as the predictor variable, and the second nested model (Stage 2) used both inattention and hyperactivity/impulsivity as the predictors. The variables were entered using the Enter method and, in this order, given that inattention was thought to be the most important symptom in technology addiction.

Social networking site addiction

The hierarchical multiple regression revealed that at stage one, inattention contributed significantly to the regression model, $F(1,148) = 51.360$, $p < 0.001$, $R^2 = 0.26$ and accounted for 25.8% of the variation in social media addiction. Introducing the hyperactivity/impulsivity explained an additional 2% of variation in social media addiction and this change in R^2 was significant, $F(2,147) = 28.239$, $p < 0.001$, $R^2 = 0.28$. The most important predictor of social media addiction was inattention which uniquely explained 25.8% of the variation in social media addiction. Together the two independent variables accounted for 27.8% of the variance with model one and two representing a large effect size in social media addiction.

Smartphone addiction

The hierarchical multiple regression revealed that at stage one, inattention contributed significantly to the regression model, $F(1,148) = 25.619$, $p < 0.001$, $R^2 = 0.15$ and accounted for 14.8% of the variation in smartphone addiction. Introducing the hyperactivity/impulsivity explained an additional 3.2% of variation in social media addiction and this change in R^2 was significant, $F(2,147) = 16.113$, $p < 0.001$, $R^2 = 0.18$. The most important predictor of smartphone addiction was inattention which uniquely explained

Table 1 Descriptive statistics and correlations for the study variables

Variable	M	SD	1	2	3	4	5	6	7
1. Composite_ADHD	29.25	10.04	—						
2.HI	15.55	6.05	0.939***	—					
3.IA	13.69	4.84	0.903***	0.699***	—				
4.BSMAS	14.19	4.99	0.519***	0.456***	0.508***	—			
5.SAS	98.37	30.18	0.424***	0.397***	0.384***	0.812***	—		
6.IAT	34.12	17.28	0.431***	0.365***	0.437***	0.694***	0.807***	—	
7.COSS	22.79	21.73	0.246**	0.243**	0.208*	0.436***	0.513***	0.451***	—

* $p < .05$, ** $p < .01$, *** $p < .001$

Composite_ADHD = attention deficit/hyperactivity disorder, HI: hyperactivity/impulsivity, BSMAS: Bergen Social Media Addiction Scale, SAS: Smartphone Addiction Scale, IAT: Internet Addiction Scale, COSS: Compulsive Online Shopping Scale

Table 2 Summary of hierarchical regression analysis for ADHD symptoms predicting technology addictions

		variable	b	SEb	β	t	sig	R^2	R^2 change	F
Social Media Addiction	Stage 1							.258		51.360
		Inattention	.523	.073	.508	7.167	< .001**			
	Stage 2							.278	.020*	28.239
		Inattention	.381	.101	.370	3.770	< .001**			
		Hyperactivity/impulsivity	.163	.081	.197	2.014	.046*			
Smartphone Addiction	Stage 1							.148		25.619
		Inattention	2.395	.473	.384	5.062	< .001**			
	Stage 2							.180	.032*	16.113
		Inattention	1.300	.651	.209	1.997	.048*			
		Hyperactivity/impulsivity	1.253	.521	.251	2.404	.017*			
Internet Addiction	Stage 1							.191		34.956
		Inattention	1.561	.264	.437	5.912	< .001**			
	Stage 2							.198	.007	18.155
		Inattention	1.268	.369	.355	3.440	< .001**			
		Hyperactivity/impulsivity	.335	.295	.117	1.134	.259			
Online Shopping Addiction	Stage 1							.043		6.667
		Inattention	.932	.361	.208	2.582	.011*			
	Stage 2							.062	.019	4.830
		Inattention	.334	.501	.074	.667	.506			
		Hyperactivity/impulsivity	.684	.402	.190	1.705	.090			

*$p < .05$, **$p < .01$

14.8% of the variation in smartphone addiction. Together the two independent variables accounted for 18% of the variance with model one and two representing a medium effect size in smartphone addiction.

Internet addiction

The hierarchical multiple regression revealed that at stage one, inattention contributed significantly to the regression model, $F(1,148) = 34.956$, $p < 0.001$, $R^2 = 0.19$ and accounted for 19.1% of the variation in internet addiction. Introducing the hyperactivity/impulsivity explained an additional 0.7% of variation in internet addiction and this change in R^2 was not significant, $F(2,147) = 1.286$, $p < 0.001$, $R^2 = 0.20$. In stage 2 of the regression model, hyperactivity/impulsivity was not significant predictors of internet addiction. The only important predictor of internet addiction was inattention which uniquely explained 19.1% of the variation with model one and two representing a medium effect size in internet addiction.

Online shopping addiction

The hierarchical multiple regression revealed that at stage one, inattention contributed significantly to the regression model, $F(1,148) = 6.667$, $p = 0.011$, $R^2 = 0.04$ and accounted for 4.3% of the variation with model one representing a small effect size in online shopping addiction Introducing the hyperactivity/impulsivity explained an additional 1.9% of variation in online shopping addiction and this change in R^2 was not significant, $F(2,147) = 2.906$, $p = 0.090$. $R^2 = 0.06$. In stage 2 of the regression model, neither inattention nor hyperactivity/impulsivity were significant predictors of online shopping addiction (see Table 2).

Discussion

The present study investigated technology addictions and their association with inattention and hyperactivity/impulsivity. It was found that higher levels of ADHD symptoms correlated with social media addiction, smartphone addiction, internet addiction and online shopping addiction. In terms of the individual core symptoms of ADHD, trait level inattention and hyperactivity/impulsivity correlated with all addiction scores. However, whilst hierarchical multiple regression analysis showed both hyperactivity/impulsivity and inattention were predictors of social media addiction and smartphone addiction, inattention was the only predictor of internet addiction. In contrast, whilst inattention predicted online shopping addiction when it was the only predictor, neither symptom alone predicted online shopping addiction when both inattention and hyperactivity/impulsivity were entered together, indicating some shared variance. In

conclusion, inattention explained most of the observed variance in the outcomes of the significant regression models.

When the current literature is reviewed, there are limited studies examining the relationship between social media addiction and adult ADHD symptoms, and they concluded that ADHD is correlated with social media addiction (Andreassen et al., 2016; Hussain & Griffiths, 2021; Hussain & Wegmann, 2021). Our findings are consistent with these studies. Although similar results were obtained, our study differs from these studies by considering ADHD at the trait, non-clinical level. As mentioned above, people who do not meet the DSM criteria can still experience symptoms of inattention, hyperactivity or impulsivity and it has been reported that 60% of the general population experience them (Li et al., 2019). Considering adult ADHD prevalence can differ from 2.58% to 6.76% (Song et al., 2021), it can be concluded that the general population may be more vulnerable to develop social media addiction. In the present study, inattention and hyperactivity/impulsivity accounted for a significant portion of the variance in social media addiction suggesting that inattention and hyperactivity/impulsivity are both important predictors of social media addiction.

Current literature associates ADHD with smartphone addiction in adults (Alageel et al., 2021; Kim & Park, 2015; Kwon et al., 2022; Müller et al., 2023). Considering ADHD at the symptom level, in the present study, in accordance with Panagiotidi and Overton (2020), we found that both inattention and hyperactivity/impulsivity were correlated with smartphone addiction. However, in contrast, Ookubo (2020) found that impulsivity was not correlated with smartphone addiction. Unfortunately, there is not much research that address ADHD and ADHD symptoms in smartphone addiction among adults. Some studies have discussed impulsivity, and they found that impulsivity correlated with smartphone addiction (Kim, 2019; Kim et al., 2014) and is a predictor of smartphone addiction (Kim et al., 2014). In the present study, regression analysis revealed that hyperactivity/impulsivity and inattention were predictors of smartphone addiction. Whereas Panagiotidi and Overton (2020) found that inattention is the only predictor of smartphone addiction, when we compare our study with Panagiotidi & Overton`s research, we can see that while their participants are mostly British, whereas our participants are mostly from Turkey and other Asian countries, and only 14 of our participants are British. Considering that Eastern countries show higher smartphone addiction compared to Western countries (Yang et al., 2019), maybe they also differ in the level of ADHD symptoms. More cross-cultural research is needed to understand the relationship between ADHD, especially at the symptom level, and smartphone addiction, more research is needed.

Consistent with previous studies (Dalbudak & Evren, 2014; Evren et al., 2018; Ko et al., 2008; Panagiotidi & Overton, 2018; Tateno et al., 2016; Wang et al., 2017), the present study found that composite ADHD and inattention were moderately associated with internet addiction. This was explained by the fact that while attention deficit continues in advancing ages, hyperactivity/impulsivity decreases, and therefore the most common ADHD symptom related to internet addiction is inattention. In addition, the main symptom of inattentive ADHD is getting bored easily. The internet reduces boredom by allowing users to engage with various activities at the same time and this can explain why inattention is related to internet addiction (Yen et al., 2009). Deficits in executive functions and self-regulation may underlie the relationship between inattention and internet addiction. Individuals with both internet addiction and ADHD exhibit executive control deficits (Dong et al., 2011; Rabinovitz et al., 2016), while deficits in self-regulation could also play a role (Barkley, 2011; Tokunaga, 2015; Zhang et al., 2022). However, the specific mechanisms linking these factors remain unknown. Therefore, it is crucial to examine shared factors, such as impaired executive function and self-regulation, present in both inattention and internet addiction. Future studies can contribute to comprehending the relationship between these two factors. Furthermore, regression analysis revealed that inattention was the only predictor of internet addiction. In contrast, Evren et al. (2018) reported that both inattention and hyperactivity/impulsivity predicted internet addiction; a difference potentially attributable to their larger sample size, the use of a different measure of internet addiction, or the younger age of their participants.

As noted above, there is currently no published research that examines the association between adult ADHD in clinical and sub-clinical level and online shopping addiction and thus this is the first study to directly examine the relationship between ADHD symptoms and OSA. Indeed, most of the relevant research in the current literature is based on compulsive buying and ADHD and has revealed that concurrent ADHD symptoms are associated with compulsive buying (Brook et al., 2015; Eroğlu et al., 2019; Tavolacci et al., 2017). In the present study, composite ADHD score, inattention, and hyperactivity/impulsivity were all weakly associated with OSA. Our regression analysis revealed that while inattention explained a small part of the variance in OSA, after adding hyperactivity/impulsivity to the model, neither inattention nor hyperactivity/impulsivity predicted OSA. Despite the well-established association between ADHD symptoms and compulsive buying (Brook et al., 2015; Eroğlu et al., 2019; Tavolacci et al., 2017), our findings are intriguing. The internet's availability for shopping at any time, coupled with its persuasive advertisements and notifications, is expected to heighten the inclination to shop among individuals with high levels of attention deficit and impulsivity. However, the results do not support this

hypothesis. It is clear that there is a knowledge gap on this subject and further research is needed.

In the present study we have examined the relationship between the core symptoms of ADHD and addictions based around the use of technology. It is important to note that the use of the internet is a key component of social media addiction, smartphone addiction (Savci & Aysan, 2017) and OSA (Rose & Dhandayudham, 2014). Therefore, it is accepted that internet addiction has a strong connection to these addictions (Savci & Aysan, 2017). In this study, whilst correlational analysis revealed positive correlations between all addiction measures and the core symptoms of ADHD, regression analysis revealed that the symptoms differed in their predictive power. It is currently unclear why these addictions are differentially predicted by the core symptoms of ADHD. Thus, future research should aim to clarify which specific aspects of internet addiction are unrelated to inattention but are associated with hyperactivity/impulsivity. Although the internet is a key component of online shopping addiction, neither inattention nor hyperactivity/impulsivity were significant predictors. These results support that while these addictions have common features, they are potentially underpinned by different mechanisms.

Current literature shows that ADHD symptoms are related with forms of technology addiction (e.g., Andreassen et al., 2016; Hussain & Griffiths, 2021; Hussain & Wegmann, 2021) as was shown in this study. Although it has been found that the inattention symptom is the most related symptom for many forms of TA (Panagiotidi & Overton, 2020; Wang et al., 2017), most of the explanations such as a reduced ability to react to punishment (Kandre et al., 2020) or seeking immediate rewards (Wang et al., 2017) are related to the features of impulsivity (Salehinejad et al., 2021). Therefore, the role of the symptom of inattention in forming TAs needs to be confirmed and further investigated experimentally. For example, it has been argued that while sustained attention is related to the inattention and impulsivity symptoms, response inhibition is related specifically with inattention (Avisar & Shalev, 2011). Another assumption is that the executive function deficits in adults with ADHD is related to the symptom of inattention, not hyperactivity/impulsivity. This is because it has been suggested that while the hyperactivity/impulsivity symptoms decrease in adulthood, the attention deficit persists (Nigg et al., 2005). Furthermore, whilst it has been shown that adults with ADHD present with slow reaction times and greater continuous performance task errors, inattention has been specifically linked to slower reaction times, whereas hyperactivity/impulsivity is linked to faster reaction times (Nigg et al., 2005), that might be derived from problems in response inhibition (Avisar & Shalev, 2011). As it is known that both people with technology addictions and with ADHD symptoms have impaired executive control (Dong et al., 2011; Rabinovitz et al., 2016), executive control deficits due to inattention may play a role in technology addictions. Therefore, more research that investigate this relationship experimentally is needed.

Limitations of the study

Despite reported significant correlations for all symptoms and addictions and moderate-to-large effect sizes for regression analyses, the small sample size is a limitation of the study. One of the other limitations of the study is using convenience sampling, the general limitation of which is that the sample cannot be clearly generalized (Jager et al., 2017). Also, participants who come from different cultural backgrounds also cause the generalizability problem. Another limitation is the cross-sectional design used, which means that we cannot infer causal relationships between the variables under study and it has also been pointed out that cross-sectional studies have a prevalence-incidence bias which means that the selection process might favour individuals that are not representative of the population as a whole (Levin, 2006). Furthermore, according to previous research (Kessler et al., 2007; Young, 2009), ASRS-v1.1 and IAT have questionable internal consistency reliability. In addition, considering that depression and anxiety are stronger predictors of TA than ADHD symptoms (Dalbudak & Evren, 2014), the lack of measures of these constructs can be considered as another limitation since they could mediate the relationship between the addictions and ADHD symptoms.

The implications of future research

While technological developments provide many advantages, they also bring with them the potential of negative consequences for certain individuals. Among the negative consequences of excessive and uncontrolled use of technology are the decreased quality of life (Chatterjee, 2021), decreased academic success and increased fatigue (Sert et al., 2019), work and family conflict (Turel et al., 2011a, 2011b; Zheng & Lee, 2016), brain structural (He et al., 2017) and functional alterations (Sun et al., 2023), physical health problems (e.g. musculoskeletal problems, and sleep) (Ratan et al., 2021), and psychological health problems (Pontes, 2017). Considering all these negative impacts, detection, prevention, and treatment of technology addictions is of great importance. Indeed, the World Health Organization (WHO) has organized different activities to address technology addiction from different perspectives (World Health, 2018).

Taxonomy and clinical descriptions of technology addictions is therefore of great importance and unfortunately, due to insufficient peer-reviewed evidence, they are not currently included in the DSM-5 (Potenza, 2014). This is an indication

that there is still a knowledge gap in this field. Considering that 5.8% to 88.3% of individuals with behavioral addictions have comorbid ADHD and also 5.9% to 71.8% of individuals with ADHD have comorbid behavioral addictions (Karaca et al., 2017), clarifying this relationship will also contribute to the classification of technology addictions and the development of public health policies. Despite its limitations, this study highlights the likelihood of these types of addictions even in those with ADHD symptoms at the trait level.

Conclusion

The research reported herein has shown that inattention and hyperactivity/impulsivity were predictors of social media addiction and smartphone addiction, but only inattention predicted internet addiction making it a potentially unique characteristic of that symptom of ADHD. Overall, the present study shows that trait-level ADHD symptoms have a significant impact on technology addictions among healthy adults, supporting the notion that a clinical diagnosis of ADHD is not necessary for behavioral addictions to manifest and have real-world implications.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflicting interests All authors declare that they have no conflict of interest.

References

Adler, L., Kessler, R. C., Spencer, T., & World Health, O. (2013). Adult ADHD Self-Report Scale (ASRS-v1. 1) Symptom Checklist Instructions. *World Health Organization (WHO)*.

Alageel, A. A., Alyahya, R. A., A Bahatheq, Y., Alzunaydi, N. A., Alghamdi, R. A., Alrahili, N. M., ... & Iacobucci, M. (2021). Smartphone addiction and associated factors among postgraduate students in an Arabic sample: A cross-sectional study. *BMC psychiatry*, *21*(1), 1-10. https://doi.org/10.1186/s12888-021-03285-0

Alimoradi, Z., Lotfi, A., Lin, C. Y., Griffiths, M. D., & Pakpour, A. H. (2022). Estimation of behavioral addiction prevalence during COVID-19 pandemic: a systematic review and meta-analysis. *Current addiction reports*, 1-32. https://doi.org/10.1007/s40429-022-00435-6.

Amudhan, S., Prakasha, H., Mahapatra, P., Burma, A. D., Mishra, V., Sharma, M. K., & Rao, G. N. (2022). Technology addiction among school-going adolescents in India: Epidemiological analysis from a cluster survey for strengthening adolescent health programs at district level. *Journal of Public Health, 44*(2), 286–295. https://doi.org/10.1093/pubmed/fdaa257

Andreassen, C. S., Billieux, J., Griffiths, M. D., Kuss, D. J., Demetrovics, Z., Mazzoni, E., & Pallesen, S. (2016). The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychology of Addictive Behaviors, 30*(2), 252. https://doi.org/10.1037/adb0000160

Avisar, A., & Shalev, L. (2011). Sustained attention and behavioral characteristics associated with ADHD in adults. *Applied Neuropsychology, 18*(2), 107–116. https://doi.org/10.1080/09084282.2010.547777

Bağcı, H., & Horzum, M. B. (2022). The relationship of smartphone addiction with chronotype and personality structures in university students. *Biological Rhythm Research*, 1–15. https://doi.org/10.1080/09291016.2022.2051302.

Barkley, R. A. (2011). The important role of executive functioning and self-regulation in ADHD. *J Child Neuropsy, 113*(21), 41–56.

Brook, J. S., Zhang, C., Brook, D. W., & Leukefeld, C. G. (2015). Compulsive buying: Earlier illicit drug use, impulse buying, depression, and adult ADHD symptoms. *Psychiatry Research, 228*(3), 312–317. https://doi.org/10.1016/j.psychres.2015.05.095

Chatterjee, S. (2021). Impact on addiction of online platforms on quality of life. *Australasian Journal of Information Systems,* 25. https://doi.org/10.3127/ajis.v25i0.2761.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.

Dalbudak, E., & Evren, C. (2014). The relationship of Internet addiction severity with Attention Deficit Hyperactivity Disorder symptoms in Turkish University students; impact of personality traits, depression and anxiety. *Comprehensive Psychiatry, 55*(3), 497–503. https://doi.org/10.1016/j.comppsych.2013.11.018

Dey, M., Studer, J., Schaub, M. P., Gmel, G., Ebert, D. D., Lee, J.Y.-C., & Haug, S. (2019). Problematic smartphone use in young Swiss men: Its association with problematic substance use and risk factors derived from the pathway model. *Journal of Behavioural Addictions, 8*(2), 326–334. https://doi.org/10.1556/2006.8.2019.17

Dong, G., Zhou, H., & Zhao, X. (2011). Male Internet addicts show impaired executive control ability: Evidence from a color-word Stroop task. *Neuroscience Letters, 499*(2), 114–118. https://doi.org/10.1016/j.neulet.2011.05.047

Eroğlu, M. Z., Demirkol, M. E., Tamam, L., & Gelegen, V. (2019). Kompulsif satın alma bozukluğu ve dikkat eksikliği hiperaktivite bozukluğu ilişkisi. *Cukurova Medical Journal, 44*(4), 1371–1378. https://doi.org/10.17826/cumj.559531

Evren, B., Evren, C., Dalbudak, E., Topcu, M., & Kutlu, N. (2018). Relationship of internet addiction severity with probable ADHD and difficulties in emotion regulation among young adults. *Psychiatry Research, 269*, 494–500. https://doi.org/10.1016/j.psychres.2018.08.112

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. sage.

Grant, J. E., Lust, K., & Chamberlain, S. R. (2019). Problematic smartphone use associated with greater alcohol consumption, mental health issues, poorer academic performance, and impulsivity. *Journal of Behavioral Addictions, 8*(2), 335–342. https://doi.org/10.1556/2006.8.2019.32

Griffiths, M. D., & Szabo, A. (2014). Is excessive online usage a function of medium or activity? An empirical pilot study. *Journal of Behavioral Addictions, 3*(1), 74–77. https://doi.org/10.1556/JBA.2.2013.016

Gul, H., YurumezSolmaz, E., Gul, A., & Oner, O. (2018). Facebook overuse and addiction among Turkish adolescents: Are ADHD and ADHD-related problems risk factors? *Psychiatry and Clinical Psychopharmacology, 28*(1), 80–90. https://doi.org/10.1080/24750573.2017.1383706

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice, 19*(2), 139–152.

He, Q., Turel, O., & Bechara, A. (2017). Brain anatomy alterations associated with Social Networking Site (SNS) addiction. *Scientific Reports, 7*(1), 1–8. https://doi.org/10.1038/srep45064

Hussain, Z., & Griffiths, M. D. (2021). The associations between problematic social networking site use and sleep quality, attention-deficit hyperactivity disorder, depression, anxiety and stress. *International Journal of Mental Health and Addiction, 19*(3), 686–700. https://doi.org/10.3389/fpsyt.2022.1106004

Hussain, Z., & Wegmann, E. (2021). Problematic social networking site use and associations with anxiety, attention deficit hyperactivity disorder, and resilience. *Computers in Human Behavior Reports, 4*, 100125. https://doi.org/10.1016/j.addbeh.2018.02.017

Jager, J., Putnick, D. L., & Bornstein, M. H. (2017). II. More than just convenient: The scientific merits of homogeneous convenience samples. *Monographs of the Society for Research in Child Development, 82*(2), 13–30. https://doi.org/10.1111/mono.12296

Jamir, L., Duggal, M., Nehra, R., Singh, P., & Grover, S. (2019). Epidemiology of technology addiction among school students in rural India. *Asian Journal of Psychiatry, 40*, 30–38. https://doi.org/10.1016/j.ajp.2019.01.009

Kandre, D., Patel, A., & Mehta, P. I. (2020). Analytical study of adult attention deficit hyperactivity disorder symptoms and Internet addiction among medical students. *Neuropsychiatria i Neuropsychologia/Neuropsychiatry and Neuropsychology, 15*(1), 7–12. https://doi.org/10.5114/nan.2020.97398

Karaca, S., Saleh, A., Canan, F., & Potenza, M. N. (2017). Comorbidity between behavioural addictions and attention deficit/hyperactivity disorder: A systematic review. *International Journal of Mental Health and Addiction, 15*(3), 701–724. https://doi.org/10.1007/s11469-016-9660-8

Kessler, R. C., Adler, L. A., Gruber, M. J., Sarawate, C. A., Spencer, T., & Van Brunt, D. L. (2007). Validity of the World Health Organization Adult ADHD Self-Report Scale (ASRS) Screener in a representative sample of health plan members. *International Journal of Methods in Psychiatric Research, 16*(2), 52–65. https://doi.org/10.1002/mpr.208

Kim, J. I. (2019). The Effects of Self-Esteem, Ego Resilience, Impulsivity and Stress on Smartphone Addiction among College Students. *Journal of the Korea Academia-Industrial Cooperation Society, 20*(7), 192–202. https://doi.org/10.5762/KAIS.2019.20.7.192

Kim, E. Y., & Park, R. W. (2015). Smartphone addiction and learning disorder, depression, ADHD association. *Journal of the Korea Academia-Industrial Cooperation Society, 16*(11), 7599–7606. https://doi.org/10.5762/KAIS.2015.16.11.7599

Kim, D., Lee, D., Lee, J., Namkoong, K., & Jung, Y.-C. (2017). Association between childhood and adult attention deficit hyperactivity disorder symptoms in Korean young adults with Internet addiction. *Journal of Behavioural Addictions, 6*(3), 345–353. https://doi.org/10.1556/2006.6.2017.044

Kim, S. M., Huh, H. J., Cho, H., Kwon, M., Choi, J. H., Ahn, H. J., ... & Kim, Y. J. (2014). The effect of depression, impulsivity, and resilience on smartphone addiction in university students. *Journal of Korean Neuropsychiatric Association*, 53(4), 214–220. https://doi.org/10.4306/jknpa.2014.53.4.214.

Ko, C.-H., Yen, J.-Y., Chen, C.-S., Chen, C.-C., & Yen, C.-F. (2008). Psychiatric comorbidity of internet addiction in college students: An interview study. *CNS Spectrums, 13*(2), 147–153. https://doi.org/10.1017/s1092852900016308

Kocyigit, S., Guzel, H. S., Acikel, B., & Cetinkaya, M. (2021). Comparison of smartphone addiction level, temperament and character and parental attitudes of adolescents with and without attention deficit hyperactivity disorder. *International Journal of Mental Health and Addiction, 19*, 1372–1384. https://doi.org/10.1007/s11469-021-00494-2

Kwon, M., Lee, J.-Y., Won, W.-Y., Park, J.-W., Min, J.-A., Hahn, C., Gu, X., Choi, J.-H., & Kim, D.-J. (2013). Development and validation of a smartphone addiction scale (SAS). *PloS one, 8*(2), e56936. https://doi.org/10.1371/journal.pone.0056936

Kwon, S. J., Kim, Y., & Kwak, Y. (2022). Influence of smartphone addiction and poor sleep quality on attention-deficit hyperactivity disorder symptoms in university students: A cross-sectional study. *Journal of American College Health, 70*(1), 209–215. https://doi.org/10.1080/07448481.2020.1740228

Larsson, H., Anckarsater, H., Råstam, M., Chang, Z., & Lichtenstein, P. (2012). Childhood attention-deficit hyperactivity disorder as an extreme of a continuous trait: A quantitative genetic study of 8,500 twin pairs. *Journal of Child Psychology and Psychiatry, 53*(1), 73–80. https://doi.org/10.1111/j.1469-7610.2011.02467.x

Levin, K. A. (2006). Study design III: Cross-sectional studies. *Evidence-Based Dentistry, 7*(1), 24–25. https://doi.org/10.1038/sj.ebd.6400375

Levy, F., Hay, D. A., McStephen, M., Wood, C., & Waldman, I. (1997). Attention-deficit hyperactivity disorder: A category or a continuum? Genetic analysis of a large-scale twin study. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(6), 737–744. https://doi.org/10.1097/00004583-199706000-00009

Li, T., Mota, N. R., Galesloot, T. E., Bralten, J., Buitelaar, J. K., IntHout, J., AriasVasquez, A., & Franke, B. (2019). ADHD symptoms in the adult general population are associated with factors linked to ADHD in adult patients. *European Neuropsychopharmacology, 29*(10), 1117–1126. https://doi.org/10.1016/j.euroneuro.2019.07.136

Li, C., Kee, Y. H., Zhang, C.-Q., & Fan, R. (2021). Predicting Effects of ADHD Symptoms and Mindfulness on Smartphone Overuse in Athletes: A Basic Psychological Needs Perspective. *Sustainability, 13*(11), 6027. https://doi.org/10.3390/su13116027

Manchiraju, S., Sadachar, A., & Ridgway, J. L. (2017). The compulsive online shopping scale (COSS): Development and validation using panel data. *International Journal of Mental Health and Addiction, 15*(1), 209–223. https://doi.org/10.1007/s11469-016-9662-6

Martin, J., Hamshere, M. L., Stergiakouli, E., O'Donovan, M. C., & Thapar, A. (2014). Genetic risk for attention-deficit/hyperactivity disorder contributes to neurodevelopmental traits in the general population. *Biological Psychiatry, 76*(8), 664–671. https://doi.org/10.1016/j.biopsych.2014.02.013

Masalimova, A. R., Khairullina, E. R., Lapidus, N. I., Orekhovskaya, N. A., Zheltukhina, M. R., & Baranova, E. A. (2022). Exploring Preservice STEM Teachers' Smartphone Addiction. *Contemporary Educational Technology, 14*(3), ep371. https://doi.org/10.30935/cedtech/11916

McLennan, J. D. (2016). Understanding attention deficit hyperactivity disorder as a continuum. *Canadian Family Physician, 62*(12), 979–982.

Meng, S.-Q., Cheng, J.-L., Li, Y.-Y., Yang, X.-Q., Zheng, J.-W., Chang, X.-W., Shi, Y., Chen, Y., Lu, L., Sun, Y., Bao, Y.-P., & Shi, J. (2022). Global prevalence of digital addiction in general population: A systematic review and meta-analysis. *Clinical Psychology Review, 92*, 102128. https://doi.org/10.1016/j.cpr.2022.102128

Müller, V., Mellor, D., & Piko, B. F. (2023). How to Procrastinate Productively With ADHD: A Study of Smartphone Use, Depression, and Other Academic Variables Among University Students With ADHD Symptoms. *Journal of attention disorders, 0*(0), 951. https://doi.org/10.1177/10870547231171724

Nigg, J. T., Stavro, G., Ettenhofer, M., Hambrick, D. Z., Miller, T., & Henderson, J. M. (2005). Executive functions and ADHD in adults: Evidence for selective effects on ADHD symptom domains. *Journal of Abnormal Psychology, 114*(4), 706. https://doi.org/10.1037/0021-843X.114.3.706

Ookubo, J. (2020). The relationship between the tendencies for internet addiction and developemental disorders: A exploratory study about ADHD tendencies. *Papers of Psychological Science, 3*, 45–49.

Osman, U. (2022). Causes and consequences of technology addiction A review of information systems and information technology studies. *International Journal of Social Sciences and Education Research, 8*(3), 299–306. https://doi.org/10.24289/ijsser.1131136

Panagiotidi, M., & Overton, P. (2020). Attention deficit hyperactivity symptoms predict problematic mobile phone use. *Current Psychology*, 1–7. https://doi.org/10.1007/s12144-020-00785-2.

Panagiotidi, M., & Overton, P. (2018). The relationship between internet addiction, attention deficit hyperactivity symptoms and online activities in adults. *Comprehensive Psychiatry, 87*, 7–11. https://doi.org/10.1016/j.comppsych.2018.08.004

Pontes, H. M. (2017). Investigating the differential effects of social networking site addiction and Internet gaming disorder on psychological health. *Journal of Behavioural Addictions, 6*(4), 601–610. https://doi.org/10.1556/2006.6.2017.075

Potenza, M. N. (2014). Non-substance addictive behaviors in the context of DSM-5. *Addictive Behaviors, 39*(1), 1–2. https://doi.org/10.1016/j.addbeh.2013.09.004

Rabinovitz, B. B., O'Neill, S., Rajendran, K., & Halperin, J. M. (2016). Temperament, executive control, and attention-deficit/hyperactivity disorder across early development. *Journal of Abnormal Psychology, 125*(2), 196. https://doi.org/10.1037/abn0000093

Ratan, Z. A., Parrish, A.-M., Zaman, S. B., Alotaibi, M. S., & Hosseinzadeh, H. (2021). Smartphone Addiction and Associated Health Outcomes in Adult Populations: A Systematic Review. *International Journal of Environmental Research and Public Health, 18*(22), 12257. https://doi.org/10.3390/ijerph182212257

Romo, L., Ladner, J., Kotbagi, G., Morvan, Y., Saleh, D., Tavolacci, M. P., & Kern, L. (2018). Attention-deficit hyperactivity disorder and addictions (substance and behavioural): Prevalence and characteristics in a multicenter study in France. *Journal of Behavioural Addictions, 7*(3), 743–751. https://doi.org/10.1556/2006.7.2018.58

Rose, S., & Dhandayudham, A. (2014). Towards an understanding of Internet-based problem shopping behaviour: The concept of online shopping addiction and its proposed predictors. *Journal of Behavioural Addictions, 3*(2), 83–89. https://doi.org/10.1556/JBA.3.2014.003

Salehinejad, M. A., Ghanavati, E., Rashid, M. H. A., & Nitsche, M. A. (2021). Hot and cold executive functions in the brain: A prefrontal-cingular network. *Brain and Neuroscience Advances, 5*, 23982128211007770. https://doi.org/10.1177/23982128211007769

Savci, M., & Aysan, F. (2017). Technological addictions and social connectedness: Predictor effect of internet addiction, social media addiction, digital game addiction and smartphone addiction on social connectedness. *Dusunen Adam: Journal of Psychiatry & Neurological Sciences, 30*(3), 202–216. https://doi.org/10.5350/DAJPN2017300304

Sedgwick-Müller, J. A., Müller-Sedgwick, U., Adamou, M., Catani, M., Champ, R., Gudjónsson, G., Hank, D., Pitts, M., Young, S., & Asherson, P. (2022). University students with attention deficit hyperactivity disorder (ADHD): A consensus statement from the UK Adult ADHD Network (UKAAN). *BMC Psychiatry, 22*(1), 292. https://doi.org/10.1186/s12888-022-03898-z

Selçuk, K. T., & Ayhan, D. (2019). The relationship between smartphone addiction risk and sleep duration and psychosocial comorbidities in health professional candidates. *Future, 7*, 8–12. https://doi.org/10.1111/ppc.12465

Serenko, A., & Turel, O. (2020). Directing technology addiction research in information systems: Part I. Understanding behavioural addictions. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems, 51*(3), 81–96.

Serenko, A., & Turel, O. (2022). Directing Technology Addiction Research in Information Systems: Part II. Understanding Technology Addiction. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems, 53*(3), 71–90.

Sert, H., Taskin Yilmaz, F., KarakocKumsar, A., & Aygin, D. (2019). Effect of technology addiction on academic success and fatigue among Turkish university students. *Fatigue: Biomedicine, Health & Behavior, 7*(1), 41–51. https://doi.org/10.1080/21641846.2019.1585598

Settanni, M., Marengo, D., Fabris, M. A., & Longobardi, C. (2018). The interplay between ADHD symptoms and time perspective in addictive social media use: A study on adolescent Facebook users. *Children and Youth Services Review, 89*, 165–170. https://doi.org/10.1016/j.childyouth.2018.04.031

Song, P., Zha, M., Yang, Q., Zhang, Y., Li, X., & Rudan, I. (2021). The prevalence of adult attention-deficit hyperactivity disorder: A global systematic review and meta-analysis. *Journal of global health*, 11. https://doi.org/10.7189/jogh.11.04009.

Stergiakouli, E., Martin, J., Hamshere, M. L., Langley, K., Evans, D. M., St Pourcain, B., Timpson, N. J., Owen, M. J., O'Donovan, M., & Thapar, A. (2015). Shared genetic influences between attention-deficit/hyperactivity disorder (ADHD) traits in children and clinical ADHD. *Journal of the American Academy of Child & Adolescent Psychiatry, 54*(4), 322–327. https://doi.org/10.1016/j.jaac.2015.01.010

Sun, J.-T., Hu, B., Chen, T.-Q., Chen, Z.-H., Shang, Y.-X., Li, Y.-T., Wang, R., & Wang, W. (2023). Internet addiction-induced brain structure and function alterations: A systematic review and meta-analysis of voxel-based morphometry and resting-state functional connectivity studies. *Brain Imaging and Behavior*. https://doi.org/10.1007/s11682-023-00762-w

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). Using multivariate statistics (6: 497–516). Boston, MA: pearson.

Tateno, M., Teo, A. R., Shirasaka, T., Tayama, M., Watabe, M., & Kato, T. A. (2016). Internet addiction and self-evaluated attention-deficit hyperactivity disorder traits among Japanese college students. *Psychiatry and Clinical Neurosciences, 70*(12), 567–572. https://doi.org/10.1111/pcn.12454

Tavolacci, M. P., Romo, L., Kern, L., & Ladner, J. (2017). Attention-deficit/hyperactivity disorder among university studentsMarie-Pierre Tavolacci. *European Journal of Public Health*, *27*(suppl_3).

Tokunaga, R. S. (2015). Perspectives on Internet addiction, problematic Internet use, and deficient self-regulation: Contributions of communication research. *Annals of the International Communication Association, 39*(1), 131–161. https://doi.org/10.1080/23808985.2015.11679174

Turel, O., Serenko, A., & Bontis, N. (2011a). Family and work-related consequences of addiction to organizational pervasive technologies. *Information & Management, 48*(2), 88–95. https://doi.org/10.1016/j.im.2011.01.004

Turel, O., Serenko, A., & Giles, P. (2011b). Integrating technology addiction and use: An empirical investigation of online auction users. *MIS quarterly*, 1043–1061.

Valsecchi, P., Nibbio, G., Rosa, J., & Vita, A. (2022). Adult ADHD and sleep disorders: Prevalence, severity and predictors of sleep disorders in a sample of Italian psychiatric outpatients. *Psychiatry research, 310*, 114447. https://doi.org/10.1016/j.psychres.2022.114447

Wang, B.-Q., Yao, N.-Q., Zhou, X., Liu, J., & Lv, Z.-T. (2017). The association between attention deficit/hyperactivity disorder and internet addiction: A systematic review and meta-analysis. *BMC Psychiatry, 17*(1), 1–12. https://doi.org/10.1186/s12888-017-1408-x

World Health, O. (2018). Public health implications of excessive use of the internet and other communication and gaming platforms. World Health Organization. https://www.who.int/news/item/13–09–2018-public-healthimplications-of-excessive-use-of-the-internet-and-other-communication-andgaming-platforms. Accessed 13 Sept 2018.

World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. (2013). *Jama*, 310(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053.

Yang, Z., Asbury, K., & Griffiths, M. D. (2019). Do Chinese and British University Students Use Smartphones Differently? A Cross-cultural Mixed Methods Study. *International Journal of Mental Health and Addiction, 17*(3), 644–657. https://doi.org/10.1007/s11469-018-0024-4

Yen, J.-Y., Yen, C.-F., Chen, C.-S., Tang, T.-C., & Ko, C.-H. (2009). The association between adult ADHD symptoms and internet addiction among college students: The gender difference. *Cyberpsychology & Behavior, 12*(2), 187–191. https://doi.org/10.1089/cpb.2008.0113

Young, K. S. (2009). *Internet addiction test*. Center for on-line addictions.

Zhang, W., Jiang, X., Yang, L., & Zhu, W. (2022). Adult Attention Deficit and Hyperactivity Disorder Symptoms and Internet Addiction in College Students Prevalence and Differential Associations. *European Journal of Psychology and Educational Research, 5*(1), 33–43. https://doi.org/10.12973/ejper.5.1.33

Zheng, X., & Lee, M. K. O. (2016). Excessive use of mobile social networking sites: Negative consequences on individuals. *Computers in Human Behavior, 65*, 65–76. https://doi.org/10.1016/j.chb.2016.08.011