

# An epidemiological study of ADHD symptoms among young persons and the relationship with cigarette smoking, alcohol consumption and illicit drug use

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**Background:** This study investigates the relationship between attention deficit hyperactivity disorder (ADHD) symptoms and cigarette smoking, alcohol use and illicit drug use. **Method:** The participants were 10,987 pupils in the final three years of their compulsory education in Iceland (ages 14–16 years). The participants completed questionnaires in class relating to anxiety, depression and anti-establishment attitudes, ADHD symptoms, smoking, alcohol consumption and illicit drug use. **Results:** Of the total sample, 5.4% met screening criteria for ADHD. Smoking, alcohol and illicit drug use were significantly related to ADHD symptoms. In addition, the number of different illicit drugs consumed was significantly higher among the ADHD symptomatic than the nonsymptomatic participants, including the illicit use of sedatives. The main distinguishing illicit drug substances were lysergic acid diethylamide (odds ratio or OR = 8.0), cocaine (OR = 7.5), mushrooms (OR = 7.1) and amphetamines (OR = 6.5). Logistic multiple regressions showed that after controlling for gender and school grade, ADHD symptoms predicted smoking, alcohol use and illicit drug use independent of anxiety, depression and anti-establishment attitudes. In addition, poly-substance use was linearly and incrementally related to ADHD symptoms with a large effect size. **Conclusions:** The findings underscore the vulnerability of young persons with ADHD symptoms to smoking, alcohol and illicit drug use, possibly as a means of self-medication, and emphasize a need for early identification and treatment to reduce the risk of escalation. **Keywords:** ADHD, smoking, alcohol and illicit drug use, mental state, anti-establishment attitudes, substance use, self-medication.

## Introduction

Attention deficit hyperactivity disorder (ADHD) is a common childhood disorder with functional impairments that often persist into adulthood (Faraone, Biederman, & Mick, 2006). Epidemiological studies that are comprised of large and representative community samples are particularly important for revealing the extent of the condition and its associated problems (Kessler et al., 2006; Kollins, McClernon, & Fuemmeler, 2005).

This study reports findings from a large epidemiological survey in Iceland among pupils in the final three years of mandatory education (i.e. 14–16-year olds) designed to investigate the relationship between ADHD symptoms and substance use. Drug use among young persons is a major mental health problem (Shedler & Block, 1990) and, compared with

controls, young persons with ADHD are known to be more likely to smoke cigarettes, consume alcohol and take illicit drugs (Barkley, Murphy, & Fischer, 2008; Galéra, Bouvard, Messiah, & Fombonne, 2008; Kessler et al., 2006; Wilens & Biederman, 2006).

The prevalence rate for comorbid substance use disorder (SUD) in adult ADHD patients is as high as 58% (Sizoo et al., 2010) and a strong relationship has been reported between ADHD symptoms, substance dependence and personality disorder among prisoners (Einarsson, Sigurdsson, Gudjonsson, Newton, & Bragason, 2009; Gudjonsson, Wells, & Young, 2011; Young, Wells, & Gudjonsson, 2011). There is likely to be a significant overlap between cigarette smoking, alcohol consumption and illicit drug taking and all three categories are potentially important precursors to the development of SUD (Biederman et al., 2006; Palmer et al., 2009; Wilens & Biederman, 2006). Alcohol and cannabis are the most frequently abused substances in people with ADHD (Barkley et al., 2008; Faraone et al., 2007). In a recent meta-analysis, Charach, Yeung, Climans, and Lillie (2011) found that childhood ADHD is associated with nicotine use in adolescence and alcohol and drug disorders in adulthood. Most of the studies reviewed

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reported the highest risk of future SUD to be associated with three specific substances: tobacco, alcohol and cannabis. It was found in this meta-analysis that of these three substances, the regular use of tobacco in mid-adolescence is the single best predictor of SUD in adulthood. This may relate to enhanced nicotine dependence (Rodriguez, Tercyak, & Audrain-McGovern, 2008), novelty-seeking (Tercyak & Audrain-McGovern, 2003) and/or self-medication (Barkley et al., 2008; Levin et al., 1996).

What requires further investigation is the extent to which ADHD symptoms predict the use of substances beyond commonly associated comorbid conditions, such as anxiety, depression, conduct disorder (CD) and oppositional defiant disorder (ODD). Kollins et al. (2005) followed 15,197 adolescents into adulthood and found increased risk of lifetime regular smoking associated with ADHD symptoms after controlling for CD. It is the coexistence of ADHD and CD that seems to represent the highest risk of future problematic drug use (Roy, 2007). Symptoms of low mood and depression are also common in SUD (Riggs, Baker, Mikulich, Young, & Crowley, 1995); thus mood instability, which is commonly related to ADHD symptoms (Skirrow, McLoughlin, Kuntsi, & Asherson, 2009), may be an important mediating factor. All these symptoms may encourage young persons with ADHD to self-medicate by the use of various substances to help regulate mood and feelings of restlessness and assist sleep (Galéra et al., 2008; Wilens & Biederman, 2006). Galéra et al. (2008) provide a good review of the relative importance of different predictors of substance use and their possible interactions and suggest that ADHD symptoms may predict substance use independent of other psychiatric and behavioural problems.

This study had five specific hypotheses (H1–H5). H1 is that all three substance use measures (cigarette smoking, alcohol consumption and illicit drug use) will be intercorrelated with medium to large effect size (i.e.  $r = .30$ – $.50$  or larger; Cohen, 1992). H2 is that they will all be significantly related to ADHD symptoms whether used as categorical or continuous measures. H3 predicts that they will correlate significantly with anxiety, depression and antiestablishment attitudes. H4 states that ADHD symptoms will predict substance use (i.e. cigarette smoking, alcohol consumption and illicit drug use) beyond anxiety, depression and antiestablishment attitudes. H5 predicts that multiple types of substance use (smoking/alcohol/drugs) are linearly and incrementally associated with ADHD symptoms.

## Methods

### Participants

The sample consisted of 10,987 pupils comprising 82.2% of the 13,361 pupils registered in the final three years of their compulsory education in Iceland

(ages 14–16 years; Statistics Iceland, 2010); 5,369 (49.7%) boys and 5,424 (50.3%) girls participated [194 participants (1.8%) did not reveal their gender]. There was an approximately equal number of participants in each of the three age groups. All secondary schools in Iceland were represented and all schools and pupils consented to take part in the survey, which was approved by the Icelandic Ministry of Education.

### Instruments

A standard national questionnaire was developed for the study consisting of 61 questions relating to family circumstances, education, ADHD symptoms, anxiety, depression, antiestablishment attitudes, contacts with mental health professionals, smoking and substance use, sport and recreation and attitudes towards the future and expectations. This questionnaire included the following items/scales.

*Barkley Current Symptoms Scale.* This is an 18-item scale used to screen for ADHD (Barkley, 1998) that corresponds with Diagnostic and Statistical Manual IV criteria. Each item was scored on a 4-point rating scale for frequency of symptoms experienced during the previous 6 months. Scores ranged between 0 and 27 for each of the two subscales (inattention and hyperactivity/impulsivity) and from 0 to 54 for the total scale. Magnusson et al. (2006) reported that the measure had good psychometric properties and correlated well with informants' ratings of symptoms and interview-based diagnoses in childhood and adulthood in an Icelandic sample. In the current study, the Cronbach's  $\alpha$  for the total score was .92, the inattention scale was .86 and the hyperactivity/impulsivity scale was .81.

A screening diagnosis for ADHD symptoms was assigned if six or more of the nine inattention or hyperactivity/impulsivity items were endorsed as occurring either 'often' or 'very often'. This classification gave three possible outcomes: predominantly inattentive, predominantly hyperactive/impulsive and combined type (i.e. where both the inattention and hyperactivity subscales had six or more items endorsed as either 'often' or 'very often'). We also used the two subscales and the total score as continuous measures.

*Anxiety and depression (Derogatis, Lipman, Covi, & Rickels, 1971).* Three anxiety and nine depression items from the original Symptom Checklist-90 were rated on a 4-point frequency scale. Sigfusdottir, Asgeirsdottir, Sigurdsson, and Gudjonsson (2008) used these same measures with the same age groups as those in the current study in four large community samples (1997, 2000, 2003 and 2006) and found them to be both reliable and valid in terms of assessing mental health outcome. In the current study, the Cronbach's  $\alpha$  was .76 for the anxiety scale and .89 for the depression scale.

*Antiestablishment Attitudes Scale.* This measure was developed on the basis of Hirschi's (1969) social control theory where the lack of bonds to conventional

society results in delinquency. Participants rated on a 4-point scale their confidence and trust in institutions: church, primary school, courts, police, parliament, government, media, unions and health care services. Scores range between 0 and 27. The higher the score the greater is the antiestablishment attitude. Cronbach's  $\alpha$  was .90.

**Smoking.** The participants were asked, 'How much have you smoked on average during the last 30 days?' and checked one of seven categories labelled: (0) 'never', (1) 'less than one cigarette a month', (2) 'less than one cigarette a week', (3) '1–5 cigarettes a day', (4) '6–10 cigarettes a day', (5) '11–20 cigarettes a day' and (6) 'more than 20 cigarettes a day'. We report two different types of scores. First, the number of participants who endorsed 'never' versus any smoking. Second, the score endorsed for one of the seven smoking frequency categories (scores range between 0 and 6). This question has been used in similar previous surveys (Sigfusdottir, Kristjansson, Thorlindsson, & Allegrante, 2008).

**Alcohol consumption.** The participants were asked, 'How often have you consumed any type of alcohol during the last 30 days?' and checked one of seven categories labelled: (0) 'never', (1) '1–2 times', (2) '3–5 times', (3) '6–9 times', (4) '10–19 times', (5) '20–39 times' and (6) '40 times or more'. This provided a categorical score and a dimensional scale using the same method described for smoking. This question has been used in similar previous surveys (Sigfusdottir, Kristjansson et al., 2008).

**Illicit drug use.** The participants were asked, 'How often (if ever) have you consumed the following substances? Sedatives without prescription; hashish, marijuana, amphetamine, lysergic acid diethylamide (LSD), e-tablet (ecstasy), cocaine, mushrooms (as intoxicant) and sniffing substances (e.g. glue)'. The participants were asked to check each of the seven categories for each of the nine substances labelled: (0) 'never', (1) '1–2 times', (2) '3–5 times', (3) '6–9 times', (4) '10–19 times', (5) '20–39 times' and (6) '40 times or more'. This measure has been used in other similar surveys (Sigfusdottir, Kristjansson et al., 2008). It provides a categorical score for the number of participants who endorsed 'never' for all nine categories of the substance (i.e. 'no drug use' vs. 'drug use') and a dimensional 'drug use' scale derived from the total score across all nine categories (scores range between 0 and 54). Cronbach's  $\alpha$  for the 'drug use' scale was .91.

**Table 1** Differences between attention deficit hyperactivity disorder (ADHD) symptomatic and nonsymptomatic groups in reports of smoking, alcohol consumption and illicit drug use

Variables	ADHD		$\chi^2$ ( $df = 1$ )	OR (95% CI)
	Symptomatic, % ( $N$ )	Nonsymptomatic, % ( $N$ )		
Smoked last 30 days	33.3 (197)	7.2 (728)	486.56*	6.5 (5.4–7.8)
Alcohol use last 30 days	43.0 (249)	12.2 (1234)	432.64*	5.4 (4.5–6.4)
Illicit drug use (ever)	39.3 (227)	11.3 (1128)	382.17*	5.1 (4.2–6.1)

CI, confidence interval; OR, odds ratio.

\* $p < .001$ .

## Procedure

The pupils were approached by teachers in scheduled classes and invited to participate in the survey. The participants were told that their answers would be anonymous. The questionnaires took about 30 min to complete and upon completion the pupils sealed them in blank envelopes and handed them to the teacher supervising the administration of the questionnaires.

## Results

### ADHD and categorical indicators of substance use

Just over 5% of pupils ( $n = 594$ , 5.4%) met screening criteria for ADHD (5.1% of boys and 5.7% of girls). Of those meeting ADHD criteria, 164 (27.6%) were predominantly inattentive, 187 (31.5%) were predominantly hyperactive/impulsive and 243 (40.92%) were combined subtype; rates of these subtypes across the total sample were 1.5%, 1.7% and 2.2% respectively.

Table 1 shows highly significant differences between the ADHD symptomatic and nonsymptomatic groups in levels of substance use, suggesting that ADHD symptoms are a strong risk factor for the use of cigarettes and alcohol, and lifetime consumption of one or more illicit drugs.

### Most common illicit drugs consumed

Most (87.8%) of the 9,204 pupils who responded to the questions on illicit drug use reported that they had not consumed any of the nine drugs, leaving 1,284 (12.2%) who had consumed one or more. Of those young people, 789 (61.4%) reported having used one drug, 163 (12.7%) two, 83 (6.5%) three and 249 (19.4%) four or more. The most frequently reported illicit drugs were: sedatives (8.0%), marijuana (5.1%), hashish (3.7%), sniffing substances (2.8%), amphetamine (2.6%), mushrooms as hallucinates (2.4%), cocaine (2.1%), ecstasy (1.9%) and LSD (1.5%). Marijuana and hashish combined (cannabis) were used by 5.9% of the participants.

Table 2 gives the proportion of the ADHD symptomatic and nonsymptomatic participants who had consumed each of the nine types of illicit substances. The ADHD symptomatic participants were

**Table 2** Differences between attention deficit hyperactivity disorder (ADHD) symptomatic and nonsymptomatic groups in reports of use of nine types of illicit drugs

Substance	ADHD		$\chi^2$ ( <i>df</i> = 1)	OR (95% CI)
	Symptomatic, % ( <i>N</i> )	Nonsymptomatic, % ( <i>N</i> )		
Sedatives	25.3 (148)	7.0 (706)	253.5*	4.5 (3.7–5.5)
Hashish	15.9 (93)	3.0 (301)	261.1*	6.2 (4.8–7.9)
Marijuana	21.1 (123)	4.2 (425)	324.1*	6.1 (4.9–7.6)
Amphetamines	12.1 (71)	2.1 (212)	217.1*	6.5 (4.9–8.6)
LSD	8.4 (49)	1.1 (114)	193.6*	8.0 (5.7–11.3)
Ecstasy	8.6 (50)	1.5 (150)	152.3*	6.3 (4.5–8.7)
Cocaine	10.7 (62)	1.6 (159)	225.4*	7.5 (5.5–10.2)
Mushrooms	12.0 (70)	1.9 (190)	238.1*	7.1 (5.3–9.5)
Sniffing substances	12.3 (72)	2.2 (224)	210.3*	6.2 (4.7–8.2)

CI, confidence interval; LSD, lysergic acid diethylamide; OR, odds ratio.

\* $p < .001$ .

significantly more likely to have used all the nine substances. The odds ratios (ORs) were lowest for sedatives (4.5) and highest for LSD (8.0), cocaine (7.5), mushrooms (7.1) and amphetamines (6.5).

#### Correlations between the continuous measures

Table 3 shows correlations among the continuous measures. The inattention and hyperactivity/impulsivity scales were highly correlated ( $r = .78$  and  $.73$  for boys and girls, respectively). Anxiety and depression correlated significantly with all the ADHD scales for both boys and girls with medium to large effect sizes ( $r = .33$ – $.55$ ), particularly for depression, and the correlations were consistently higher among the girls. The amount of smoking and alcohol consumption during the previous 30 days, and the extent of illicit drug use (lifetime) correlated

significantly with the ADHD measures, anxiety, depression and antiestablishment attitudes (with the exception of one – anxiety and drinking for boys). The effect sizes were consistently higher for the relationship with the ADHD measures than anxiety and depression. There were moderately high correlations between the smoking, drinking and the substance use measures for both genders (.37–.51) with medium to large effect sizes (14–26% of the variance).

#### Predictors of smoking, alcohol use and illicit drug use

To investigate which variables best predicted substance use (smoking, alcohol, illicit drugs) sequential binomial logistic regression analysis was performed. The data were entered into the logistic regression

**Table 3** Means and standard deviations for the study measures, and correlations between measures for boys (above diagonal) and girls (below diagonal)

Variables	Mean ( <i>SD</i> ) ( <i>N</i> )									
		1.	a.	b.	2.	3.	4.	5.	6.	7.
1. ADHD symptoms	9.9 (9.1) (9,895)	–	.94*	.93*	.36*	.42*	.22*	.16*	.16*	.22*
a. Inattention	5.2 (4.9) (10,155)	.94*	–	.78*	.35*	.45*	.22*	.17*	.16*	.22*
b. Hyperactivity/impulsivity	4.8 (4.8) (10,245)	.92*	.73*	–	.33*	.34*	.19*	.16*	.15*	.19*
2. Anxiety	2.3 (2.2) (10,522)	.42*	.42*	.35*	–	.55*	.10*	.08*	.04	.09*
3. Depression	6.5 (6.1) (10,312)	.53*	.55*	.41*	.59*	–	.19*	.12*	.09*	.16*
4. Antiestablishment scale	13.5 (6.5) (9,964)	.32*	.33*	.26*	.21*	.32*	–	.21*	.20*	.20*
5. Smoking the last 30 days	0.2 (0.9) (10,754)	.25*	.26*	.23*	.17*	.23*	.23*	–	.51*	.48*
6. Drinking the last 30 days	0.2 (0.8) (10,659)	.27*	.27*	.25*	.16*	.21*	.21*	.51*	–	.40*
7. Extent of drug use	0.7 (3.3) (10,488)	.28*	.29*	.24*	.20*	.28*	.23*	.42*	.37*	–

ADHD, attention deficit hyperactivity disorder.

\* $p < .001$ .

**Table 4** Logistic regression analyses of predictors of any smoking, alcohol use and illicit drug use

	Block 1 – Gender and grade		Block 2 – Mental state		Block 3 – ADHD symptoms	
	OR	95% CI	OR	95% CI	OR	95% CI
Smoked last 30 days						
Constant	0.02***		0.00***		0.00***	
Gender	1.00	0.85–1.17	1.35***	1.13–1.62	1.25*	1.04–1.51
Grade	2.11***	1.89–2.36	1.95***	1.74–2.19	2.00***	1.78–2.25
Anxiety			1.05*	1.00–1.10	1.00	0.96–1.05
Depression			1.07***	1.05–1.09	1.04***	1.02–1.06
Antiestablishment			1.13***	1.11–1.14	1.11***	1.10–1.13
ADHD symptoms					1.06***	1.05–1.07
Nagelkerke $R^2$	0.06		0.20		0.24	
$\chi^2$	199.92***		560.90***		162.03***	
	( <i>df</i> = 2)		( <i>df</i> = 3)		( <i>df</i> = 1)	
Alcohol last 30 days						
Constant	0.04***		0.01***		0.01***	
Gender	0.98	0.86–1.11	1.19*	1.03–1.37	1.09	0.95–1.26
Grade	1.88***	1.73–2.05	1.77***	1.62–1.92	1.79***	1.64–1.96
Anxiety			1.03	1.00–1.07	0.99	0.96–1.03
Depression			1.05***	1.04–1.06	1.02***	1.01–1.04
Antiestablishment			1.09***	1.08–1.10	1.08***	1.06–1.09
ADHD symptoms					1.05***	1.05–1.06
Nagelkerke $R^2$	0.05		0.14		0.18	
$\chi^2$	240.62***		451.93***		196.90***	
	( <i>df</i> = 2)		( <i>df</i> = 3)		( <i>df</i> = 1)	
Illicit drug use ever						
Constant	0.10***		0.01***		0.01***	
Gender	1.07	0.94–1.22	1.58***	1.36–1.83	1.46***	1.26–1.70
Grade	1.50***	1.38–1.62	1.37***	1.26–1.50	1.38***	1.26–1.51
Anxiety			1.06**	1.02–1.10	1.02	0.98–1.06
Depression			1.09***	1.07–1.10	1.06***	1.05–1.08
Antiestablishment			1.09***	1.08–1.10	1.08***	1.07–1.09
ADHD symptoms					1.05***	1.04–1.06
Nagelkerke $R^2$	0.02		0.17		0.21	
$\chi^2$	95.45***		711.68***		175.75***	
	( <i>df</i> = 2)		( <i>df</i> = 3)		( <i>df</i> = 1)	

ADHD, attention deficit hyperactivity disorder; CI, confidence interval; OR, odds ratio.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

model in three blocks – Block 1: gender and school grade (8th, 9th or 10th grade); Block 2: anxiety, depression, antiestablishment attitudes (continuous variables); and Block 3: ADHD inattention and hyperactivity/impulsivity symptoms (continuous variables). Table 4 gives the ORs, 95% confidence intervals, and for the overall model in each block the  $R^2$  value (Nagelkerke-adjusted value), and each model's chi-squared value.

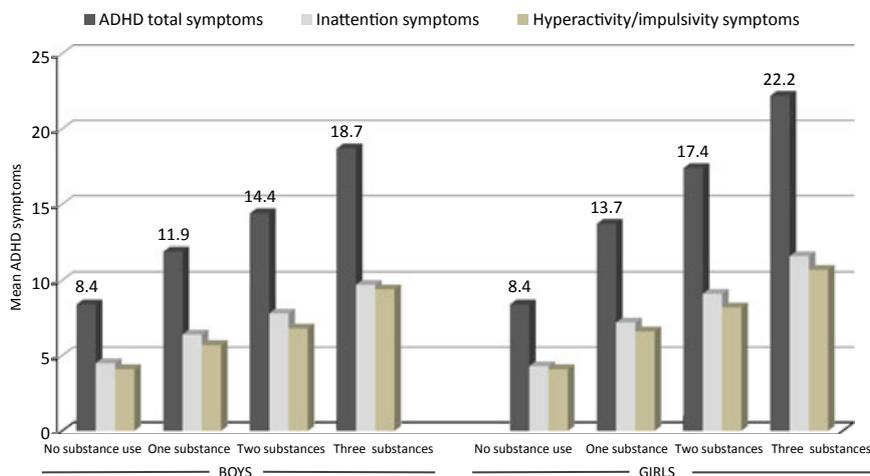
The Nagelkerke  $R^2$  values in Table 4 show increases in the variance explained by each successive model, with the final models explaining 24%, 18% and 21% of the variances in smoking, alcohol use and illicit drug use, respectively. The final models achieved a 92.5%, 87.4% and 88.3% correct group classification, respectively. Anxiety did not contribute significantly to any of the three final models, but school grade showed significant associations with all the three categories of substances (i.e. smoking, alcohol use and illicit drug use), as did depression symptoms and antiestablishment attitudes. Adding ADHD symptoms increased the variance explained by the other predictor variables by 4% for each of the three illicit substances.

### Multiple categories of substance use and ADHD symptoms

Figure 1 shows mean ADHD total, inattention and hyperactivity/impulsivity scores for boys and girls across four categories of single/poly-substance use: 'no substance use', 'one substance only' (of smoking, alcohol and drugs), 'two substances' and 'three substances'. One-way analysis of variances (ANOVAs) revealed highly significant differences across these categories on all three ADHD scales: (a) boys: ADHD total  $F = 133.91$ ,  $df = 3$ ,  $p < .001$ ; inattention  $F = 139.08$ ,  $df = 3$ ,  $p < .001$ ; and hyperactivity/impulsivity  $F = 121.68$ ,  $df = 3$ ,  $p < .001$ . (b) Girls: ADHD total  $F = 324.56$ ,  $df = 3$ ,  $p < .001$ ; inattention  $F = 321.77$ ,  $df = 3$ ,  $p < .001$ ; and hyperactivity/impulsivity  $F = 259.01$ ,  $df = 3$ ,  $p < .001$ . All scores were in the expected direction (i.e. multiple categories being linearly and incrementally associated with ADHD symptoms).

### Discussion

The findings in this study supported all five hypotheses. H1 was confirmed by showing that



**Figure 1** The relationship between attention deficit hyperactivity disorder symptoms and multiple categories of substance use (smoking, drinking and illegal drugs)

cigarette smoking, alcohol use and illicit drug use were all moderately interrelated with medium to large effect sizes, which revealed an overlap between 14% and 26% in the variance across the three measures. H2 was supported by showing that all three substance use measures were significantly related to ADHD symptoms, whether categorical or dimensional measures were used, with ORs for the categorical measures ranging between 5.1 and 6.5, demonstrating large effects. H3 showed that the substance use measures correlated significantly with anxiety, depression and antiestablishment attitudes. H4 was confirmed by showing that ADHD symptoms predicted substance use beyond anxiety, depression and antiestablishment attitudes after controlling for gender and school grade (i.e. they contributed unique variance). Tests of H5 showed clear linear and incremental associations between severity of ADHD symptoms and categories of poly-substance use, with large effect size for both boys and girls. For total ADHD symptoms the effects were substantially larger among the girls than the boys, suggesting relatively greater vulnerability among girls who are symptomatic for ADHD to engage in poly-substance use. There was a similar gender effect for symptoms of inattention and hyperactivity/impulsivity when these were analysed separately.

It is evident that ADHD symptoms, mental health symptoms (anxiety, depression) and personality features (antiestablishment attitudes), were all significantly correlated and all were related to the substance use measures. The unique variance for ADHD symptoms in predicting substance use was very similar for cigarette smoking, alcohol consumption and illicit drug use (i.e. 4%); this may have been further reduced if a robust measure of CD had been available. As outlined earlier, there is evidence that CD is an important mediating variable between ADHD symptoms and substance dependence (Barkley et al., 2008; Lynskey & Hall, 2001),

although this may not be so marked for nicotine dependence (Kollins et al., 2005; Roy, 2007). The antiestablishment measure used in the present study had high reliability, probably identifies rebellious youngsters and may be an important precursor to delinquency in a similar way to ODD and CD. Future studies with more direct indicators of CD would, however, be valuable in confirming our findings.

Affective dysregulation is also an important factor in substance use among adolescents (Holtmann et al., 2011) and our results support this finding. Anxiety did not contribute significantly to any of the final models, but it is interesting that entering ADHD into the models did not eliminate the effect of depressive symptoms on the illicit substance use measures (i.e. ADHD symptoms did not appear to fully mediate the effect). This suggests that mood may have an independent effect on illicit substance use and this merits further investigation.

This study focused on early drug use rather than substance dependence, and our findings suggest there is a specific pathway into initial substance use for young persons with ADHD symptoms, aside from unconventional attitudes and poor socialization. This is consistent with Gorsuch and Butler's (1976) Multiple Models Theory that proposes there are at least two additional pathways to the 'CD' route. The first, undue compliance to peer influence, has been supported by an elevated level of compliance among adult prisoners with ADHD symptoms (Gudjonsson, Sigurdsson, Bragason, Newton, & Einarsson, 2008; Gudjonsson et al., 2011). A second additional pathway may arise from vulnerable mental states, such as susceptibility to boredom, need for stimulation and/or distress associated with ADHD symptoms. The findings in the present study are consistent with this particular pathway (i.e. the types of drugs associated with ADHD symptoms and the linear and

incremental association between ADHD symptoms and the number of different categories of substances used). The current findings clearly demonstrate the heightened risk for young persons with ADHD symptoms to experiment with different categories of substances, which may increase the likelihood of them developing subsequent SUD (Palmer et al., 2009).

The final regression models in Table 4 showed that depression, anxiety and antiestablishment attitudes contributed significantly to the variance in the three substance use measures, but importantly ADHD symptoms also contributed to the variance beyond these key predictors. One possibility is that ADHD symptoms increase the likelihood of drugs being used for self-medication, although such a putative mechanism cannot be determined by a cross-sectional (correlational) study. The high ORs for the use of stimulant drugs (i.e. LSD, cocaine, amphetamines) and illicit sedatives distinguishing the ADHD symptomatic and nonsymptomatic groups (see Table 2) would, however, be consistent with a self-medication hypothesis.

The rates of smoking, alcohol consumption and illicit drug use found in the present study are similar to those found in a previous Icelandic study (Sigfusdottir, Kristjansson et al., 2008), but are below average for those found in other developed countries in the world (Bauman & Phongsavan, 1999; Hibell et al., 2009). However, the high rate of illicit sedatives reported in the present study, which was marginally higher than that of cannabis use, and its relationship with ADHD symptoms merits some discussion. This may be partly due to cultural factors, such as the availability and common use of sedatives and mood stabilizers in Iceland (Zoëga et al., 2009). The type of substances available to young persons will influence their choice of substances (Gorsuch & Butler, 1976). However, a study conducted in France (Galéra et al., 2008) also showed a high rate of sedative use among young persons with ADHD and the authors emphasized their potential importance in relieving ADHD symptoms. The authors suggested that contrary 'to what is suggested by the self-medication hypothesis, this association was not explained by the use of stimulant drugs (i.e., LSD, ecstasy, cocaine, amphetamine). Inhalants and sedatives seemed to account for the link between Hyperactivity-inattention symptoms and lifetime use of other substances' (p. 35). This suggests that it is important to include questions about use of sedatives in studies into the relationship between ADHD and substance use, which is commonly not the case currently.

A preference for cannabis among ADHD participants is consistently reported (Barkley et al., 2008; Sizoo et al., 2010). There are fewer studies on the use of sedatives or tranquilizers by young people with ADHD and these drugs may function to reduce

feelings of restlessness, regulate mood and assist with sleep problems (Wilens & Biederman, 2006). The illicit use of these substances may be a risk factor for future SUD, including cocaine, heroin and amphetamine addiction. For example, Young et al. (2011) found a higher rate of heroin use among Scottish prisoners with ADHD symptoms compared with nonsymptomatic prisoners, which could be explained by a need to use sedatives as a form of self-medication. In a recent Swedish study among long-term prisoners, there was a very high rate of SUD found among those prisoners who were currently symptomatic with ADHD and the preferred choice of drug was amphetamine (Ginsberg, Hirvikoski, & Lindfors, 2010).

The main strengths of the current study are its large sample size, its focus on a representative sample for an entire country, the relatively young age of the participants, its ability to control for anxiety and depressive symptoms and its examination of relationships between ADHD symptoms and poly-substance use. The main limitations are the use of self-report for all the constructs in the study; the use of a measure of antiestablishment attitudes rather than a more direct indicator of CD; the cross-sectional (correlational) nature of the data; and the fact that no information was available on how many of the participants were on medication for the management of their ADHD symptoms. The reliance on a single reporter may have inflated estimates of associations among the variables, and lower estimates might have emerged if independent reports had been available. In addition, self-reported ADHD screens lack sensitivity and specificity for a diagnosis of ADHD (Kooij et al., 2008; Murphy & Schachar, 2000). Although it would have been desirable to have information on medication use, treatment with stimulant medication has not been associated with an overall increase in drug abuse problems and, on the contrary, may be related to reduced illicit drug use (Faraone & Upadhyaya, 2007; Wilens, 2003; Wilens, Faraone, Biederman, & Gunawardene, 2003). Finally, this was a cross-sectional study and longitudinal studies are needed to investigate the pathways of ADHD symptoms into substance use and dependence. In spite of these limitations, the present study adds significantly to the literature on ADHD and substance use among young persons and emphasizes the need for early intervention in this vulnerable group who may be attempting to self-medicate.

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### Key points

- Smoking, alcohol and illicit drug use are all significantly related to ADHD symptoms in adolescents with similar (large) effect sizes. The main distinguishing illicit drug substances were LSD, cocaine, mushrooms and amphetamines, which suggest an attempt to self-medicate.
- ADHD symptoms predict smoking, alcohol use and illicit drug use beyond that of anxiety, depression and antiestablishment attitudes, which suggests that ADHD symptoms represent a special vulnerability to initial substance use.
- There is a large incremental effect of multiple categories of poly-substance use on ADHD symptoms for both boys and girls.
- There is need for early intervention in this vulnerable group who may be attempting to self-medicate.

### References

- Barkley, R.A. (1998). *Attention deficit/hyperactivity disorder: A handbook for diagnosis and treatment* (2nd edn). New York: Guilford Press.
- Barkley, R.A., Murphy, K.R., & Fischer, M. (2008). *ADHD in adults: What the science says*. New York: Guilford Press.
- Bauman, A., & Phongsavan, P. (1999). Epidemiology of substance use in adolescence: Prevalence, trends and policy implications. *Drug and Alcohol Dependence*, 55, 187–207.
- Biederman, J., Monuteaux, M., Mick, E., Wilens, T., Fontanel-la, J., Poetzel, K., ... & Faraone, S. (2006). Is cigarette smoking a gateway drug to subsequent alcohol and drug use disorders? A controlled study of youths with and without ADHD. *Biological Psychiatry*, 59, 258–264.
- Charach, A., Yeung, E., Climans, T., & Lillie, E. (2011). Childhood attention-deficit/hyperactivity disorder and future substance use disorders: Comparative meta-analyses. *Journal of the American Academy of Child & Adolescent Psychiatry*, 50, 9–21.
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112, 155–159.
- Derogatis, L.R., Lipman, R.S., Covi, L., & Rickels, K. (1971). Neurotic symptoms dimensions: As perceived by psychiatrists and patients of various social classes. *Archives of General Psychiatry*, 24, 454–464.
- Einarsson, E., Sigurdsson, J.F., Gudjonsson, G.H., Newton, A.K., & Bragason, O.O. (2009). Screening for attention deficit hyperactivity disorder and co-morbid mental disorders among prison inmates. *Nordic Journal of Psychiatry*, 63, 361–367.
- Faraone, S.V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: A meta-analysis of follow-up studies. *Psychological Medicine*, 36, 159–165.
- Faraone, S.V., & Upadhyaya, H.P. (2007). The effect of stimulant treatment for ADHD on later substance abuse and the potential for medication misuse, abuse, and diversion. *Journal of Clinical Psychiatry*, 68, e28.
- Faraone, S.V., Wilens, T.D., Petty, C., Antshel, K., Spencer, T., & Biederman, J. (2007). Substance use among ADHD adults: Implications of late onset and subthreshold diagnoses. *American Journal of Addiction*, 16, 24–34.
- Galéra, C., Bouvard, M.P., Messiah, A., & Fombonne, E. (2008). Hyperactivity-inattention symptoms in childhood and substance use in adolescence: The youth gazel cohort. *Drug and Alcohol Dependence*, 94, 30–37.
- Ginsberg, Y., Hirvikoski, T., & Lindfors, N. (2010). Attention deficit hyperactivity disorder (ADHD) among longer-term prison inmates is a prevalent, persistent and disabling disorder. *BMC Psychiatry*, 10, 112.
- Gorsuch, R.J., & Butler, M.C. (1976). Initial drug abuse: A review of predisposing social psychological factors. *Psychological Bulletin*, 83, 120–137.
- Gudjonsson, G.H., Sigurdsson, J.F., Bragason, O.O., Newton, A.K., & Einarsson, E. (2008). Interrogative suggestibility, compliance and false confessions among prisoners and their relationship with attention deficit hyperactivity disorder (ADHD) symptoms. *Psychological Medicine*, 38, 1037–1044.
- Gudjonsson, G.H., Wells, J., & Young, S. (2011). Motivation for offending among prisoners and the relationship with Axis I and Axis II disorders and ADHD symptoms. *Personality and Individual Differences*, 50, 64–68.
- Hibell, B., Guttormsson, U., Ahlström, S., Balakireva, O., Bjarnason, T., Kokkevi, A., & Kraus, L. (2009). *The 2007 ESPAD Report: Substance use among students in 35 European countries*. Stockholm: The Swedish Council for Information on Alcohol and Other Drugs (CAN). Modintryckoffset AB.
- Hirschi, T. (1969). *Causes of delinquency*. Berkeley, CA: University of California Press.
- Holtmann, M., Buchmann, A.F., Esser, G., Schmidt, M.H., Banaschewski, T., & Laucht, M. (2011). The child behaviour checklist-dysregulation profile predicts substance use, suicidality, and functional impairment: A longitudinal study. *The Journal of Child Psychology and Psychiatry*, 52, 139–147.
- Kessler, R.C., Adler, L., Barkley, R., Biederman, J., Conners, C.K., Demler, O., ... & Howes, M.J. (2006). The prevalence and correlates of adult ADHD in the United States: Results from national co-morbidity survey replication. *American Journal of Psychiatry*, 163, 716–722.
- Kollins, S.H., McClernon, J., & Fuemmeler, B.F. (2005). Association between smoking and attention-deficit/hyperactivity disorder symptoms in a population based sample of young adults. *Archives of General Psychiatry*, 62, 1142–1147.
- Kooij, J.J.S., Boonstra, A.M., Swinkels, S.H.N., Bekker, E.M., de Noord, I., & Buitelaar, J.K. (2008). Reliability, validity, and utility of instruments for self-report and informant report concerning symptoms of ADHD in adult patients. *Journal of Attention Disorders*, 11, 445–458.
- Levin, E.D., Conners, C.K., Sparrow, E., Hinton, S.C., Erhardt, D., Meck, W.H., ... & March, J. (1996). Nicotine effects on adults with attention-deficit/hyperactivity disorder. *Psychopharmacology*, 123, 55–63.
- Lynskey, M.T., & Hall, W. (2001). Attention deficit hyperactivity disorder and substance use disorders: Is there a causal link? *Addiction*, 96, 815–822.
- Magnusson, P., Smari, J., Sigurdardottir, D., Baldursson, G., Sigmundsson, J., Kristjansson, K., ... & Sigurbjornsdottir, S. (2006). Validity of self-report and informant rating scales of adult ADHD symptoms in comparison with a semistructured diagnostic interview. *Journal of Attention Disorders*, 9, 494–503.
- Murphy, P., & Schachar, R. (2000). Use of self-ratings in the assessment of symptoms of attention deficit hyperactivity disorder in adults. *American Journal of Psychiatry*, 157, 1156–1159.

- Palmer, R.H.C., Young, S.E., Hopfer, C.J., Corley, R.P., Stallings, M.C., Crowley, T.J., & Hewitt, J.K. (2009). Developmental epidemiology of drug use and abuse in adolescence and young adulthood: Evidence of generalized risk. *Drug and Alcohol Dependence*, *102*, 78–87.
- Riggs, P.D., Baker, S., Mikulich, S.K., Young, S.E., & Crowley, T.J. (1995). Depression in substance-dependent delinquents. *Journal of the American Academy of Child Adolescent Psychiatry*, *34*, 764–771.
- Rodriguez, D., Tercyak, K.P., & Audrain-McGovern, J. (2008). Effects of inattention and hyperactivity/impulsivity symptoms on development of nicotine dependence from mid adolescence to young adulthood. *Journal of Pediatric Psychology*, *33*, 563–575.
- Roy, A. (2007). The relationship between attention-deficit/hyperactivity disorder (ADHD), conduct disorder (CD) and problematic drug use (PDU). *Drugs: Education, Prevention and Policy*, *15*, 55–75.
- Shedler, J., & Block, J. (1990). Adolescent drug use and psychological health. A longitudinal inquiry. *American Psychologist*, *45*, 612–630.
- Sigfusdottir, I.D., Asgeirsdottir, B.B., Sigurdsson, J.F., & Gudjonsson, G.H. (2008). Trends in depressive symptoms, anxiety symptoms and visits to health care specialists: A national study among Icelandic adolescents. *Scandinavian Journal of Public Health*, *36*, 361–368.
- Sigfusdottir, I.D., Kristjansson, A.F., Thorlindsson, T., & Allegrante, J. (2008). Trends in prevalence of substance use among Icelandic adolescents, 1995–2006. *Substance Abuse Treatment, Prevention, and Policy*, *3*, 12; doi: 10.1186/1747-597X-3-12.
- Sizoo, B., van den Brink, W., Koeter, M., van Eenige, M., van Wijngaarden-Cremers, P., & van der Gaag, R.J. (2010). Treatment seeking adults with autism or ADHD and co-morbid substance use disorder: Prevalence, risk factors and functional disability. *Drug Alcohol Dependence*, *107*, 44–50.
- Skirrow, C., McLoughlin, G., Kuntsi, J., & Asherson, P. (2009). Behavioral, neurocognitive and treatment overlap between attention-deficit/hyperactivity disorder and mood instability. *Expert Review of Neurotherapeutics*, *9*, 489–503.
- Statistics Iceland (2010). *Educational statistics*. Reykjavik, Iceland: Hagstofa Islands.
- Tercyak, K.P., & Audrain-McGovern, J. (2003). Personality differences associated with smoking experimentation among adolescents with and without comorbid symptoms of ADHD. *Substance Use and Misuse*, *38*, 1953–1970.
- Wilens, T.E. (2003). Does the medicating of ADHD increase or decrease the risk for later substance abuse? *Revista Brasileira de Psiquiatria*, *25*, 127–128.
- Wilens, T.E., & Biederman, J. (2006). Alcohol, drugs, and attention-deficit/hyperactivity disorder: A model for the study of addictions in youth. *Journal of Psychopharmacology*, *20*, 580–588.
- Wilens, T.E., Faraone, S.V., Biederman, J., & Gunawardene, S. (2003). Does stimulant therapy of attention-deficit/hyperactivity disorder beget later substance abuse? A meta-analytic review of the literature. *Pediatrics*, *111*, 179–185.
- Young, S., Wells, J., & Gudjonsson, G.H. (2011). Predictors of offending among prisoners: The role of attention-deficit hyperactivity disorder and substance use. *Journal of Psychopharmacology*, *25*, 1524–1532.
- Zoëga, H., Baldursson, G., Hrafnkelsson, G., Almarsdóttir, A.B., Valdimarsdóttir, U., & Halldórsson, M. (2009). Psychotropic drug use among Icelandic children: A nationwide population-based study. *Journal of Child and Adolescent Psychopharmacology*, *19*, 757–764.

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