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Prevalence and clinical correlates of insomnia in adults with attention-deficit hyperactivity disorder

Brevik EJ, Lundervold AJ, Halmøy A, Posserud MB, Instanes JT, Bjorvatn B, Haavik J. Prevalence and clinical correlates of insomnia in adults with attention-deficit hyperactivity disorder

Objective: To investigate the prevalence of insomnia in adults with Attention-deficit hyperactivity disorder (ADHD) and its association with clinical subtypes, current ADHD symptoms, and stimulant treatment.
Method: We obtained diagnostic information, symptom rating scales and treatment history from clinically ascertained adult ADHD patients diagnosed according to DSM-IV criteria (n = 268, mean age 38.1 years) and randomly selected population controls (n = 202, mean age 36.5 years). The Bergen Insomnia Scale (BIS) was used to measure insomnia. ADHD symptom domains were self-rated using the Adult ADHD Self-Rating Scale.
Results: Insomnia was far more frequent among adults with ADHD (66.8%) than in the population controls (28.8%) ($P < 0.001$). Insomnia was more common in adults with the combined subtype than in those with the inattentive subtype (79.7% and 55.6%, respectively) ($P = 0.003$). For self-reported current ADHD symptoms, inattention was strongly correlated to insomnia. Patients currently using stimulant treatment for ADHD reported a lower total insomnia score compared to patients without medication ($P < 0.05$).
Conclusion: Insomnia was highly prevalent among adults with ADHD. The lower insomnia score in patients on current stimulant treatment suggests that stimulant treatment is not associated with worsening of insomnia symptoms in adult ADHD patients.

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Key words: attention-deficit hyperactivity disorder; sleep; psychostimulants; clinical aspects; neuropsychiatry

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Significant Outcomes

- Insomnia is highly relevant in adult ADHD, with a fivefold increased risk compared with controls
- Stimulant treatment of ADHD in adults is not associated with worsening of insomnia, and may potentially even be helpful in alleviating insomnia symptoms
- Insomnia was more common in the combined and hyperactive/impulsive subtypes than in the inattentive subtype

Limitations

- Insomnia symptoms were based on self-reports, which may be unreliable and lead to an overestimation
- We do not include other sleep variables which may be of interest
- This study employed a cross-sectional, survey design, limiting the possibility of making causal conclusions.

Introduction

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by symptoms of inattention and/or hyperactivity/impulsivity. Based on these symptom domains, the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV/DSM-5) differentiate between inattentive (IA), hyperactive/impulsive (HI), and combined subtypes/presentations (1). It is estimated that 2–3% of the adult population suffer from ADHD (2). People with ADHD typically struggle with maintaining structure and regulating their behaviour and daytime activities. The regulatory difficulties also seem to affect the diurnal rhythm, as ADHD has been associated with various sleep problems, with insomnia being one of the most commonly reported comorbid conditions (3). Insomnia is defined as difficulties initiating or maintaining sleep, early morning awakenings or having non-restorative sleep, lasting for at least a month (1). Insomnia is one of the most frequent health concerns in the general population as well (4), typically affecting 6% to 15% of the adult population (5). Insomnia causes irritability and fatigue as well as reduced productivity, increased absenteeism, increased morbidity, and increased health care costs (4). Most studies examining the relationship between insomnia and ADHD have been performed in children and adolescents, and the few studies addressing insomnia in adult ADHD have given conflicting results (6, 7). One study found that more than half of adults with probable ADHD fulfilled the criteria for insomnia (8). In another study, four of five adults with ADHD reported having sleep problems, irrespective of sex and subtype (9), indicating the importance of addressing insomnia in adult ADHD.

It is well established that ADHD is associated with impairment in cognitive functions such as attention, vigilance and working memory, as well as long-term memory, and decision-making (10). Considering that insomnia also affects cognitive functioning (9), insomnia in addition to ADHD may lead to a vicious cycle where impairments are exacerbated. Studies have shown that sleep problems in general are associated with inattention, whereas some specific sleep problems have been associated with the different ADHD subtypes (3). According to Gau and Kessler (11), HI has been associated with decreased sleep duration, whereas IA has been associated with disturbed sleep, delayed circadian rhythm, and greater sleep need (8, 11–14). Meanwhile, the ADHD combined subtype is characterized by an overall higher symptom burden and severity compared with the other subtypes (15), which may also affect the rate of insomnia. Conversely, the severity of sleep problems is associated with the severity levels of self-reported ADHD symptoms, both among ADHD patients and in the general population (11, 16, 17). Among ADHD patients, this association held when comorbidity and medication were taken into account (17). Of the above cited studies, only three studies (14, 16, 17) used samples with clinically ascertained ADHD patients, the remaining used questionnaires to assign ADHD status.

The relationship between sleep problems and pharmacological treatment for adults with ADHD is not settled. One study reported that nearly four of five non-medicated ADHD participants suffered from sleep-onset insomnia (18), while other studies have found insomnia to be a side-effect of treatment with both stimulants (19) and atomoxetine (20). There is, however, substantial individual variation in whether these medications cause insomnia or not, and sleep problems seem to decrease as the medication is titrated and ADHD symptoms improve (21). Usually, insomnia as a side-effect of stimulant treatment attenuates after 1–2 months treatment (22) and ADHD patients on methylphenidate treatment have even been found to self-report an improvement in sleep quality (23).

Thus, although several studies on the relationship between adult ADHD and insomnia have been published, many of these are of modest quality, with few participants, unclear inclusion criteria, and lack of validated diagnostic protocols. Studies using large samples of clinically ascertained adult ADHD patients and validated measures of insomnia are therefore needed to clarify the relationship between insomnia, clinical subtypes, and symptoms of ADHD and their relationship to stimulant treatment (3).

Aims of study

The aim of the current study was to determine the prevalence of insomnia in a large Norwegian sample of adults with Attention-deficit hyperactivity disorder (ADHD) compared with population controls. Based on previous findings, we expected adults with ADHD to experience higher levels of insomnia than control subjects. We first compared the prevalence of insomnia in the patient group with the control group, then in subtypes of ADHD, and in groups of patients on and off current stimulant treatment. Finally, we calculated the odds ratio of insomnia based on self-reported symptoms of ADHD.

Method

Sample

This cross-sectional study is part of an ongoing project on adults with ADHD in Norway (http://www.uib.no/kgj-npd). The data included in the present study were collected between 2011 and 2016. The sample included adult ADHD patients (n = 268), clinically diagnosed by psychiatrists and psychologists according to the DSM-IV criteria (1). All patients were born in Norway of Norwegian parents. The first patients were recruited from regional expert committees on ADHD, subsequent patients were recruited from clinical psychologists and psychiatrists in outpatient clinics nationwide. Controls (n = 202) were randomly selected and invited to participate in the study directly from the Medical Birth Registry of Norway. This registry includes all persons born in Norway from January 1st 1967 (approx. 2.5 million persons at the time of recruitment). To allow for comorbidities no formal exclusion criteria were used in either sample. This allowed for considerable comorbidities, most noticeably in the adult ADHD group (Table S1). All participants (n = 470) completed a questionnaire including the six Bergen Insomnia Scale (BIS) items, the 18 item Adult ADHD Self-Rating Scale (ASRS) and questions about life-time comorbid disorders (e.g., have you ever had severe anxiety and/or depression). For half of the patients (n = 135/50.4%) clinician reported information was available on the patients' ADHD subtype and pharmacological treatment. The ADHD subtypes were IA (n = 54), HI (n = 6) or Combined (n = 75). As the HI group was very small, the HI group was analyzed together with the Combined group for ease of interpretation. Pharmacological treatment data included whether the patients were on (n = 94) or off (n = 36) current pharmacological treatment with methylphenidate (n = 69), amphetamines (n = 12), atomoxetine (n = 3), or a combination of these (n = 7). Three patients had missing data on use of pharmacological treatment. The patients on atomoxetine are included in the group on current stimulant treatment in this paper, as analyzing the data without these patients did not alter the results. The differences in distribution of sex and age between the ADHD subtypes and between the stimulant treatment groups were all non-significant. As no interaction was found between medication use and ADHD subtypes, we used the greatest sample sizes available when performing the respective analyses. All participants signed a written informed consent, and the study was approved by the Norwegian Regional Committee for Medical and Health Research Ethics, RECWest (IRB #3 (FWA00009490, IRB00001872)).

The Bergen Insomnia Scale

The Bergen Insomnia Scale (24) was constructed based on the diagnostic criteria for insomnia according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (1). It includes six items rated on an 8-point scale, ranging from 0 to 7 days per week during the last month. The first four assess sleep impairment (criteria A of the DSM-IV) (has it taken you more than 30 min to fall asleep after the light was switched off; have you been awake for more than 30 min between periods of sleep; have you awakened more than 30 min earlier than you wished without managing to fall asleep again; have you felt that you have not had enough rest after waking up). The last two items refer to daytime sleepiness/tiredness that has affected your participation at school or work, and your dissatisfaction with sleep respectively (criteria *B*). The criteria for a DSM-IV diagnosis of insomnia are fulfilled if a respondent reports ≥3 days per week on at least one of the A-items and ≥3 days per week on at least one *B* item. In addition, a total composite score is calculated by adding together the scores for each item, with a possible range of 0–42. The BIS thus provides both a dichotomous score for the presence of insomnia and a dimensional symptom score. The Cronbach's alpha of the BIS scale used in the present study was 0.86.

The Adult ADHD Self-Rating Scale

The Adult ADHD Self-Rating Scale (ASRS) is the World Health Organization's (WHO) official

screener for ADHD, and consists of the 18 symptoms listed in the DSM-IV criteria A (25). Nine items assess symptoms of inattention (ASRS-IA) and nine items assess hyperactive/impulsive symptoms (ASRS-HI), respectively, rated on a scale from 0 to 4 (0 = never, 1 = rarely, 2 = sometimes, 3 = often and 4 = very often), yielding a total range of 0–72. The total scores on the two subscales of IA and HI were used as continuous measures of the two main symptom domains of ADHD. Cronbach's alpha was 0.92 on the ASRS-IA subscale and 0.92 on the ASRS-HI subscale.

Statistics and analytical plan

Data were analyzed using SPSS v-23 (26). Independent samples *t*-tests were used to compare pairs of groups on continuous variables and chi-square tests for categorical variables. Logistic regression analysis with insomnia (yes/no) as the output variable was used to investigate the association between self-reported current ADHD symptom scores and the insomnia diagnosis. A final linear regression model, with the BIS score as the output variable, was included to investigate the association between self-reported symptoms of inattention and hyperactivity-impulsivity and the severity level of insomnia symptoms. These two regression models were run separately for the ADHD and the control group. Adjusted models are controlled for age, sex and self-reported comorbid anxiety/depression. Significance levels were set at the 0.05 level on two-tailed tests, unless otherwise indicated.

Results

The differences in mean age and sex distribution between the ADHD patients and the controls were non-significant (age range from 18 to 74 in the ADHD sample and 19–73 in the controls, for more details see Table 1). The BIS total sum score was significantly higher in the ADHD group compared to the control group (t (457.7) = 11.5, P < 0.001). In the clinician defined subgroups, the Combined subtype had higher scores than the IA subtype (t (131) = 2.1, P = 0.036). Furthermore, ADHD patients currently using ADHD medication had lower insomnia scores than patients without stimulant treatment (t (126) = −2.4, P = 0.017) (Table 2).

As shown in Table 2, the ADHD group had higher scores on all six BIS items than the control group. Overall, the prevalence of adults with ADHD fulfilling the criteria for an insomnia diagnosis was 66.8%, which was significantly higher than the prevalence of 28.8% in the control group (χ^2 = 65.2, P < 0.001). The ADHD subtypes also differed in prevalence of insomnia (χ^2 = 8.9, P = 0.003), with the Combined subtype having a higher prevalence of insomnia than the IA subtype (79.7% and 55.6% respectively). There was no significant difference in prevalence of insomnia between the groups on and off stimulant treatment, 66.3% and 72.2% respectively) (Table 2). However, the treatment group reported a significantly lower insomnia symptom score than the group not currently on stimulant treatment.

As expected, the ADHD group had significantly higher ASRS scores than the control group (P < 0.001) (Table 3). Of note, the group off medication reported higher ASRS scores than the subgroup on current stimulant treatment on both the ASRS-IA (t(87.4) = 3.7, P < 0.001) and the ASRS-HI subscales (t(127) = 2.6, P = 0.011). A logistic regression analysis showed that having ADHD was associated with a five-fold increased odds-ratio for insomnia in the full sample [OR: 5.0 (95% CI: 3.3–7.4)]. Further analyses included the ASRS subscales as predictors (Table 4). Logistic regression analysis showed that both ASRS subscales were significantly associated with insomnia in the full sample, but that only ASRS-IA remained a significant predictor when adjusting for sex, age and comorbid anxiety/depression. Of note, the anxiety/depression variable was dichotomous, whereas the ASRS consisted of two scales. The odds of self-reported insomnia thus increased by 0.091 (OR = 1.091) per increased score of ASRS-IA in the full sample. When analyzed separately, anxiety/depression was the only significant predictor of insomnia in

Table 1. Age and sex distributions in the control sample and the ADHD sample

	Controls	Total ADHD	ADHD Subtypes		On current stimulant treatment	
			Combined	Inattentive	Yes	No
	n = 202	n = 268	n = 81	n = 54	n = 94	n = 36
Age (SD)	36.5 (8.0)	38.1 (11.4)	33.2 (9.5)	35.9 (10.0)	34.1 (10.4)	36.7 (8.6)
Female (%)	62.9	59.7	70.4	55.6	66.0	63.9

SD, Standard deviation.

Table 2. Scores on the Bergen Insomnia Scale (BIS)

		Controls	Total	ADHD Subtypes		On current stimulant treatment	
	During the past month, how many days a week	$n = 202$	$n = 268$	Combined $n = 81$	Inattentive $n = 54$	Yes $n = 94$	No $n = 36$
BIS1	Has it taken you more than 30 min to fall asleep after the light was switched off?	1.4 (1.8)	3.4 (2.5)**	3.9 (2.4)	3.2 (2.6)	3.5 (2.5)	3.9 (2.4)
BIS2	Have you been awake for more than 30 min between periods of sleep?	1.0 (1.7)	2.2 (2.2)**	2.4 (2.4)	1.9 (2.1)	2.0 (2.2)	2.8 (2.3)
BIS3	Have you awakened more than 30 min earlier than you wished without managing to fall asleep again?	0.8 (1.3)	2.2 (2.3)**	2.1 (2.5)	1.7 (1.9)	1.7 (2.1)	2.8 (2.4)*
BIS4	Have you felt that you have not had enough rest after waking up?	2.7 (2.0)	4.4 (2.3)**	4.9 (1.9)	4.0 (2.3)*	4.3 (2.1)	4.9 (2.3)
BIS5	Have you been so sleepy/tired that it has affected you at school/work or in your private life?	1.0 (1.5)	2.5 (2.2)**	2.9 (2.1)	2.5 (2.1)	2.4 (2.0)	3.3 (2.1)*
BIS6	Have you been dissatisfied with your sleep?	1.9 (2.0)	3.7 (2.4)**	4.3 (2.1)	3.3 (2.4)*	3.6 (2.2)	4.5 (2.5)
	BIS Sum (SD)	8.9 (7.4)	18.3 (10.1)**	20.6 (10.0)	16.8 (10.3)*	17.5 (9.5)	22.2 (10.6)*
	BIS Insomnia (%)	28.8	66.8**	79.7	55.6**	66.3	72.2

*$P < 0.05$
**$P < 0.01$

Table 3. Scores on the Adult ADHD Self-Rating Scale (ASRS)

	Controls	Total ADHD	ADHD Subtypes		On current stimulant treatment	
			Combined	Inattentive	Yes	No
	$n = 202$	$n = 268$	$n = 81$	$n = 54$	$n = 94$	$n = 36$
ASRS SUM (SD)	21.5 (9.6)	42.7 (13.0)**	46.0 (12.0)	37.0 (13.9)**	40.2 (14.5)	47.8 (9.6)**
Inattention (SD)	11.8 (5.0)	22.5 (6.5)**	23.8 (6.2)	20.7 (7.5)**	21.1 (7.1)	25.4 (5.2)**
Hyperactivity/Impulsivity (SD)	9.7 (5.6)	19.9 (7.3)**	22.2 (6.6)	16.4 (7.3)**	18.8 (7.6)	22.4 (6.1)*

*$P < 0.05$
**$P < 0.01$

the control sample, whereas ASRS-IA was the only significant predictor in the ADHD sample.

The BIS sum score was included as an outcome variable in a linear regression analysis (Table 5), showing that 31% of its variance was explained by the two ASRS-subscales in the full sample. Each subscale contributed significantly, and they continued to do so even when controlled for sex, age and comorbid anxiety/depression. When analyzed separately within the ADHD and control groups, significant contribution was restricted to the ASRS-HI subscale, with a somewhat stronger overall explained variance in the ADHD group (16.1%) than in the control group (9.7%). The ASRS-HI scale remained significant in the adjusted models, with sex and anxiety/depression as added significant predictors in the control sample and ASRS-IA and anxiety/depression as added significant predictors in the ADHD sample.

Discussion

The present study showed that insomnia was far more frequent among adults with ADHD (66.8%) than in the population controls (28.8%), with the highest prevalence in the Combined subtype (79.7%). There was no significant difference in the prevalence of insomnia between the ADHD subgroups on and off medication. The total BIS scores of the un-medicated patients were, however, significantly higher than for patients receiving stimulant treatment, as were the BIS scores of the Combined compared to the IA subtype. Regression analyses showed that the self-reported IA subscale of the ASRS significantly contributed to explain an insomnia diagnosis in the ADHD and the control group, while both the ASRS-HI and ASRS-IA subscales contributed significantly when the total BIS score was used as an outcome variable.

Attention-deficit hyperactivity disorder and sleep problems, including insomnia, are bi-directionally related and mutually exacerbating conditions (9, 27). As ADHD is a heterogeneous developmental disorder, there are likely to be variations in the relationship between ADHD and insomnia. We explored this by examining differences in insomnia for subtypes of ADHD as rated by the clinicians referring the patients, and by including information about self-reported ADHD symptoms. We found that the ADHD Combined subtype had a higher

Table 4. Odds Ratios for Insomnia for the different ASRS ADHD symptom domains

Predictor	Crude OR	95% CI	*P*	Adjusted OR	95% CI	*P*
Full sample						
Inattention	1.092	1.045–1.140	<0.001	1.091	1.043–1.141	<0.001
Hyperactivity/Impulsivity	1.050	1.008–1.093	0.019	1.036	0.994–1.080	0.095
Sex				0.697	0.453–1.072	0.100
Age				0.982	0.962–1.003	0.096
Anxiety/Depression				1.858	1.179–2.929	0.008
Controls						
Inattention	1.095	1.007–1.191	0.035	1.087	0.995–1.188	0.065
Hyperactivity/Impulsivity	1.036	0.963–1.116	0.341	1.032	0.956–1.113	0.420
Sex				0.558	0.271–1.149	0.114
Age				0.984	0.945–1.025	0.443
Anxiety/Depression				2.504	1.098–5.711	0.029
ADHD						
Inattention	1.062	1.005–1.123	0.034	1.068	1.009–1.131	0.022
Hyperactivity/Impulsivity	1.044	0.993–1.097	0.091	1.033	0.982–1.088	0.208
Sex				0.732	0.417–1.284	0.277
Age				0.983	0.960–1.008	0.179
Anxiety/Depression				1.324	0.738–2.374	0.346

OR, Odds ratio; CI, Confidence interval. Adjusted ORs have been controlled for age, sex, and comorbid anxiety/depression.

Table 5. Multiple Regression analyses for the effect of ASRS ADHD symptom domains on the BIS sum score

	Crude					Adjusted				
Predictor	*B*	SE *B*	β	*P*	95% CI for *B*	*B*	SE *B*	β	*P*	95% CI for *B*
Full sample										
Inattention	0.327	0.084	0.255	<0.001	0.163–0.491	0.291	0.083	0.227	0.001	0.127–0.454
Hyperactivity/Impulsivity	0.406	0.079	0.334	<0.001	0.250–0.562	0.338	0.079	0.278	<0.001	0.183–0.492
Sex						1.704	0.796	0.082	0.033	0.140–3.268
Age						−0.061	0.039	−0.061	0.113	−0.137–0.014
Anxiety/Depression						−3.672	0.880	−0.180	<0.001	−5.401 to −1.943
Model	*F*:	103.949		$AdjR^2$	0.310	*F*:	49.207		$AdjR^2$	0.345
Controls										
Inattention	0.230	0.134	0.156	0.087	−0.033 to 0.493	0.186	0.131	0.128	0.158	−0.072 to 0.443
Hyperactivity/Impulsivity	0.265	0.120	0.201	0.028	0.029–0.501	0.238	0.114	0.185	0.038	0.014–0.463
Sex						2.065	1.000	0.138	0.040	0.094–4.037
Age						−0.112	0.060	−0.125	0.063	−0.229 to 0.006
Anxiety/Depression						−3.578	1.337	−0.187	0.008	−6.215 to −0.941
Model	*F*:	11.572		$AdjR^2$	0.097	*F*:	8.009		$AdjR^2$	0.152
ADHD										
Inattention	0.229	0.119	0.148	0.056	−0.006 to 0.464	0.237	0.119	0.153	0.047	0.003–0.471
Hyperactivity/Impulsivity	0.411	0.107	0.295	<0.001	0.200–0.622	0.350	0.108	0.251	0.001	0.136–0.563
Sex						1.598	1.194	0.078	0.182	−0.754 to 3.949
Age						−0.036	0.051	−0.040	0.480	−0.136 to 0.064
Anxiety/Depression						−2.923	1.242	−0.137	0.019	−5.368 to −0.478
Model	*F*:	25.910		$AdjR^2$	0.161	*F*:	12.246		$AdjR^2$	0.178

B, Beta; SE, Standard Error; β, Standardized Beta; CI, Confidence interval; $AdjR^2$, Adjusted R^2. Adjusted models have been controlled for age, sex, and comorbid anxiety/depression.

prevalence of insomnia than the IA subtype. When including information about symptom domains, reported at the same time as the insomnia symptoms, inattention was found to be most closely associated with a diagnosis of insomnia. Since the inattention score was substantially higher in the ADHD-Combined subtype than the other subtypes (see Table 3), both findings support the interpretation that overall ADHD severity is a main predictor of insomnia. Our findings thus support previous reports of the severity of sleep problems being positively related to the severity of ADHD symptoms (17).

The finding that inattentive symptoms were more strongly correlated to insomnia symptoms in the control group than in the ADHD group, suggests that a close association between inattentive symptoms and insomnia is not restricted to adults with an ADHD diagnosis. Without any information about causal relationship, inattentive symptoms may as likely be a consequence of sleep problems than the other way around. It is well known that in itself, insomnia may mimic and cause symptoms resembling ADHD and may also exacerbate underlying ADHD symptoms (7), creating a vicious cycle. This may be detrimental to,

for example, learning outcomes, both through lack of attentional resources and through lack of consolidation through sleep (10). The bidirectionality of this relationship indicates that adequate treatment of ADHD may also be important in improving insomnia. One may be hesitant to use stimulant medication late in the afternoon/evening as insomnia has been associated with stimulant treatment. Our findings however do not support the advice to abstain from medication for fear of causing or exacerbate insomnia in ADHD. The prevalence of insomnia was so high that it should rather be viewed as a problem intrinsic to ADHD. Second, we found no support of an exacerbating effect of stimulant treatment. In fact, and in line with studies suggesting a beneficial effect of ADHD medication in adults with ADHD (21, 23), we found that adult ADHD patients who were currently on stimulant treatment obtained a *lower* BIS sum score compared to those who were not on stimulant treatment, although the prevalence of insomnia was similar across the two groups. Generally, our findings fit well with and extend previous studies on ADHD and insomnia in children and adolescents (28, 29). According to the present knowledge and the present study, the best clinical practice seems to be active pharmacological management of ADHD, combined with a close monitoring of sleep problems in all patients with ADHD regardless of medication. The high overall prevalence of insomnia in ADHD found in the present study, and indications that ADHD patients with the most severe symptoms are also the ones with the most severe insomnia, make it imperative to provide adequate treatment targeting insomnia in the clinical management of ADHD, alongside other problems associated with ADHD symptoms (30, 31). If insomnia is detected, it should be specifically targeted in addition to the ADHD itself, but not preclude stimulant treatment.

Limitations

This study employed a cross-sectional, survey design, limiting the possibility of making causal conclusions. Our definition of insomnia may be inadequate to differentiate patients suffering from delayed sleep phase disorder (DSPD), which is not easily distinguishable from sleep-onset insomnia (32). The use of stimulant treatment was clinician reported, not based on, for example, blood samples, thus not objectively measured. Particularly in the ADHD group, a large fraction of the participants reported present and/or life-time occurring comorbid conditions, such as anxiety/depression, bipolar disorder, dyslexia or substance use disorders (Table S1) (33). While no formal exclusion criteria were used to ensure more clinically valid phenotypes, such comorbidities may have added to the general symptom load, and also influenced the associations with insomnia. The design of the present study precludes strong conclusions, as insomnia as a side-effect from medication may be the cause for cessation. Further studies with experimental designs are needed to clarify this association. One way to assess the relationship between sleep problems and ADHD would be to systematically screen for insomnia before starting stimulant treatment of ADHD, thus enabling the clinical evaluation of insomnia symptoms associated with stimulant treatment (21).

Strengths of the study include the use of a large, clinically validated sample of adult ADHD patients and representative population controls, as well as validated screening tools for insomnia and ADHD symptoms. The BIS has high external and internal validity and worked well in the present study. Its brevity and free availability thus makes it well suited to screen for and detect insomnia in ADHD patients in clinical practice.

To conclude, insomnia is an important health problem that needs to be addressed in adult ADHD patients. Compared to population-based controls, ADHD patients had a five-fold increased odds ratio of having insomnia. Patients with the Combined subtype of ADHD reported a significantly higher prevalence of insomnia than the Inattentive subtype. Patients currently using ADHD medication reported significantly lower insomnia scores than patients not using ADHD medication. Our results indicate that stimulant treatment of ADHD, as used in practice and over time, is not associated with worsening of the severe difficulties with insomnia that are found to be a commonly associated condition of ADHD.

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Declaration of interests

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Prevalence of self-reported psychiatric comorbidities in the control sample and the ADHD sample.