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A prospective study of insomnia in adolescents with ADHD and the association with self-perception and psychosocial function three years later.

Graduate thesis in Medicine

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Abstract

Purpose: In adolescence, there are increased environmental demands and it is important to identify factors that may impair psychosocial function and self-worth in the transition from adolescence to young adulthood. Sleep disorders, including insomnia, in adolescents with ADHD is well established and is shown to impair academic performance and self-esteem. Although there are no conclusive results of the interaction of insomnia and ADHD and if insomnia is a risk factor for additional difficulties in a long-term perspective. The aim of the study was to investigate if there were an association with insomnia and psychosocial function, and insomnia and self-perception of scholastic competence, social acceptance, athletic competence, physical appearance, romantic appeal, close friends, and global self-worth, three years later.

Method: Longitudinal data were obtained from a sample of 200 adolescents – aged 13 to 18 – referred to the Department of Child and Adolescent Psychiatry in Trondheim, Norway. In the baseline study, insomnia was measured by the means of self-report, and the amount of ADHD symptoms was measured by parental report. Participants' psychosocial function and self-perception were assessed three years later; Psychosocial function by clinical psychiatric interview and self-perception by questionnaire.

Results: Analysis shows that reported insomnia at baseline predicted lower self-perception of self-worth, physical appearance, close friends and social acceptance, and a lower psychosocial functioning, three years later. Adjusted for age, gender, and ADHD symptom score.

Conclusion: The results highlight the relevance of identifying sleep disorders amongst adolescents with ADHD in clinical practice, and which associations sleep disorder can have with psychosocial function and self-worth, physical appearance, close friends, and social acceptance in a long-term perspective.

1 Introduction

1.1 ADHD and adolescence

Attention Deficit Hyperactivity Disorder/Hyperkinetic Disorder is a neurodevelopmental disorder that occurs in early childhood and has a chronic course with impairment throughout life. ADHD is characterized by persistent patterns of inattention, hyperactivity and impulsivity, present in several life domains. Because of its chronic course it seriously affects the productivity, life expectancy and quality of life of those diagnosed (Erskine et al., 2013; Franke et al., 2018). 75% of those with ADHD/hyperkinetic disorder have a psychiatric comorbidity. As ADHD is a heterogenous disorder it is important to consider presentation and comorbidity both in clinical practice and in research (Spencer, 2006). Most common among the comorbid disorders are anxiety, Tourette's syndrome, developmental- or sleep-disorder, and these are shown to process and worsen the outcome (Franke et al., 2018; Schei, Novik, Thomsen, Indredavik, & Jozefiak, 2015; Steinhausen et al., 2006). Adolescent's with ADHD who have a comorbid disorder often experience greater social impairment, poorer academic functioning, and increased substance use in comparison with those with no comorbid disorder(Becker, Langberg, & Evans, 2015). Supplementary, psychiatric comorbidity is shown to be an important predictor for the persistence of ADHD as children and adolescents with ADHD transition to adulthood (Biederman, Petty, Clarke, Lomedico, & Faraone, 2011). Other risk factors for persistent ADHD and poor outcome include severity of ADHD, low social competence and peer rejection (Mrug, Hoza, Pelham, Gnagy, & Greiner, 2007; Murray-Close et al., 2010).

The transition into early adulthood can be particularly demanding for those with ADHD, thus knowledge about risk factors associated with poor outcome is of clinical importance (Schei et al., 2018). Several epidemiological studies have found that up to 2/3 of children with ADHD have a sleep disorder (Sung, Hiscock, Sciberras, & Efron, 2008). Sleep disorders impair academic performances and self-esteem, but there are still no conclusive results of the interaction of sleep disorders and ADHD and if sleep disorders are a risk for additional difficulties in a long-term perspective (Cortese et al., 2013). It is therefore interesting to investigate how much the comorbidity of a sleep disorder affects psychosocial function and self-perception in several life domains.

1.2 Sleep, circadian rhythms and insomnia

Sleep is regulated circadian rhythms coordinated by the central suprachiasmatic nucleus. Circadian rhythms also play an important role in regulating physical and mental well-being.

Disruption of rhythm can give unfavorable health effects (Ferguson et al., 2018). Sleep disorder can be divided into several subgroups, including insomnia. Insomnia is defined as problems initiating sleep, frequent awakenings, early awakenings, or a combination of these. In order to diagnose a sleep disorder, the sleep problems are required to affect and reduce the daily function, such as daily tiredness, mood swings, reduced performance ability, reduced attention, worrying about sleep, and be present for at least one month (4th ed., text rev; DSM-IV-TR; American Psychiatric Association, 2000; Riemann et al., 2017; Schutte-Rodin, Broch, Buysse, Dorsey, & Sateia, 2008).

People suffering from a sleep disorder have a higher risk of developing psychiatric and somatic diseases, and studies have found a moderate, positive correlation between sleep disorders and reduced psychosocial function (Norwegian Directorate of Health, 2017). The presence of sleep-related problems in children with ADHD is well established and studies on ADHD and sleep disorders suggests that there is correlation between ADHD, sleep disorders and impaired daily function (Cortese, Faraone, Konofal, & Lecendreux, 2009). Becker et al. (2015) reports that parent rated sleep problems in youth with ADHD at baseline predicted parent-rated symptoms of ODD and externalizing problems and youth rated depressive symptoms one year later. This suggesting that sleep problems may contribute to developmental trajectory of externalizing behaviors in youth with ADHD, exacerbating externalizing behavior problems over time. More studies assessing the long-term effect of insomnia on psychosocial function and self-perception in adolescents with ADHD is needed, especially during the transition to young adult (Becker et al., 2015; Franke et al., 2018; Steinhausen et al., 2006; Virring, Lambek, Thomsen, Moller, & Jennum, 2016).

1.3 Self-perception and psychosocial functioning

A necessary requirement for the ADHD diagnosis is having functional impairment in addition to the core symptoms of hyperactivity/impulsivity and/or inattention. Measuring self-esteem and psychosocial function is valuable in order to assess aspects of functional impairment (World Health Organization, 1992). Self-esteem is derived from the term self-concept and may be described the way people feels about who they are (G. M. Houck, 1999). Self-concept and self-perception have various definitions, but is commonly referred to as one's view of him or herself or of any mental or physical aspect that contribute to the individual's sense of identity (VandenBos, 2007). It also includes one's ideas, beliefs and competencies of oneself in various domains (G. Houck, Kendall, Miller, Morrell, & Wiebe, 2011).

To measure self-perception of self-esteem and psychosocial function we will assess the following seven life domains: scholastic competence, social acceptance, view of own physical appearance, athletic competence, evaluation of romantic appeal, the ability to achieve and maintain close friends and global self-worth. The two subscales of physical appearance and global self-worth are shown to be strongly correlated (Jozefiak, 2019). In developmental psychology it has been shown that physical appearance is reflective of the global self-evaluation (Harter, 2012), in other words; they are the internalized factor and the externalized factor of what makes up a person's self-concept. To assess self-perception of function in domains, will give a more nuanced picture and make it easier to detect which areas may be associated with a certain disorder or stimuli.

Global psychosocial function was measured by a trained clinician, assessing the adolescent's function and need for help in daily life. Giving an overall score of psychosocial function will give an estimate of the severity of impairment, and can add an observed estimate of psychosocial function to the subjective self-perception of function. It gives the opportunity to compare and evaluate if the results are consistent..

Several studies have shown that ADHD leads to a lower quality of life, but there is lack of studies on self-perception of psychosocial function (Harpin, Mazzone, Raynaud, Kahle, & Hodgkins, 2016; G. Houck et al., 2011). What predicts self-perception and psychosocial function in a long-term perspective is not fully covered.

We aimed to study whether insomnia is associated with self-perception and psychosocial function in adolescents with ADHD in a long-term perspective. The following hypotheses were stipulated:

1. Insomnia is associated with worse self-perception of psychosocial functioning in the following domains three years later:
 - a. Scholastic competence
 - b. Social acceptance
 - c. Athletic competence
 - d. Physical appearance
 - e. Romantic appeal
 - f. Close friends
 - g. Global self-worth

2. Insomnia is associated with a worse a clinician-set score of psychosocial function three years later.

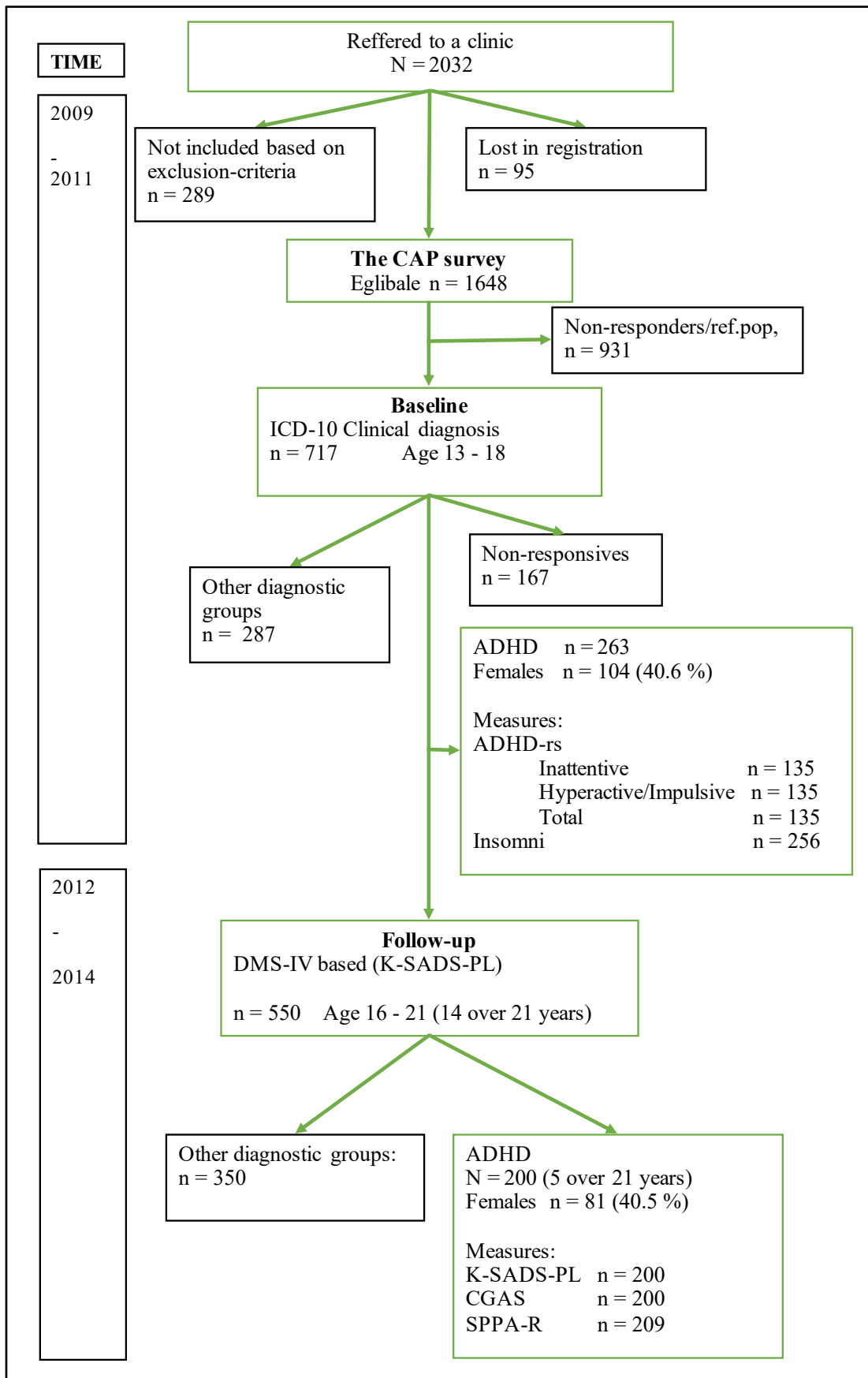
2 Methods

2.1 Clinical sample

The clinical sample was gathered from the Health Survey in the Department for Child and Adolescent psychiatry (CAP) St. Olav's University Hospital, Trondheim, Norway. The CAP survey is a prospective cohort-study. It has its objective to examine the development and consequences of psychiatric disorders, including neuropsychiatric disorders, from childhood and adolescence to adulthood . Inclusion criteria were all adolescents aged 13 and 18 referred to CAP clinic, with attendance in the time between February 15, 2009, and February 15, 2011. Exclusion criteria were major difficulties in answering the questionnaire because of their psychiatric state, cognitive function, or lack of sufficient language skills. During the two years of inclusion, 2032 adolescents were referred to the clinic. From these, 289 were not included based on the exclusion criteria, and 95 were lost during registration. The total amount of invited participants was 1648. From these, 717 participated in the CAP survey baseline (T1), 54,8% female. From the included 717, 263 were diagnosed with hyperkinetic disorder, of them 40,6% female (Schei et al., 2018). From the 263, 257 had answered the questions of insomnia in T1.

The number of base-line participants agreeing to participate in the follow-up three years later (T2), was 648 out of 717. From these 550 participated in a semi-structured diagnostic interview (Kiddie-SADS-PL). Out of the 263 diagnosed with hyperkinetic disorder, 200 participated in the follow-up, 40,5% female (Figure 1).

Figure 1. Overview of the clinical sample.



2.2 Study procedures

Newly referred patients as well as patients already enrolled at the CAP clinic received oral and written invitations at their first attendance after the project started. Written informed consent was obtained from adolescents and parents prior to inclusion, according to the CAP survey procedures. Relevant for this study: the participating adolescents responded to an electronic questionnaire about his or her mental and physical health in conjunction with an appointment at the clinic, without the presence of their parents. The questionnaire contains questions similar to the questions used for adolescents in the Health Study in Nord-Trøndelag (HUNT). The questionnaire was accessed via a password-protected website. A project coordinator provided assistance if needed. Participants had a unique ID-code linked to their questionnaire. Once the questionnaire was submitted, it was not possible to resubmit a new questionnaire using the same code. In addition, data were collected from clinical charts. At follow-up (T2), adolescents participating at baseline were invited to respond to an electronic questionnaire measuring physical and mental health status, using the same ID-code. A telephone-interview was also performed (Henriksen, Ranoyen, Indredavik, & Stenseng, 2017).

2.3 Baseline measures (T1)

2.3.1 Diagnosis

Diagnoses were collected from clinical charts at baseline and followed the *International Statistical Classification of Disease and Related Health Problems*, 10th revision ICD-10 multi-axial diagnostic system (i.e., axes I – IV) (World Health Organization, 1992). All diagnoses were made by a clinical psychologist or a child and adolescent psychiatrist based on the available clinical information. The CAP clinic's standardized procedure for the assessment and diagnosis of hyperkinetic disorders is based on the National Guideline for Assessment and Treatment of ADHD (Norwegian Directorate of Health, 2018a). This guideline, similar to other established ADHD guidelines (Subcommittee on Attention-Deficit/Hyperactivity et al., 2011), requires a clinical diagnostic interview of the ADHD-symptoms described in the DSM-IV (4th ed., text rev; *DSM-IV-TR*; American Psychiatric Association, 2000), possible coexisting disorder and a somatic assessment. It recommends the use of questionnaires filled out by the adolescents, their parents and a teacher to obtain an ADHD symptom score (ADHD-rating scale). The ICD-10 diagnosis of hyperkinetic disorder is referred to as ADHD in this study. The diagnostic criteria for hyperkinetic disorder are nearly identical to the criteria for ADHD combined type in the DSM-IV (4th ed., text rev;

DSM-IV-TR; American Psychiatric Association, 2000) however specifiers such as mainly attention problems or mainly hyperactivity/impulsivity problems are not used in the ICD-10. The Norwegian Health Authorities permit the use of DSM-IV criteria for ADHD, and patients who fulfill the criteria for one of the ADHD subtypes may be diagnosed with one of the categories within the ICD-10 hyperkinetic disorder.

2.3.2 ICD-10

The diagnostic process aims to map the child's or adolescent's behaviour over time to decide if the behavioural characteristics fits the description of ADHD/hyperkinetic disorder. This process also includes the possibility of finding differential diagnoses that better can describe the behaviour. To set the diagnose of ADHD/hyperkinetic disorder the patient must have difficulties with concentration and/or hyperactivity/impulsivity, which must cause noticeably decreased function and be present over time and in different situations. In Norway we use the ICD-10 diagnosis Hyperkinetic disorder, although the guidelines for diagnostics given by the Norwegian Directorate of Health are less strict than the ICD-10 diagnostic criteria. The ICD-10 criteria includes a more severe symptomatology and significant deviation from normality, more than the DSM-IV criteria (Norwegian Directorate of Health, 2018c).

The DSM-IV category are more broadly defined and many clinicians in Europe, including Norway use the wider definition of the DSM-IV and DSM-V in addition to the ICD-10. This allows somewhat less loss of daily function and symptom level, and patients with disorders not included in the ICD-10 criteria, such as the ADHD Inattentive type can be receive treatment (Norwegian Directorate of Health, 2018b; Schei et al., 2015; Taylor et al., 2008).

2.3.3 DSM-IV

DSM-IV diagnostic criteria for AD/HD include 9 symptoms within the area inattention and 9 symptoms within the area Hyperactivity/Impulsivity (4th ed., text rev; *DSM-IV-TR*; American Psychiatric Association, 2000). The symptoms must be present for the past 6 months, deviate from age and developmental level and have a negative impact on social and scholastic-related competence. AD/HD is divided into three subcategories: combined presentation, predominantly inattentive presentation, and predominantly hyperactive-impulsive presentation. For the age below 16 a patient needs to fulfill 6 or more symptoms in one of the categories, and for the age above 16 needs to fulfill 5 symptoms in one category. Within research there is a more frequent use of the diagnosis AD/HD (DSM-IV), than ICD-10s

Hyperkinetic disorder (Norwegian Directorate of Health, 2018b). In this study we have used the term ADHD when describing AD/HD/Hyperkinetic disorder. The semi-structured interview done at follow-up is based on DSM-IV-TR criteria (Kaufman et al., 1997).

2.3.4 ADHD-rating scale-IV (ADHD-RS-IV)

To assess the participant's symptom load ADHD-RS parent version was used (G. J. DuPaul, Ervin, Hook, & McGoey, 1998). The instrument is based on the DSM-IV criteria addressing ADHD symptoms and has a total of 18 items, of which 9 items map hyperactivity/impulsivity and 9 items map inattention. It may be filled out by parent, guardian, or grandparent (Kornør & Bøe, 2011). The score for each item ranges from 0 – 3, so the maximum score for each symptom dimension is 27, and the total score is 54. A higher score reflects a higher amount of symptoms (George J. DuPaul, 2016).

2.3.5 Insomnia

The assessment of sleep difficulties were based on two categorical questions from the CAP survey similar to questions of insomnia in the HUNT-study. They were formulated as follows: “During the last month, 1) «Have you woken to early and not been able to fall asleep again?», 2) «Have you had trouble falling asleep?». The response alternatives were: never, sometimes, often or almost every night. Based on these two questions a new dichotomous-variable was made, 0 = no insomnia and 1 = insomnia. Those who answered often or almost every night in one or both of the questions were included in the insomnia-group (N = 105).

2.4 Follow-up measures (T2)

2.4.1 Kidde Schedule for Affective Disorders and Schizophrenia (Present and Lifetime version; K-SADS-PL)

K-SADS-PL (Kaufman et al., 1997; translated to Norwegian by Sund, NTNU, Trondheim; Kornør & Skarphedinsson, 2016) is a well-established, semi-structured diagnostic interview designed to assess present and past episodes of psychopathology among children and adolescents on Axis 1 of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev; DSM-IV-TR; American Psychiatric Association, 2000). Diagnosis was based on interviews with the participants, executed by trained clinicians. Diagnosis of ADHD included ADHD inattentive and hyperactive/impulsive type and ADHD INA. Young adults taking medication prescribed for ADHD were classified with a diagnosis of ADHD regardless of whether they fulfilled symptom criteria.

2.4.2 Self-Perception for Adolescents-revised (SPPA-R)

To measure the adolescent's self-esteem we used the self-report questionnaire Self-Perception for Adolescents, revised (SPPA-R) (Harter, 1988; Wichstrøm, 1995). In the revised version adjusted to suit Norwegian culture, adolescents make self-assessments in seven different domains; School Competence (SC), Social Acceptance (SA), Athletic Competence (AC), Physical Appearance (PA), Romantic Appeal (RA), Close Friends (CF), and Global Self-worth (GS) (Greger, Myhre, Klockner, & Jozefiak, 2017). The grading ranges from "1 = describes me poorly" to "4 = describes me very well". 21 questions were negatively formulated and were changed so that higher scores indicate a high self-perceived function in the revised version. The questionnaire has satisfactory psychometric qualifications (Wichstrøm, 1995).

2.4.3 Children's Global Assessment Scale (CGAS)

Children's Global Assessment Scale (CGAS) was used to assess psychosocial function. It is a screening tool for mapping of a child's or adolescent's psychosocial function during the last month (Shaffer et al., 1983). We used a Norwegian version (Schorre & Vandvik, 2004). CGAS is a semi-structured psychiatric interview used routinely in psychiatric healthcare in Norway. For this study, a summary score was assigned by the interviewers, being a psychiatrist or child's psychologist, based on information gathered during the interview. The instrument yields a score on a 0 to 100 scale. A score above 70 indicates normal psychosocial functioning (Bird et al., 1990). CGAS has been shown to have good psychometric abilities (Green, Shirk, Hanze, & Wanstrath, 1994).

2.5 Statistical analysis

Descriptive statistics are reported as mean and standard deviation (SD) for continuous variables, and as frequency and percentage of categorical variables. An independent samples T-test was conducted to compare ADHD-RS scores (hyperactivity/impulsivity, inattentive and total) in the group reporting insomnia and the group not reporting insomnia.

The SPPA-R scores in each subdomain were compared in the two groups using a Mann-Whitney U-test for not normally distributed data, *p*-values given.

Linear regression was performed once with SPPA-R as dependent variable and once with CGAS as dependent variable with insomnia as the predictor. The analysis was first performed unadjusted, and then adjusted for age, sex and ADHD-RS scores. A two-sided *p*-

value < 0.05 was considered statistically significant and 95% confidence intervals (CI) were reported where relevant. The analysis was done using IBM SPSS Statistics for Macintosh version 26 (IBM Corp., Armonk, N. Y.).

3 Results

3.1 General description

Table 1 shows descriptive statistics for the study sample. Of those included at baseline ($n = 263$), 256 answered the insomnia questions. From these 105 (39.90%) reported to have insomnia. At baseline 104 (39.90%) were women, and at follow-up 81 (40.50%) were women. Age at attendance was mean 14.99 years (SD 1.65). We included 4 participants over the age of 18 because those referred or in treatment in child and adolescent psychiatry can be up to 23 years old. To assess the symptom load a mean score of ADHD rating scale were calculated, inattention mean score of 18.20 (SD 5.67) of 27 points, hyperactivity/impulsivity mean score of 11.71 (SD 6.77) of 27 points, and a mean total of 29.99 (SD 10.19) of 54 points. ADHD-RS scores for our participants were in the same range as in other studies of adolescents with ADHD, compared with both international studies and Norwegian studies (Dopfner et al., 2006; Egeland, Johansen, & Ueland, 2010; Schei et al., 2018).

3.2 ADHD-rating scale

There were no significant differences in ADHD-RS scores between those reported to have insomnia and those without (Hyperactivity/Impulsivity: $p = 0.371$, Inattentive $p = 0.468$ and Total $p = 0.775$). Summary of these results are displayed in Table 2.

3.3 Self-Perception Profile for Adolescents – Revised

There were significant differences between the two groups in all seven domains of SPPA-R. The largest difference between the groups were in the domain of global self-worth, with 0.44 points lower mean score in the group reporting to have insomnia at baseline (Table 3).

Results from linear regression analysis, showed that age were not associated with a lower score in any of the seven domains ($p > 0.05$). Female gender was associated with a lower score in scholastic competence (regression coefficient $B = -0.262$, $p = 0.041$), physical appearance ($B = -0.719$, $p = 0.001$) and global self-worth ($B = -0.406$, $p = 0.002$). Insomnia predicted a lower score in the following domains, social acceptance ($B = -0.305$, and $p = 0.013$), physical appearance ($B = -0.395$, $p = 0.004$), close friends ($B = -0.264$, $p = 0.028$)

and global self-worth ($B = -0.437, p = 0.001$; Table 4). Adjusting for ADHD-RS scores were shown to not predict a lower score in any of the seven subdomains of SPPA-R (Table 4).

3.4 Children’s Global Assessment Scale

Evaluating CGAS as dependent variable adjusted for age, female gender and ADHD-RS scores showed that age ($B = -2.171, p = 0.006$), female gender ($B = - 4.935, p = 0.046$) and insomnia ($B = -4.967, p = 0.043$) were associated with a lower psychosocial score. Age had a smaller mean reduction in score compared to the association of female gender and insomnia. Adjusting for ADHD-RS scores were shown to not predict a lower psychosocial score ($p > 0.05$; Table 5).

Table 1. Descriptive statistics for the sample at baseline (T1, $n = 256$) and follow-up (T2, $n = 200$).

	Mean	SD	n	%	Missing
T1					
Age	14.99	1.65			0
Females			104	40.60	0
Insomnia			105	39.90	7
Medicated at baseline			200	78.10	56
ADHD-RS Inattention scale	18.20	05.67			121
ADHD-RS Hyperactivity/Impulsivity scale	11.71	06.77			121
ADHD-RS Total	29.99	10.19			121
T2					
Age	18.40	01.68			0
Females			81	40.50	0
Medicated			96	55.49	27
ADHD-present			148	74.00	0
CGAS	71.95	13.57			0
SPPA-R			210	82.00	46

Note. ADHD-RS: ADHD-rating scale. CGAS: Children’s Global Assessment Scale. SPPA-R: Self Perception Profile for Adolescents - revised.

Table 2. ADHD-rating scale, insomnia compared to not insomnia.

	Hyperactivity/ Impulsivity		Inattentive		Total	
	n	Mean	n	Mean	n	Mean
Insomnia	59	12.31	62	17.80	59	30.27
Not insomnia	76	11.25	78	18.51	76	29.76
Total	135		135		135	
<i>p</i>		0.371		0.468		0.775

Table 3. Self-esteem in young adulthood in seven domain-specific areas assessed in the Self-Perception Profile for Adolescents, Revised (SPPA-R) in two groups, insomnia compared to not insomnia.

	Insomnia				Not Insomnia		
	n	Mean	SD	<i>p</i>	n	Mean	SD
School competence	89	2.38	0.677	0.013	120	2.63	0.64
Social acceptance	89	2.72	0.675	0	120	3.08	0.558
Athletic competence	89	2.02	0.695	0.001	120	2.35	0.698
Physical appearance	89	2.26	0.772	0.001	120	2.64	0.75
Romantic appeal	89	2.45	0.676	0.038	119	2.64	0.538
Close friends	89	3.05	0.687	0.026	120	3.27	0.559
Global self-worth	89	2.49	0.675	0	120	2.93	0.696

P values based on the Mann-Whitney *U* test.

Table 4. Linear regression analysis of the relationship between insomnia at baseline and self-perception self-esteem three years later, reported in SPPA-R.

Dependent variable	Independent variables	n	B	95% CI Lower Bound	95% CI Upper Bound	p
School competence	Insomnia	115	-0.141	-0.39	0.108	0.256
	Age, years	115	-0.039	-0.118	0.04	0.332
	Female gender	115	-0.262	-0.512	-0.011	0.041
	ADHD-RS Ina	115	-0.006	-0.029	0.016	0.591
	ADHD-RS Hyp	115	-0.015	-0.035	0.005	0.142
Social acceptance	Insomnia	115	-0.305	-0.545	-0.065	0.013
	Age, years	115	-0.015	-0.091	0.061	0.698
	Female gender	115	-0.12	-0.361	0.212	0.327
	ADHD-RS Ina	115	-0.005	-0.027	0.017	0.659
	ADHD-RS Hyp	115	0.015	-0.004	0.034	0.117
Athletic competence	Insomnia	115	-0.273	-0.513	0.038	0.091
	Age, years	115	0.037	-0.051	0.038	0.091
	Female gender	115	-0.268	-0.545	0.009	0.057
	ADHD-RS Ina	115	-0.005	-0.03	0.02	0.68
	ADHD-RS Hyp	115	0.013	-0.009	0.035	0.257
Physical appearance	Insomnia	115	-0.395	-0.659	-0.132	0.004
	Age, years	115	-0.006	-0.09	0.079	0.896
	Female gender	115	-0.454	-0.719	-0.189	0.001
	ADHD-RS Ina	115	-0.021	-0.045	0.002	0.077
	ADHD-RS Hyp	115	0.012	-0.009	0.033	0.257
Romantic appeal	Insomnia	114	-0.172	-0.41	0.067	0.156
	Age, years	114	0.019	-0.057	0.095	0.622
	Female gender	114	-0.208	-0.448	0.032	0.089
	ADHD-RS Ina	114	-0.008	-0.029	0.014	0.468
	ADHD-RS Hyp	114	0.005	-0.014	0.024	0.604
Close friends	Insomnia	115	-0.264	-0.5	-0.029	0.028
	Age, years	115	-0.011	-0.086	0.064	0.78
	Female gender	115	0.055	-0.182	0.291	0.646
	ADHD-RS Ina	115	-0.004	-0.026	0.017	0.697
	ADHD-RS Hyp	115	0.005	-0.014	0.024	0.584
Global self-worth	Insomnia	115	-0.437	-0.688	-0.187	0.001
	Age, years	115	-0.053	-0.133	0.026	0.188
	Female gender	115	-0.406	-0.658	-0.154	0.002
	ADHD-RS Ina	115	-0.014	-0.037	0.009	0.222
	ADHD-RS Hyp	115	0.014	0.006	0.034	0.163

Note. SPPA-R: Self Perception Profile for Adolescents. ADHD-RS Ina: ADHD-rating scale Inattentive. ADHD-RS Hyp: ADHD-rating scale Hyperactivity/Impulsivity

Table 5. Linear regression analysis of clinical set CGAS three years after reported insomnia

Independent variables	n	B	95% CI Lower Bound	95% CI Upper Bound	p	Missing
Insomnia	116	-4.967	-9.77	-0.163	0.043	
Age, years	116	-2.171	-3.702	-0.64	0.006	
Female gender	116	-4.935	-9.776	-0.093	0.046	
ADHD-RS Ina	116	0.03	-0.422	0.481	0.897	
ADHD-RS Hyp	116	0.126	-0.25	0.501	0.508	

Note. CGAS: Children’s Global Assessment Scale. ADHD-RS Ina: ADHD-rating scale Inattentive. ADHD-RS Hyp: ADHD-rating scale Hyperactivity/Impulsivity

4 Discussion

4.1 Summary main findings

In this study, we examined the prospective effect of insomnia on clinician-set psychosocial function and self-perception of skills, physical appearance, and self-worth in adolescents with ADHD. Insomnia predicted a worse self-perception of social acceptance, physical appearance, close friends, and global Self-worth, and a lower score in clinician-rated psychosocial function three years later compared to participants not reporting to have insomnia. Importantly, insomnia predicted these outcomes after controlling for age, gender, and level of baseline ADHD-symptoms (see Tables 1 and 2).

There is an agreement between the results for psychosocial evaluation set by a clinician and by self-evaluation, which indicate that insomnia in adolescents with ADHD contributes to the developmental trajectories of psychosocial functioning and self-perception. This underlines the importance of evaluating and addressing sleep disturbances in adolescents with ADHD.

4.2 Psychosocial function

In assessing the psychosocial function in adolescents with ADHD we found that insomnia predicts a significant reduced clinician-set score of psychosocial function. The diagnostic criteria of insomnia requires that it also impairs daily function, and here we have seen that insomnia is associated with a reduced daily function three years later. When comparing ADHD and controls without ADHD, sleep problems are shown to be associated with impaired

daily function regardless of diagnostic status (Virring, Lambek, Jennum, Moller, & Thomsen, 2017). Virring et al. (2017) also suggest, like we have found here, that there is a high prevalence of sleep problems among children with ADHD and a strong association between sleep problems and functional impairment.

Female gender was shown to predict reduced psychosocial function. This may be because of a higher prevalence of emotional problems in females during adolescence in both clinical and epidemiological studies (Cyranowski, Frank, Young, & Shear, 2000; Schei et al., 2015; Skrove, Romundstad, & Indredavik, 2013). A recent large-scale and prospective register based study performed by Du Rietz et al. (2020) found that adult females with childhood ADHD have a greater healthcare utilization and economic burden than men, because of a higher amount and different combinations of comorbid disorders. Du Rietz's study can support our findings by suggesting that a higher amount and different combinations of comorbid disorders will give a lower psychosocial function in women with ADHD. Our findings may imply that female gender predicts a reduced psychosocial function, and also will predict reduced psychosocial function in the transition from adolescence to young adulthood. There was an association with gender and self-perceived global self-worth, which also can be explained by the outcome from the studies mentioned here.

The negative association with increasing age and psychosocial function may be explained by the persistence of ADHD into young adulthood and the increased risk for developing comorbid disorders like depression and anxiety (Biederman et al., 2012). Those with ADHD are reported to have poorer social skills, and as environmental demands increase with age, in addition to a decline of parental support, thus the psychosocial function can decrease with age (Schei et al., 2018).

In summary, suggesting ADHD and co-morbid sleep problems, female gender, or higher age predicts a lower score of psychosocial function in a long-term perspective, regardless of diagnostic status.

4.3 Self-perception

4.3.1 Physical appearance and global self-worth

Insomnia among adolescents with ADHD predicts a lower score in the self-perception of physical appearance and global self-worth three years later, compared to those not reporting insomnia. Of all the subdomains of self-perception, global self-worth was most severely impaired by insomnia in a long-term perspective among adolescents with ADHD.

It is shown that those with ADHD often have reduced self-esteem compared to peers with non-ADHD (Harpin et al., 2016). It is also shown that sleep disorders in a general population of adolescents gives a higher representation of depression, anger, inattention, CD, drug and alcohol use, impaired academic performance and suicidal thoughts and they also have more fatigue and a lower self-perception of health (Roberts, Roberts, & Duong, 2009). A study done by Becker et al. (2015) found that sleep problems in young adolescents with ADHD were not only associated with externalizing and depressive symptoms, but sleep problems also contributed to the developmental trajectory of externalizing behaviors and depressive symptoms in a long-term perspective. Reduced perception of self-worth because of the ADHD symptomatology in addition to the possible difficulties one may experience when having sleep disorder can be explanatory for the prospective effect we have seen on global self-worth.

We found that insomnia, after adjusting for ADHD symptoms, predicts a reduction in self-perception of physical appearance. As mentioned previously, the subdomains global self-worth and physical appearance are correlated, which we also can see by the results in this study. In general, the effect of sleep disorder was shown in a previous study saying that shorter sleep duration (< 7h) could increase unhealthy weight control behaviors and risky behavior for both female and male adolescents (Wheaton, Perry, Chapman, & Croft, 2013). The tendency amongst those with ADHD when it comes to assessing body image and self-worth, there is indicated an increased rate of depression and eating disorders, and that with increasing ADHD symptoms they are less satisfied with their body (Van Eck, Morse, & Flory, 2018).

Self-esteem and self-worth are possible protecting factors for better adjusting to new demands during the transition from adolescence to young adulthood, and higher self-esteem in adolescence is associated with better psychosocial function in early adulthood (Schei et al., 2018). Why insomnia impairs the self-perception of self-worth and physical appearance in young adults with ADHD may be explained by a higher prevalence of negative body image and depression, or that sleep disorders may give a higher presentation of emotional difficulties, reduced academic performance and high risk behavior. It is important to early detect which factors may impair the protective factors that are self-esteem, and self-perception of self-worth, to improve the transition from adolescence to young adulthood.

4.3.2 Social acceptance and close friends

Insomnia among adolescents with ADHD predicted reduced self-perception of social acceptance and close friends. Supporting this, a study with a 12-week intervention on sleep-hygiene in 10-year-olds with ADHD showed that both self-reported and parent-reported physical and psychological well-being in the children improved, and that they also improved relationships with family and friends (Keshavarzi et al., 2014). This may suggest an association with sleep disorders, social acceptance, and ability to preserve close relations. Children with ADHD compared to children without ADHD, report to have fewer friends and lower quality friendships, and that they also experience greater peer victimization compared to other children their age (Hoza, 2007). It is also shown that adults with ADHD are at increased risk for poor social outcomes such as high rates of separation and divorce (Franke et al., 2018; Surman, Thomas, Alardi, Pagano, & Biederman, 2006) So, with the diagnose of ADHD social difficulties may be present in childhood and adolescence, and even persist into adulthood. With co-existing chronic sleep disorder, social difficulties may be increased, partly because chronic sleep disorder in adolescents are shown to increase risk-taking behavior, violent behavior and emotional difficulties (Tarokh, Saletin, & Carskadon, 2016).

4.3.3 School competence

Our results showed that there was no correlation between insomnia and scholastic competence three years later. ADHD impairs function across multiple life domains, including school performance, but their impairment cannot solely be blamed on the core-symptoms of ADHD. The scholastic competence is often affected in children with ADHD, and it is shown that about 25 – 40% of those with ADHD have major reading- and writing difficulties, and some may also show co-existing language disorders (Sciberras et al., 2014). Sleep disorders are known to affect academic performance in adolescents. A previous study done by Lucas, Mulraney, and Sciberras (2019) showed that daytime-sleepiness has the highest impact on scholastic performance. A large study from Shanghai, China, also found that symptoms of insomnia were related to lower school performance, poorer concentration, attention, and motivation and that there is a dose-response relationship between insomnia symptoms and school performance in adolescents (Zhao et al., 2019). We suggest that there is an impact of insomnia on scholastic performance in adolescents with ADHD, but a more thorough questionnaire and objective measures should be used to quantify the effect of sleep disorders.

4.3.4 Athletic competence and romantic appeal

Insomnia did not predict a reduced self-perception of athletic competence three years later. This is not consistent with what we hypothesized. An explanation may be that these subdomains have been little used in previous studies and that they may show a low validity (Jozefiak, 2019). There is little literature to be found on the self-perception of romantic appeal in adolescents with ADHD, and even so when including the association with a sleep disorder. As mentioned, those with ADHD may have trouble finding close friends and being accepted by peers because of their symptoms, and this may suggest low scores in romantic appeal. There was a difference between the two groups, but this may have other explanations than insomnia.

Athletic competence and performance in those with ADHD have been more broadly studied. It is shown that the prevalence of ADHD may be more common in elite athletes than in the general population, estimated to be 4,2% - 8,1 % in the athlete's group 15 -19 years (Poysophon & Rao, 2018). The reason for this may be because of the positive reinforcing and attentional activating effects of physical activity. It is also reported that many children with ADHD are («hyper-focused») and able to not be distracted in the same way as their peers when doing physical activity. On the other hand, athletic competence may be impaired because of the core-symptoms and comorbidities of ADHD, for example, poor concentration, lack of focus, oppositional behavior, lowered self-esteem and labile mood and memory deficit. The influence of sleep disorder alone on physical performance is well known. Thus, Bjorvatn, Flo, Harris, and Pallesen (2015), found by looking at several studies, that sleep deprivation decreased physical performance in the evening, most likely because of accumulating fatigue due to lack of sleep. Others have shown that sleep reduction in athletes decrease reaction-time, reduced ability for understanding and implement training or game strategies. From this, we can suggest that ADHD both can impair or have an improving effect on athletic competence. Sleep disturbances are shown to give similar difficulties and symptoms as ADHD and can give a reduced performance in several areas needed to succeed in physical activity. Concluding that there are many aspects both by ADHD and sleep that affects athletic performance, and to find answers more research is needed.

4.4 Degree of ADHD-difficulties

Adjusting for and evaluating the correlation between function scores and amount or combination of ADHD symptoms is valuable to estimate how much can be blamed on the ADHD symptomatology. In our study we did not find any significant correlation between function score and parent reported ADHD symptoms, which suggests that the amount of

symptoms may not predict observed scores. A prospective, non-interventional study performed by Dopfner et al. (2006) showed low correlations between symptom score and measures of functional impairment, implying that symptom ratings and functional impairment are different concepts. In our study there were also no significant correlation between self-perception and the degree of ADHD-symptoms. When it comes to the subdomains mapped here, other studies have found a correlation between teacher rated ADHD-symptoms inattentive type and a reduction in score for the domains social acceptance, scholastic performance, and global self-worth (Kita & Inoue, 2017). Kita and Inoue (2017) also found a correlation between ADHD symptom score hyperactivity/impulsivity and self-precepted behavior. This is not consistent with our results. One reason for this may be because information gathered in the mentioned study was from teacher reports not parent reports as used here, or that the age of the participants differs slightly from the age of our participants. Behaviors and mental state vary widely between school and home environment (Kita & Inoue, 2017). The inconsistency in findings between ours and other studies may suggest that more investigations on the subject are needed.

4.5 Strengths, limitations and future directions

The strengths of this study include the fairly large study sample of above 200 both at baseline and follow-up. The group of comparison also were adolescents with ADHD, which made it possible to compare the amount of symptoms to the effect of insomnia. It is a study investigating the long-term perspective of insomnia, which has been asked for in previous studies (Franke et al., 2018; Virring et al., 2017). With a loss at follow-up of 63 participants, we still had a large study sample, with approximately the same gender distribution. In the present study the inclusion were of consecutively clinic-referred children during a 2-year period, which was important to avoid selection bias. In the follow-up, 200 out of 263 participated in the diagnostic interview, which speaks for higher generalizability. The exclusion criteria of low IQ and demanding psychiatric states strengthens the study by moving potential confounders.

Amount of ADHD symptoms, self-perception, and psychosocial function were all measured differently; symptoms by parent report, self-perception by self-report and psychosocial function assessed by a clinician. The different approaches to detect associations with insomnia gives a better look at the effect on both internalizing and externalizing factors, and can be used to support findings where there are imbricating results. The value of assessing psychosocial function by a clinician gives us an observed measure of psychosocial

function. When it comes to self-assessment it has been shown that those with ADHD and with severe impairment in areas of functioning, reports higher than expected self-esteem. This is called positive illusory bias, and is characterized by positive illusions (Hoza, 2007). By different reports, positive illusory bias can be avoided.

We did not include objective measurements of sleep. Some studies assessing sleep disorder by objective measures like actigraphy, polysomnography (PSG) and multiple sleep latency test (MSLT) has less conclusive findings than in questionnaire studies and when comparing the two types of studies, it is also shown that the results from subjective and objective sleep studies are inconsistent (Virring et al., 2016; Yurumez & Kilic, 2016). This may suggest different results if measures here also were done with objective methods.

ADHD is a heterogenous disease with a high prevalence of comorbidity, and it is shown that comorbidity in ADHD may effect sleep (Yurumez & Kilic, 2016). We did not adjust for any comorbid diseases in this study. Comorbidity of anxiety and depression are known to impair both sleep-pattern and self-perception, more specific it is shown that depression influence the self-perception of physical appearance and social acceptance (Kita & Inoue, 2017). On the other hand, others have shown an association between ADHD, anxiety and increased movement during sleep; ADHD and depression shows a greater self-report of sleep problems in adolescents with ADHD, and it is shown that ADHD combined with ODD were associated with resistance to going to bed and sleepiness in the morning (Corkum, Moldofsky, Hogg-Johnson, Humphries, & Tannock, 1999). If ADHD and comorbid diseases increase sleep disturbances, or ADHD and sleep disturbances increase the risk for comorbidity, this association is not fully covered.

5 Conclusion

Sleep disorders are frequently reported in adolescents with ADHD and are shown to impair daytime functioning and self-perception in a long-term perspective. In adolescence, there are increased environmental demands and it is important to identify factors that may impair psychosocial function and self-worth in the transition from adolescence to young adulthood. This suggests that sleep history assessment in children and adolescents with ADHD should be a part of psychiatric evaluation, so that targeted treatment would be started earlier to improve self-perception of skills, self-worth and psychosocial function; factors that are all important for the developmental trajectory of ADHD.

6 Competing interests

Torunn Stene Nøvik has received a speaker's fee from Medice during the last year. The remaining authors declare that they have no competing interests.

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