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Original Article

Sleep and daytime function in adults with attention-deficit/hyperactivity disorder: subtype differences

Sun Young Rosalia Yoon [a,*], Umesh Ravi Jain [b], Colin Michael Shapiro [c]

[a] Institute of Medical Science, University of Toronto, Centre for Addiction and Mental Health, Child, Youth and Family Program, Toronto, Ontario, Canada
[b] Centre for Addiction and Mental Health, Hospital for Sick Children, Toronto, Ontario, Canada
[c] Youthdale Child and Adolescent Sleep Centre, Division of Patient Based Research, Toronto Western Hospital Research Institute, Toronto, Ontario, Canada

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ABSTRACT

Objectives: Although sleep disorders have been reported to affect more than half of adults with attention-deficit/hyperactivity disorder (ADHD), the association between sleep and ADHD is poorly understood. The aims of our study were to investigate sleep-related variables in adults with ADHD and to assess if any differences exist between ADHD of the predominantly inattentive (ADHD-I) and combined (ADHD-C) subtypes.
Methods: We used the Epworth sleepiness scale (ESS), the Pittsburgh Sleep Quality Index (PSQI), and the fatigue severity scale (FSS) to collect data on daytime sleepiness, sleep quality, and fatigue in 126 subjects (45 ADHD-I and 81 ADHD-C subjects).
Results: Approximately 85% of subjects reported excessive daytime sleepiness or poor sleep quality. The most common sleep concerns were initial insomnia, interrupted sleep, and feeling too hot. When examining ADHD subtype differences, ADHD-I subtypes reported poorer sleep quality and more fatigue than ADHD-C subtypes. Partial correlation analyses revealed that interrelationships between sleep quality, daytime sleepiness, and fatigue differ between ADHD subtypes; in ADHD-I subtypes fatigue was associated with sleep quality, while in the ADHD-C subtypes fatigue was associated with both sleep quality and daytime sleepiness. There also appears to be a subtype × gender interaction that affects the perception of fatigue, as subjective fatigue was markedly higher in ADHD-I women than in ADHD-C women.
Conclusion: Altogether our data indicate that the interplay of variables associated with daytime function and sleep varies between ADHD subtypes. This finding may have considerable relevance in the management and pathophysiologic understanding of ADHD, and thus lead to tailored treatments for ADHD subtypes.

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1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a condition characterized by inattention or impulsivity and hyperactivity that persists into adulthood in 60% of cases [1–4]. In adults ADHD is classified as ADHD of the predominantly inattentive (ADHD-I) subtype or ADHD of the combined (ADHD-C) subtype. The primary difference between ADHD-I and ADHD-C is that, while both subtypes are affected by inattention, clinically notable hyperactive and impulsive behaviors are only present in ADHD-C patients [5]. Extensive research suggests that differences between ADHD subtypes are not limited to the core symptoms of ADHD but rather extend to associated symptoms, comorbidities, efficacy of pharmacologic treatment, genetic profiles, and possibly neurochemistry [6–12].

Sleep disorders are common comorbidities of both childhood and adult ADHD. Twenty-five to 50% of children and more than half of adults with ADHD reportedly experience sleep concerns [13]. Sleep is particularly interesting in the context of ADHD. The fact that brain structures involved in the regulation of sleep also are involved in the regulation of attention, wakefulness, and alertness—three features that are affected in ADHD—suggests common neurologic pathways underlying sleep disorders and ADHD. Importantly sleep deprivation is known to be associated with deficits in cognitive performance, hyperactivity, irritability, and inattention, all of which are hallmarks of ADHD [14–28].

Although the importance of sleep in ADHD is acknowledged in clinical practice, the nature of the association between sleep and ADHD is poorly understood. This misunderstanding is particularly true for the adult ADHD population, in which studies on sleep are

* Corresponding author. Address: Institute of Medical Science, University of Toronto, Centre for Addiction and Mental Health, Child, Youth and Family Program, 80 Workman Way #6214, Toronto, Ontario, Canada M6J 1H4. Tel.: +1 416 535 8501; fax: +1 416 979 4996.
E-mail address: rosalia_yoon@camh.net (S.Y.R. Yoon).

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scarce. Therefore, the aim of our study was to investigate subjective (self-administered questionnaires) parameters of sleep in an independent sample of adults with ADHD. Given the extensive literature on ADHD subtype differences regarding associated symptoms and comorbidities, we also set out to investigate if subjective parameters of sleep differ between ADHD subtypes.

2. Methods and materials

2.1. Recruitment process

Participants were subjects referred to the Centre for Addiction and Mental Health (CAMH) between June 2009 and June 2010 for an assessment of ADHD. Referred subjects were consecutively contacted to come to CAMH to complete the Conners Adult ADHD Rating Scale Self-report: Long Version (CAARS-S:L), the Adult ADHD Self Report Scale (ASRS), the Diagnostic and Statistical Manual of Mental Disorders – fourth edition, text revision (DSM-IV-TR) checklist of symptoms, and the Temperament and Character Inventory (TCI) [5,29–31] as well as sleep-related questionnaires.

Subjects with *t* scores >72 on CAARS subscales corresponding to DSM-IV ADHD symptoms, at least four positive items on the ASRS, at least six positive items on the DSM-IV-TR checklist for inattentive symptoms, or a *t* score <30 on the self-directedness subscale of the TCI were considered to meet criteria for ADHD. These subjects had appointments booked for a board-certified psychiatrist-led semistructured interview, which served to assess presenting symptoms and clinical history, and thus confirmed or rejected ADHD diagnosis. Clinical history in childhood was confirmed by interviewing collateral (i.e., one of the patient's parents, older sibling, or spouse if they know the patient's history). A structured clinical interview for DSM-IV Axis I disorders (SCID-I) was used to rule out concurrent psychopathologies.

Psychotropic medication-free subjects (within one month before participation) diagnosed with ADHD-I or ADHD-C between the ages of 19 to 65 years were eligible to participate in our study. Subjects were excluded if they were nightshift workers or if they had a concurrent Axis I disorder in addition to ADHD.

A total of 284 adults were referred to CAMH, and 126 adults were enrolled in our study. Subjects each gave informed consent in writing. The research ethics board at CAMH approved the procedures for the protocol. The investigation was conducted according to the principles expressed in the Declaration of Helsinki and the Belmont report.

2.2. Determination of ADHD subtypes

The sum of observations on the semistructured interviews with the patient and with the collateral was used to determine ADHD subtypes. Subjects who displayed externalizing behaviors, hyperactivity, and impulsivity in childhood and adulthood were classified as ADHD-C, while subjects who displayed introvert traits were classified as ADHD-I. In ambiguous cases, trends in CAARS subscales corresponding to hyperactivity/restlessness and impulsivity/emotional lability and in DSM-IV-TR criteria for hyperactive-impulsive symptoms were used, in addition to observations on clinical history to determine the subtype.

2.3. Subjective parameters of sleep

2.3.1. Epworth sleepiness scale

The Epworth sleepiness scale (ESS) is a self-administered eight-item scale that rates a subject's trait sleepiness [32]. It significantly correlates, albeit weakly, with the multiple sleep latency test, an objective method for measuring sleep propensity [33]. Despite its weak correlation with the multiple sleep latency test, the use of ESS may be advantageous due to its ability to measure sleep propensity in different situations, and thus be a better reflection of the more general characteristic of sleepiness in daily life [33].

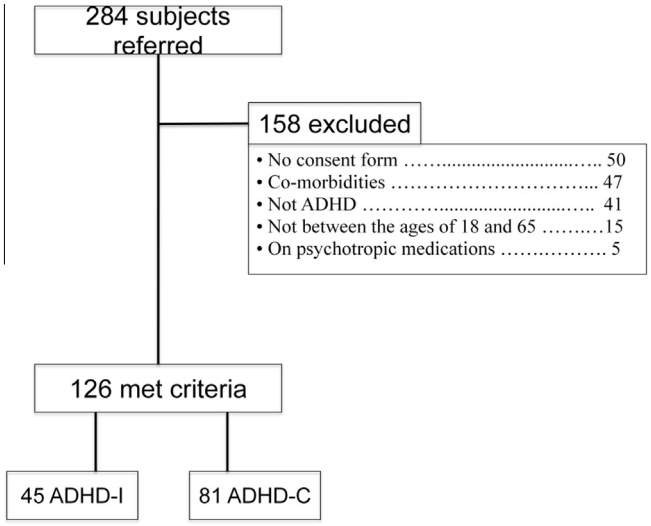

Fig. 1. Schematic representation of patient enrollment. Two hundred and eighty four adult subjects were referred to the Centre for Addiction and Mental Health between June 2009 and June 2010 for an assessment of attention-deficit/hyperactivity disorder (ADHD). One hundred and fifty eight subjects were excluded from the study for not providing consent for participation in the study ($n = 50$), for comorbidities ($n = 47$), for not meeting criteria for ADHD ($n = 41$), for not being between the ages of 18–65 ($n = 15$), and for being on psychotropic medications ($n = 5$). One hundred and twenty six subjects were included in the study, of whom 45 were diagnosed with ADHD of the predominantly inattentive (ADHD-I) subtype, and 81 were diagnosed with ADHD of the combined (ADHD-C) subtype.

2.3.2. Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) is a self-rated nine-item questionnaire that assesses quality of sleep over the past month, with diagnostic sensitivity of 89.6% and specificity of 86.5% ($\kappa = 0.75$; $p < .001$) in distinguishing adequate sleepers from poor sleepers [34].

2.3.3. Fatigue severity scale

The fatigue severity scale (FSS) is a self-administered nine-item scale that determines a subject's trait fatigue; it has high internal

Table 1
Demographics of study subjects.

	ADHD-I ($n = 45$)	ADHD-C ($n = 81$)
Age (y)	40	37
mean age (SD)	(±11)	(±10)
Proportion of women	11	22
n (%)	(24%)	(27%)
Proportion of subjects with sleep concerns	43	70
n (%)	(96%)	(85%)

Abbreviations: ADHD-I, attention-deficit/hyperactivity disorder of the predominantly inattentive subtype; ADHD-C, attention-deficit/hyperactivity disorder of the combined subtype; y, years; SD, standard deviation.

A number of statistical analyses were conducted to compare the patients diagnosed with attention-deficit/hyperactivity disorder (ADHD) of the predominantly inattentive (ADHD-I) subtype and patients diagnosed with ADHD of the combined (ADHD-C) subtype. Significance was set at $p \leqslant .01$ for all tests. A Student *t* test revealed no significant differences regarding mean age, $t(124) = 1.49$; $p = .69$. χ^2 tests conducted to determine gender distribution and proportion of subjects with sleep concerns (subjects who reported excessive daytime sleepiness with Epworth sleepiness scale score $\geqslant 10$ or poor sleep quality with Pittsburgh Sleep Quality Index score $\geqslant 5$ were considered to have sleep concerns) in ADHD-I and ADHD-C groups revealed no statistical significance (for gender, χ^2 (1, 126) = 0.11; $p = .74$) (for sleep problems, χ^2 (1, 126) = 3.15; $p = .08$).

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