

## Sleep in conduct-disordered adolescents—a polysomnographic and spectral power analysis study

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### Abstract

The aim of the present study was to characterize sleep in conduct-disordered adolescents using polysomnography and spectral power analysis. The two hypotheses were that conduct disorder would be associated with objective sleep problems, and that conduct disorder—as a precursor of adult antisocial personality disorder—would be associated with the same kind of abnormal sleep architecture, with both increased deep sleep and delta power, as previously reported in antisocial personality disorder. The patients consisted of 15 adolescents (age range 13–17 years, mean age 14.7 years) with histories of antisocial behavior so functionally impairing that they were ordered by child welfare to undergo a psychosocial evaluation in a closed social services ward. The healthy age-matched controls comprised 20 volunteers recruited with a newspaper advertisement. Opposite to earlier subjective sleep studies among conduct-disordered children, no significant differences in sleep parameters were observed between the two groups. The adolescents with conduct disorder slept a little bit longer, but the percentage amount of different sleep stages did not differ significantly between the two groups. Relative spectral power of sleep, delta power in particular, was similar in both groups, assessed in total sleep time as well as in first half of it. Different alternative explanations for these findings are discussed. © 2007 Elsevier Ireland Ltd. All rights reserved.

**Keywords:** Adolescence; Conduct disorder; Polysomnography; Spectral power analysis

### 1. Introduction

Conduct disorder (CD) is the most common psychiatric disorder in children and adolescents and one of the

most frequent bases for clinical referral to child and adolescent treatment services, encompassing one-third to one-half of all referrals (Kazdin, 2000). CD is characterized by a variety of repetitive maladaptive behaviors, including aggressive and impulsive behavior, truancy, lying, stealing, cruelty to animals and people, violation of rules as well as vandalism (American Psychiatric Association, 2000). Prevalence rates of CD vary from <1 to >10%, depending on the population sample (American Psychiatric Association, 2000).

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Prognosis has been described to be relatively poor, often leading to adult antisocial personality disorder and substance abuse (Robins, 1966). The neurophysiologic basis of CD is, however, still quite unknown. Autonomic underarousal and a low resting heart rate have been reported to be the best replicated biological correlates of CD (Raine, 2002), but also waking-EEG slowing has also long been associated with antisocial and aggressive behavior in children and adolescents (Forssman and Frey, 1953; Bayrakal, 1965).

In recent years, an increasing number of studies have reported associations between children's sleep disturbances and various psychiatric symptoms, including behavioral problems. In questionnaire-based studies, a significant correlation between CD scores and reports of sleep problems among children has been shown (Morrison et al., 1992; Owens-Stively et al., 1997). Moreover, daytime behavioral disruption has been noted as a concomitant of disturbed sleep with primary sleep disorders (Chervin et al., 2003). As far as the authors are aware, only one polysomnographic study in pre-adolescent 10- to 13-year-old boys with CD as a primary diagnosis has been published (Coble et al., 1984). In that study no differences in percentage amount of different sleep stages was shown, but a larger number of delta waves were counted in the boys with CD as compared with the age- and gender-matched healthy controls. By far, no spectral power analysis studies have been published in this patient group. Even though sleep disturbances are known to remain common during adolescence (Morrison et al., 1992), there is little literature concerning associations between disturbed sleep and conduct problems in adolescents (Carskadon et al., 2004).

Human sleep consists of two main components: rapid eye movement (REM) sleep, and non-REM sleep, the latter divided into stages 1–4 (S1–S4). Each sleep stage can be recognized by its distinct characteristics in polysomnography: electroencephalography (EEG), electro-oculography (EOG), and electromyography (EMG) recordings. Stage 3 sleep (S3) and stage 4 sleep (S4) in non-REM sleep are defined as slow wave sleep (SWS), also called delta sleep or deep sleep based on the presence of high-amplitude, slow delta waves. In normal sleep, REM and non-REM sleep periods alternate cyclically. Sleep normally begins with S1, progresses through S2 and S3 to S4, and finally to REM sleep. This cycle is repeated every 70 to 110 min, four to six times a night. SWS predominates during the first third of the night, whereas REM sleep predominates during the last third (Rechtschaffen and Kales, 1968; Turek and Zee, 1999). One of the consistent alterations in normal ageing is a reduction in SWS, while REM

sleep is less affected (Bliwise, 2000). The change in the amount of SWS has been interpreted as a sign of brain maturation (Bliwise, 2000). Though the exact functions of the different sleep stages are unknown, it is generally accepted that SWS is the physiologically significant, refreshing part of sleep. For example, most psychiatric disorders are associated with a decreased amount of non-REM sleep (Benca et al., 1992).

Adult antisocial personality disorder, in contrast to other psychiatric disorders, has been shown to be associated with increased deep sleep, especially S4 sleep, as well as with increased relative delta power (Lindberg et al., 2003a; Lindberg et al., 2006). Whether this abnormal sleep architecture reflects a delay in the normal development of sleep patterns in the course of aging, or specific brain pathology, is not known. Although antisocial personality disorder is diagnostically always preceded by CD before the age of 15 (American Psychiatric Association, 2000), not much is known about the biological mechanisms that are involved in this process. From the perspective of sleep research, the interesting question is whether the exceptional deep sleep phenomenon reported in adults with antisocial personality disorder can already be observed in adolescents with CD. The previous findings that the spectral profiles in the delta, theta, alpha and beta frequency bands of a subject's waking EEG are highly correlated with spectral profiles of the sleep EEG (Ehlers et al., 1998), and that waking-EEG slowing has been shown in both patient groups (Lindberg et al., 2005; Raine et al., 1990), might predict an increase in SWS and delta power in the sleep EEG of adolescents with CD compared with healthy adolescents.

The aim of the present study was to characterize sleep in adolescents with CD using polysomnography and spectral power analysis. There were two hypotheses to be tested; first, CD would be associated with objective sleep problems, and second, subjects with CD would display a similar profile of sleep architecture (increased amount of deep sleep and delta power) to that described in subjects with adult antisocial personality disorder (Lindberg et al., 2003a).

## 2. Materials and methods

### 2.1. Participants

The patients consisted of 15 adolescents (age range 13–17 years, mean age 14.7 years, S.D. 1.0) with histories of antisocial behavior so functionally impairing that they were ordered by child welfare to undergo a psychosocial evaluation in a closed social services ward. All adolescents (9 girls and 6 boys) met the DSM-IV

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