

# Sleep-Related Breathing Disorder, Cognitive Functioning, and Behavioral-Psychiatric Syndromes in Children



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## KEYWORDS

• Sleep-disordered breathing • Behavioral outcome • Psychiatric outcomes • Cognitive outcomes

## KEY POINTS

- Childhood sleep-disordered breathing (SDB) is robustly associated with behavioral disturbances such as hyperactivity, inattention, and aggression.
- Many studies find that cognitive problems and psychiatric disorders are more common in children with SDB than in those without.
- Dysfunction of the prefrontal cortex has been proposed as a mechanism linking sleep disruption to behavioral and cognitive problems.
- Nonetheless, the majority of children with SDB remain undiagnosed.

## INTRODUCTION

There is a wealth of literature describing the relationships between sleep-disordered breathing (SDB), behavior, and cognition in children. Although these relationships were first recognized in the 1800s, it is only in recent decades that there has been a focus on the underlying pathophysiology, consequences, and treatment. This article summarizes current neurobehavioral and psychiatric manifestations of pediatric SDB.

## PREVALENCE AND RISK FACTORS

SDB is a spectrum of breathing disturbances ranging from habitual snoring through to obstructive sleep apnea with associated sleep fragmentation and alterations in ventilation. Definitions of SDB vary, thus hampering accurate prevalence

data, but a recent review of the epidemiology of pediatric SDB reported that “always snoring” occurs in 1.5% to 6.0% of children, with various constellations of SDB symptoms reported by questionnaire to occur in 4% to 20% of children.<sup>1,2</sup> Objective evidence of SDB from polysomnography, using various criteria, occurs in approximately 1% to 4% of children.<sup>2</sup>

The major risk factors for pediatric SDB are adenotonsillar hypertrophy and obesity. Symptoms of SDB have been reported in infancy,<sup>3</sup> although the majority of studies focus on elementary and middle school children. Although there does not seem to be a clear age-related pattern for SDB, young children are believed to be at greatest risk possibly owing to adenotonsillar tissue being largest relative to airway size. However, this belief has recently been questioned, because in normal children the growth of adenotonsillar tissue may

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actually be proportionate to airway growth, suggesting that any deviation from this trajectory would be abnormal.<sup>4</sup> Children with enlarged tonsils and adenoids may have increased upper airway collapsibility.<sup>5</sup> Several studies suggest that SDB may be more frequent in children of African-American race compared with Caucasians<sup>6,7</sup> and that boys may be at higher risk of SDB than girls,<sup>8-10</sup> especially in studies that included teenagers,<sup>11</sup> where pubertal hormonal changes likely contribute to the gender differences observed in adults. In addition, children with craniofacial anomalies and those with disorders affecting upper airway patency are at higher risk of SDB. Risk factors for SDB can include prenatal and perinatal complications, but such factors seem to become insignificant when controlling for socioeconomic status and race.<sup>12</sup>

### CONSEQUENCES OF SLEEP-DISORDERED BREATHING

There is now a wealth of literature showing strong and significant associations between habitual snoring and/or objective measures of SDB with a range of neurobehavioral, cognitive, and psychiatric problems. Such consequences are likely related to interactions between the episodic hypoxemia and sleep fragmentation that characterize SDB. These outcomes have shown to be at least partially reversible after treatment for SDB, suggestive of a causal relationship. A summary of the relationships between SDB and behavioral, cognitive, and psychiatric outcomes is provided in this article.

### BEHAVIORAL OUTCOMES

Behavioral problems demonstrate the most robust association with pediatric SDB, particularly hyperactive and inattentive behaviors. Furthermore, there is evidence suggestive of a role for SDB in conduct problems and aggressive behaviors. In the 1970s, Guilleminault and co-workers<sup>13,14</sup> reported on behavioral problems associated with SDB and since then this has remained a topic of considerable interest.

#### Hyperactivity

Hyperactivity has been reported in both children with habitual snoring,<sup>15-23</sup> as well as those in whom SDB was formally diagnosed by polysomnography.<sup>24-31</sup> Despite differences in definition of snoring or polysomnography-confirmed SDB, many studies support the relationship between snoring/SDB and hyperactive behaviors even when hyperactivity is measured with a range of

parent-report tools, including the Conners' Parent Rating Scales,<sup>23-25,27</sup> the Child Behavior Checklist,<sup>24,26,29-31</sup> or the Behavioral Assessment Scale for Children.<sup>28,32</sup> Only a small number of studies have failed to find associations with SDB and hyperactive behaviors.<sup>33-35</sup> The vast majority of published studies report cross-sectional findings that, although important, provide no information on the direction of the proposed relationships. More recently, some evidence in support of the hypothesis that SDB may play a causal role in hyperactive behaviors comes from a 4-year, prospective study in Michigan.<sup>36</sup> In this study, snoring and symptoms of SDB were strong risk factors for the future development or exacerbation of hyperactive behaviors, with habitual snoring at baseline increasing the risk for hyperactivity at follow-up by more than 4-fold. Findings were particularly strong in boys. Results were independent of hyperactivity at baseline and stimulant use as well as SDB symptoms at follow-up. This suggests that damage done 4 years earlier may have been visible as a hyperactive phenotype only years later, and alludes to the belief that there may be a "window of vulnerability" in developing humans.

#### Inattention

Attention is a critical behavior arising from brain mechanisms and is required for optimum learning. It describes a set of cognitive processes that can optimize the detection and discrimination of stimuli, as well as stimulus processing. Attention can be categorized as sustained, selective, and divided attention, thus representing a cluster of variables, each of which contribute to learning and memory. Inattentive behaviors identified by parental report have been observed in children with habitual snoring<sup>15,17,23,37</sup> and polysomnography-defined SDB,<sup>28-30,32-34</sup> although this finding is not as robust as the associations with hyperactivity. Different categories of attention, for example selective and sustained attention, can also be measured using objective assessments, such as auditory or visual continuous performance tests (CPT) and therefore may provide more robust assessment than parental report.

In a small study of 13 children who snored, in the absence of objective SDB, and 13 controls, Kennedy and colleagues<sup>38</sup> found that both selective and sustained attention measured objectively using the auditory CPT were found to be impaired by habitual snoring. Galland and colleagues<sup>39</sup> found that, in comparison with a normal population, children with objectively confirmed SDB, compared with those without, had significantly higher scores on a visual CPT for inattention and

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