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Original Article

Increased severity of sleep-disordered breathing is associated with insomnia and excessive somnolence in primary school children

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ABSTRACT

Objective: The aim of the study was to investigate the prevalence of difficulty with initiation or maintenance of sleep (DIMS) and excessive daytime sleepiness (EDS) in a general pediatric population, and to evaluate the relationship between these conditions and sleep-disordered breathing (SDB) symptom intensity.

Methods: This population-based cross-sectional study from 27 primary schools in a medium-sized city in Poland was based on use of a questionnaire regarding demographic data, symptoms of SDB, DIMS, and EDS. Data were collected between September and December 2014. In all, 2940 caregivers were recruited and were asked to fill-out questionnaires and written consent.

Results: A total of 68% of the questionnaires (n = 1987) were returned and analyzed. Habitual snoring (HS) was reported in 104 (5.3%) children. DIMS and EDS were seen in 137 children (6.9%) and 117 children (5.9%), respectively. The prevalence of DIMS increased from 3.5% in children who never snored to 28.6% in children who snored very often or always. Similarly, the prevalence of EDS was 2.7% in children who did not snore and increased to 19% in children who snored very often or always. No correlation was seen between increasing DIMS (r = 0.006, p > 0.05) or EDS (r = -0.031, p > 0.05) scores and body mass index.

Conclusions: This study is the first to measure the symptoms of both DIMS and EDS in a general pediatric population and to assess the relationship between both DIMS and EDS and SDB in children. We found that children with more frequent snoring had a higher prevalence of DIMS as well as EDS; however, there was no correlation between body mass index and either DIMS or EDS symptom severity.

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1. Introduction

Epidemiological studies suggest that up to 50% of children experience difficulties related to sleep; however, only 4% of children go on to receive a formal sleep disorder diagnosis [1,2]. The most common sleep disorder seen in a pediatric otolaryngology (ENT) practice is sleep-disordered breathing (SDB). This disorder comprises a spectrum of nocturnal ventilation disorders, which range from primary snoring to obstructive sleep apnea (OSA) [3]. SDB has been linked to reduced neurocognitive function, negative cardiovascular effects, and growth deficits [4]. However, a number of other sleep disorders may cause sleep difficulties, such as insomnia, parasomnias, restless legs syndrome (RLS), periodic limb movement

disorder, and narcolepsy. These conditions can coexist with SDB, and children with these conditions may experience excessive daytime sleepiness, which requires further investigation.

Insomnia is defined as difficulty with initiation or maintenance of sleep (DIMS), or nonrestorative sleep, which occurs at least three nights per week for at least three months' duration, despite adequate opportunity to sleep. The co-occurrence of OSA and insomnia was first described in adults by Guilleminault et al. in 1973 [5]. Since that time, many studies have confirmed this association [6–9], but few studies have evaluated this association in children.

Excessive daytime sleepiness (EDS), which may result from insomnia and SDB, is defined as the inability to maintain wakefulness and alertness during the major waking episodes of the day, with sleep occurring unintentionally or at inappropriate times almost daily for at least three months [10]. It is often recognized by parents when children fall asleep in public places, during class, as passengers in cars, or while watching television. Adults with SDB typically experience EDS with poor concentration, whereas children with SDB are more likely to exhibit hyperactivity than EDS [11]. In light of the

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association between SDB, EDS, and other sleep disorders, it was our aim to investigate the prevalence of DIMS and EDS in a general pediatric population and to evaluate the relationship between these conditions and SDB symptom intensity.

2. Methods

2.1. Participants

A total of 2940 questionnaires were distributed to the parents of every child attending first grade at 27 public primary schools in an urban area of Radom, which is a medium-sized city in central Poland with approximately 200,000 inhabitants. The questionnaires included a statement regarding the voluntary nature of the questionnaire and informed consent. School authorities were trained to answer questions regarding the survey, distributed the questionnaires to the parents, and collected the data between September and December 2014. The bioethical committee of the Medical University of Warsaw and the regional director of education approved the study.

2.2. Procedure

This study was designed as a population-based cross-sectional study. Parents of every first-grade student were given an informational brochure regarding pediatric SDB and asked to fill out a two-page questionnaire. The first page included demographic questions (eg, current age, height, and weight of the child) as well as SDB symptoms such as the intensity of snoring, mouth breathing during the night, and observed apneas.

The second page included questions screening for DIMS (seven questions), and EDS (five questions). The seven questions regarding DIMS and five questions regarding EDS were taken from the Sleep Disturbance Scale for Children (SDSC) by Bruni et al., which is validated in English [12]. A bilingual interpreter translated each question into Polish, and a separate interpreter who was blinded to the original survey translated the Polish language version back into the source language and compared it to the original questions to assure the validity. Each item was scored on five-point scale indicating the incidence of the symptom as follows: 1 = never; 2 = occasionally (≤ 1 or 2 times per month); 3 = sometimes (1 or 2 times per week); 4 = often (3 to 5 times per week); and 5 = always (daily). The score for each investigated sleep disorder was obtained by summing the questions related to this disorder. Based on validation data for SDSC published by Bruni et al. [12], cutoff scores of 16 and 12 were used for DIMS and EDS, respectively. The SDB questions used the same five-point scale and included questions regarding the frequency of snoring, mouth breathing during sleep, and observed apneas. Habitual snoring (HS) was defined as a response of 4 (often) or 5 (very often/always) to the question regarding snoring frequency. All data were stored in a password-protected computer database, which was checked for errors by a trained data technician.

2.3. Statistical analysis

The categorical data are expressed as the number and percentage of observations with the characteristic of interest. Continuous variables are reported with mean values and standard deviations. A one-way between-groups analysis of variance was conducted to compare the effect of SDB on the prevalence of DIMS and EDS in children with increasing SDB symptom severity. The Spearman rank correlation test was used to determine correlations between variables. All p values less than 0.05 were considered significant for this analysis.

Cronbach's α , a measure of the internal consistency, was used to assess the reliability of the translated survey; the item-total correlation coefficients were also determined. Factor analysis was performed to assess SDSC item scores using the principal component method of extraction, and factors were rotated by using the varimax method.

We also performed analysis of the correlation between variables using regression modeling; we evaluated DIMS and EDS as dependent variables and age, body mass index (BMI) percentile, and gender as independent variables.

3. Results

In all, 68% of the questionnaires ($n = 1987$) were returned and analyzed. This cohort was 48.3% female with a mean age of 6.7 ± 0.5 years, a mean height of 126.0 ± 6.9 cm, a mean weight of 25.7 ± 5.8 kg, with a mean BMI percentile of 59.3 ± 33.1 for boys and 54.2 ± 31.8 for girls. Caregivers reported habitual snoring in 104 children (5.2%); 83 (4.2%) were described as snoring often and 21 (1.0%) were described as snoring very often or always. Overall, DIMS was reported in 137 children (6.9%), whereas EDS was seen in 117 children (5.9%). There was an overlap between children with DIMS, habitual snoring, and EDS. DIMS and EDS were reported in 46 children (2.3%), and DIMS and habitual snoring as well as EDS and habitual snoring in 17 children (0.9%), respectively. In six children (0.3%), all three conditions were present.

The mean DIMS score increased as the intensity of snoring increased (Table 1), as did the percentage of children with a high likelihood of DIMS (Fig. 1). Similarly, the mean frequency of EDS increased with increasing snoring intensity (Table 1), as did the percentage of children with a high likelihood of EDS (Fig. 1). The prevalence of DIMS increased from 3.5% in children who never snored to 28.6% in children who snored very often or always. Similarly the prevalence of EDS was 2.7% in non-snoring children and increased to 19% in children who snored very often or always. No correlation was seen between increasing DIMS ($r_s = 0.006$, $p > 0.05$) or EDS ($r_s = -0.031$, $p > 0.05$) scores and BMI.

Regression analysis did not reveal any significant relationships between gender, BMI percentile, or age with either DIMS or EDS. No significant relationships between gender, BMI percentile, and age as independent and DIMS and EDS as dependent variables were also found in the regression model. However there were gender differences in age, height, BMI, and frequency of mouth breathing during sleep.

Table 1
Mean scores for difficulty with initiation or maintenance of sleep (DIMS) and excessive daytime sleepiness (EDS) in a school-based population of first-grade students from the city of Radom, Poland.

Snoring frequency	1	2	3	4	5	p
n	748	697	379	83	21	
DIMS	10.26 (2.71)	11.22 (3.07)	11.88 (3.46)	12.66 (3.77)	13.76 (4.32)	<0.001
EDS	6.91 (2.16)	7.55 (2.61)	8.30 (2.89)	9.47 (3.08)	9.19 (3.72)	<0.001

Note: These scores are presented according to snoring frequency levels. For DIMS, the maximum possible score was 35, and a score greater than 16 signified that a child was likely to have clinically relevant symptoms of DIMS. For EDS, the maximum possible score was 25, and a score greater than 12 signified that a child was likely to have clinically relevant symptoms of EDS. Snoring frequency levels were coded as follows: 1 = never; 2 = occasionally; 3 = sometimes; 4 = often; 5 = very often/ always.

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