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# Influence of age and gender on reference values for common pediatric sleep questionnaires: Results from a community-based study☆

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ABSTRACT

*Objectives:* Sleep problems are often assessed using questionnaires, but it is unclear whether the responses given are influenced by age and gender. We addressed this question in several widely used pediatric sleep questionnaires and provide age-dependent percentile curves.

*Methods:* Data of a community-based study in schoolchildren were reanalyzed (N = 163, 50% males, age 6–17 years). Children and their parents completed the Sleep-Related Breathing Disorder Scale (SRBDS) of the Pediatric Sleep Questionnaire, the Sleep Disturbance Scale for Children (SDSC), the Sleep Self Report (SSR) of the Children's Sleep Habits Questionnaire in a long and short version, the Epworth Sleepiness Scale in a parent- (ESSp) and self-report version for children (ESSc), and the Pediatric Daytime Sleepiness Scale (PDSS). Linear and quantile regression analysis was used to i) assess the influence of age and gender on scores of questionnaire scales/subscales, ii) to calculate age- and gender-appropriate reference values and iii) to provide age-depending percentile curves.

*Results:* Only the PDSS showed relevant gender differences (β [95th confidence interval] = 0.155 [0.000; 0.270], p-value = 0.04, reference category: male), while the following subscales were all age dependent: SRBDS-somnolence and behavioral subscales, SDSC-somnolence subscale, SSR-long and short version; ESSp and ESSc, as well as the PDSS.

*Conclusions:* Age and gender should be taken into account for research purposes and individual patient assessments regarding sleep problems. Preliminary age- and gender-appropriate reference values and percentile curves are now available and may be used by researchers and clinicians.

## 1. Introduction

Sleep questionnaires are among the most helpful tools to assess symptoms and impact of sleep disorders in children. The main reasons for their success may be the quick and easy way of application and the low costs involved. Many investigators have developed and validated questionnaires, which has led to a massive increase of their use in clinical and research settings [1]. In most cases, pediatric sleep questionnaires rely on parental responses [2,3] or - in older children - on self-reports [4]. While some questionnaires are designed to screen for obstructive sleep apnea [3], others focus on sleep problems, quality of sleep, and/or daytime sleepiness [5,6].

Most pediatric sleep questionnaires have been developed for a specific age group, only few are generally used across childhood and adolescence. Due to developmental changes in expression and severity of sleep problems and disorders, reference- and cutoff-values for questionnaires and their respective diagnostic test accuracy may vary with age. In this case, age-appropriate cutoff-values for disease classification

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are needed to improve accuracy.

However, the effects of age (and gender) on scores of pediatric sleep questionnaires, their reference values and cutoffs have not yet been sufficiently studied. Following current recommendations, the development of questionnaires should consider age and gender differences in sufficient detail to enable accurate interpretation of scores [1]. Hence, studies concerning reference values should include samples of all ages to cover developmental changes in sleep behaviors and physiology occurring during childhood and adolescence.

These considerations may be particularly true for questionnaires covering symptoms of excessive daytime sleepiness (EDS). It is well known that daytime sleepiness and sleep propensity increase across childhood and particularly during adolescence. For example, in one study mean daytime sleep latency decreased from 18.8 min in children with Tanner stage 1–15.8 min in older adolescents [7].

As part of an interdisciplinary project on EDS in schoolchildren, we aimed to assess the distribution of markers of daytime sleepiness by applying parent- and self-report questionnaires to a community sample of schoolchildren. Preliminary analysis indicated that some questionnaire (sub)scales covering daytime sleepiness may depend on age and gender [8]. We, hence, aimed to thoroughly reinvestigate questionnaire (sub)scales in more detail to describe their age and gender dependency and to establish preliminary age- and gender-appropriate reference values as percentile curves.

## 2. Methods

### 2.1. Study sample

The present study was part of the interdisciplinary Tuebingen Project on Excessive Daytime Sleepiness in Childhood (TuPEDS; see for details: [9,10]). The sample included pupils of two public schools within the city limits of Tuebingen (85,300 inhabitants; Baden-Wuerttemberg, Germany). One primary school (1st to 4th grade) and one high school (5th to 12th grade) were selected to cover the total age span of schoolchildren. Of all children whose parents were interested in study participation (n = 251), 163 children were selected using a stratified random procedure to obtain a representative sample concerning age distribution. The Institutional Review Board and the headmasters of both schools approved the study and written informed consent was obtained from participating parents and pupils.

### 2.2. Questionnaires

Parents and children completed the following pediatric sleep questionnaires at the same time: the Sleep-Related Breathing Disorder Scale (SRBDS) of the Pediatric Sleep Questionnaire [3], the Sleep Disturbance Scale for Children (SDSC; [5]), (the Epworth Sleepiness Scale [11]) in a parent-report (ESSp) and self-report version for children (ESSc; [12]), the Sleep Self Report (SSR) [13], and the Pediatric Daytime Sleepiness Scale (PDSS; [4]). For all questionnaires, response options and rating rules were based on the original versions to obtain comparability of results with published reference values.

The SRBDS of the Pediatric Sleep Questionnaire is a 22-item questionnaire on symptoms of obstructive sleep apnea and consists of a total scale and three subscales (i.e., snoring, behavior, and sleepiness subscale). Possible responses to each question are “No”, “Yes”, and “Don't know”. The score of the total scale is calculated as follows: total count of all “Yes” answers/total count of all “No” and “Yes” answers. The German version has been validated previously and is accepted by the developer of the SRBD scale [14].

The SDSC is a 26-item instrument for assessing the frequency of sleep problems in children [5]. This questionnaire consists of a total scale and the following subscales: disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of arousal/nightmares, sleep wake transition disorders, disorders of excessive somnolence, and sleep hyperhydrosis. Items are rated on a 5-point scale, ranging from never to occasionally (once or twice per month or less), sometimes (once or twice per week), often (3–5 times per week) and always (daily). We applied a German version, which we had already used in previous studies [15].

The ESS is a 10-item, self-report questionnaire reflecting the general level of daytime sleepiness and sleep propensity. It has been developed for adults [11], but adapted versions have been increasingly used in children [16,17]. A German version for adults [18] has been adapted to be applicable to children [19]. In this version, item no. 8 was modified to ask for the propensity of falling asleep in school during classes. For the present study, we used a parent- (ESSp) and self-report version for children (ESSc).

The SSR is a 26-item self-report questionnaire for children investigating sleep habits and disturbances during the previous week [13]. It was designed for use in 7–12 year old children. Responses are rated on a 3-point scale ranging from usually (5–7 times per week) to sometimes (2–4 times per week) and rarely (0–1 time per week) [13]. The German version of the SSR has been validated [20]. More recent publications used an abbreviated short scale consisting only of 13 items [21,22]. Both, the total and short scale were used for this study.

The PDSS is an 8-item, 1-scale, self-report questionnaire on subjective daytime tiredness and sleepiness in children. The original English version showed a high item loading ($> 0.4$) and good internal consistency in a sample of 11–15 year old children. Reference values have also been provided [4]. For the present study, PDSS items were translated to German by a native speaker.

### 2.3. Statistical analysis

An exploratory re-analysis was performed. For descriptive analysis, absolute and relative frequencies for categorical data as well as mean, standard deviation, percentiles, minimum and maximum for quantitative data were calculated.

Simple linear regression analysis was used to investigate the relationships between gender as independent variable and the scores of questionnaire (sub)scales as dependent variables. The same analysis was used for age as independent variable. Effect estimates (beta), their 95% confidence intervals, and p-values were calculated. For this analysis, no adjustments for multiple testing were performed.

For calculating age-depending percentile curves for (sub)scales, quantile regression as introduced by Koenker and Bassett [23] and Koenker and Hallock [24] was used. The quantile regression used in this study was based on least absolute deviations estimation as median regression is more robust to outliers than least squares regression. Percentile curves for the following quantiles were calculated: 0.50, 0.75, 0.90 and 0.95.

All statistical tests were performed in an exploratory way and for illustrative purposes. All effect estimates and p-values are given for descriptive reasons and, hence, should be interpreted with caution. Descriptive analyses were performed using PASW Statistics 18 for Windows, quantile regression analyses were performed using the SAS 9.4 procedure QUANTREG.

## 3. Results

Demographic characteristics of the study sample and percentiles for scores of questionnaire (sub)scales are given in Tables 1 and 2, respectively.

Results for gender effects are given in Table 3. Only the scores of the PDSS showed relevant gender differences (p-value = 0.042). In males, the 50$^{th}$, 75th, 90$^{th}$, and 95th centile as well as the maximum score were 11, 15, 18, 25, and 29, respectively. For females, the same figures were 9, 14, 18, 20, and 22, respectively.

Results for age effects are also given in Table 3. Linear regression analysis revealed age effects for the scores of the following scales/