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Sleep problems and poor academic performance in primary school children

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Abstract

Objective: Sleep problems may affect daytime performance. Thus, the prevalence of sleep problems and their associations with poor academic performance in a cross-sectional study performed in 27 primary schools in Hannover, Germany, were investigated.

Methods. Sleep problems (e.g., sleep onset delays, night awakenings, sleepwalking, nightmares, and bedwetting) were examined by parental and children's questionnaires. Poor academic performance, defined as grade 4 or more on a 6-point scale, or requirement for additional lessons in mathematics, science, reading, spelling, or handwriting was assessed using grades from the last term's school report forms.

Results. Of 1,144 children enrolled (mean age 9.6 years, 51% males), 760 (66.4%) had sleep problems reported by their parents, with sleep onset delays having the highest prevalence (prevalence 49.1%, 95% confidence interval (CI) 46.1–51.9). Children reported sleep problems more frequently than their parents. Significant associations with academic performance were found for night awakenings and nightmares; however, clear dose–response relationships were only found for nightmares. Children who “often” had nightmares ($n = 24$) were more likely to have poor academic performance in mathematics (odds ratio 5.2, 95% CI 1.6–17.1), science (6.8, 95% CI 1.4–32.1), and spelling (7.5, 95% CI 2.3–24.9).

Conclusion. Sleep problems are common in primary school children. Among these, nightmares may have a negative impact on academic performance.

Sleep problems or disturbed sleep is common in childhood. Insomnia symptoms such as sleep onset delays and awakenings during the night affect 5–23% of school children [1, 2, 3, 4]. Besides insomnia symptoms, 5- to 12-year-old children as well as their parents often report nightmares (2–7%) [3, 4, 5, 6] as well as enuresis (5–18%) [4, 5, 7], whereas sleepwalking seems to be less frequent with prevalence rates ranging from 0.6–2% [5, 8].

Chronic sleep problems, in particular insomnia, are suspected to have negative effects on children's daytime performance. Nearly a fifth of children report sleepiness or decreased motivation and tiredness [9]. Furthermore, they show emotional changes and increased fluctuations in attention and performance [9, 10]. Diminished sleep quantity and quality is related to compromised cognitive functioning [11].

Frequent sleep disruptions have also been related to academic performance; poorer sleep is associated with lower teacher ratings [12, 13]. Daytime sleepiness and inattention were found to be associated with sleep problems in school children [14, 15].

Low true sleep time is highly associated with teacher-reported externalizing symptoms such as

aggressive and delinquent behavior as well as inattention and social problems [16, 17]. Others report that sleep problems in general in early childhood are predictors of depression/anxiety, inattention/hyperactive behavior, and aggression [18, 19]. Thus, the first few years of school are a vulnerable period, and there may be long-lasting effects in children suffering from sleep disturbances.

As part of an investigation into the prevalence of sleep problems in primary school children, we performed an explorative analysis to investigate associations between sleep problems and poor academic performance [20]. Of particular interest was the impact of childhood insomnia on academic achievement in this age group of school children.

Methods

Subjects and study procedures

Subjects participated in a cross-sectional study on the prevalence of sleep disturbances in primary school children. Children of 27 public primary schools in Germany were selected at random within strata of average socioeconomic status of parents. Following approval by the institutional review board and the regional directorate of education, all children attending the 3rd grade in these schools ($n = 1,760$) were identified.

Pupils were contacted in their classrooms by two investigators and received a cover letter explaining the study, an informed consent form, and two questionnaires.

The first questionnaire contained questions on symptoms of sleep problems and sleep-disordered breathing completed by the parents, the second one focused on sleep problems to be filled out by the children. Questionnaires were collected by the classroom teacher and picked up by a study crew-member 1–2 weeks after the initial visit. A total of 1,144 children (65.0%) with a mean age of 9.6 years (SD 0.66) participated in the study.

Comparisons to all eligible 3rd graders ($n = 1,760$) and the underlying source population of 3rd graders ($n = 3,809$) revealed good to excellent representativeness concerning gender distribution, socioeconomic status, and academic performance. Further details on the study design, recruitment strategy, and basic characteristics of the study sample are published elsewhere [20, 21].

Parental questionnaire

Children were screened for sleep problems using a 25-item parental questionnaire designed for the survey on sleep-disordered breathing. This questionnaire has been published previously [20]. Frequencies of the five most frequent nonrespiratory pediatric sleep problems (sleep onset delays, night awakenings, bedwetting, nightmares, and sleepwalking; see Appendix) were assessed [1]. Response categories were rated on a 3-point scale (never/rarely: 0–1 times per week; sometimes: 2–4 times per week; often: 5–7 times per week) [22]. The questionnaire also included further questions on gender, age, and parental graduation from school (4-point scale: no graduation/primary school, secondary school, high school, college/university) [20].

Children's questionnaire

Sleep problems were also assessed using a small questionnaire of 5 items for children. The problems addressed were the same as in the parental questionnaire, except for bedwetting (see Appendix). This item was substituted by a question on sleep onset delays following night awakenings. Answers were likewise rated on a 3-point scale (never/rarely, sometimes, often).

Poor academic performance

Based on last term's report form (including grades on a 6-point scale: 1 for "outstanding" and 6 for "failed"), poor academic performance was defined as grade 4 or worse, or requirement for additional lessons in mathematics, science, reading, spelling, and handwriting [21].

Statistical analysis

Descriptive statistics were used to summarize subject characteristics, questionnaire results, and school grades. Prevalence proportions were given with their 95% confidence intervals (95%CI). Cohen's κ coefficient was used to investigate the interrater agreement between parent reports and children's self-reports.

To quantify associations between parent-reported sleep problems and academic performance, analysis of variance (ANOVA) and covariance as well as unconditional binary logistic regression analysis were performed. For the ANOVA models, the individual school grade was used as a dependent variable. For logistic regression models, the above mentioned dichotomized academic performance variable was used as a dependent variable and odds ratios (OR) and their 95%CI were calculated.

In both types of analyses, effect measures and p values were adjusted for gender, age, maternal and paternal education, and school class membership.

As snoring was related to academic achievement in other studies [21], ORs were also adjusted for the frequency of snoring (4-point rating scale ranging from "never" and "occasionally" to "frequently" and "always"). Associations were regarded as relevant if a dose-response relationship (i.e., mean grades decrease or ORs increase according to the frequency of the sleep problem) was observed. Significant associations between parental reports and poor academic performance were reevaluated using children's self-reports. A p value < 0.05 was considered statistically significant. All analyses were done with statistical software (IBM SPSS Statistics 19; Chicago, IL).

Results

Of 1,144 questionnaires returned, 585 (51.1%) were from boys. Mean age (standard deviation) of the study sample was 9.6 years (0.66). Parents of 386 (33.6%) children reported that they had no sleep problem, while parents of 760 (66.4%) reported that their child had one. In detail, 352 (30.8%) children had one, whereas 230 (20.1%) children had two, and 147 (12.8%) children were reported to have three sleep problems.

The remaining children ($n = 31$, 2.7%) were reported to have four out of the five sleep problems being studied. All of these 31 children had night awakenings and the majority ($n = 21$) also had sleep onset delays, sleepwalking, and nightmares.

No child was reported to exhibit all 5 sleep problems. Parents reported sleep onset delays to occur at least sometimes in 49.1% (95% CI 46.1–51.9) and night awakenings in 35.3% (32.6–38.1) of children. Sleepwalking was reported to occur at least sometimes in 4.6% (3.4–5.9), nightmares in 27.4% (24.9–30.0), and bedwetting in 3.9% (2.8–5.1) of children, respectively. Prevalence proportions for parent-reported sleep problems are given in **Tab. 1**.

The frequency of sleep problems reported by the children was generally higher than that reported by their parents. Sleep onset delays were reported to occur at least sometimes by 70.1% (95% CI 67.5–72.8), sleepwalking by 8.9% (7.3–10.6), and nightmares by 51.0% (48.2–54.0) of the children, respectively. Night awakenings were reported by 37.8% (35.0–40.7) and sleep onset delays following night awakenings by 53.7% (50.8–56.6; **Tab. 2**) of the children.

Three items were directly comparable in parental and self-report questionnaires: sleep onset delays, sleepwalking, and nightmares. All of these were reported significantly more frequently by children. Concerning sleep onset delays, 38.3% of children rated this problem at a higher frequency, while only 13.9% rated this problem at a lower frequency than their parents (Cohen's κ coefficient: 0.217, $p < 0.001$).

Regarding the frequency of sleepwalking, 7.3% of children rated it at a higher frequency and 2.3% rated it at a lower frequency than their parents (0.256, $p < 0.001$). Compared to parental responses, nightmares were reported at a higher frequency by 36.2% of children and at a lower frequency by 9.7% (0.154, $p < 0.001$).

Average grades stratified by sleep problem and school subject are shown in **Tab. 3**. ANOVA revealed

significant associations between nighttime awakenings and grades in science, spelling, and handwriting, as well as between nightmares and grades in mathematics, science, and reading. Dose–response relationships could only be observed for nightmares.

Using the above definitions, the frequency of poor academic performance was 19.1% for mathematics, 14.0% for science, 21.8% for spelling, 18.8% for reading, and 13.6% for handwriting. After adjustment for potential confounders in multiple logistic regression analysis, only parent-reported nightmares showed clinically and statistically significant associations in a dose–response manner with poor academic performance in mathematics (OR [95% CI] for sometimes: 1.7 [1.2–2.5]; often: 5.2 [1.6–17.1]), science (sometimes: 1.0 [0.6–1.6]; often: 6.8 [1.4–32.1]), reading (sometimes: 1.5 [1.02–2.4]; often: 2.9 [0.8–10.2]), and spelling (sometimes: 1.1 [0.7–1.6]; often: 7.5 [2.3–24.9]; see **Fig. 1**). Adjusting for snoring did not change results (data not shown).

Reevaluation of this association using children’s self-reports also revealed significant dose–response relationships between nightmares and poor academic performance in mathematics (OR [95% CI] for sometimes: 1.6 [1.1–2.3]; often: 2.2 [1.1–4.1]), spelling (sometimes: 1.6 [1.1–2.3]; often: 2.3 [1.5–4.9]), and reading (sometimes: 1.6 [1.1–2.4]; often: 2.5 [1.2–5.1]). Associations with science and handwriting were not significant.

Discussion

At least one sleep problem was reported in 66% of these primary school children. Though somewhat higher than in other studies [1, 14, 23], our prevalence data agree with previous findings that disturbed sleep, particularly sleep onset delays and night awakenings, is common in school children. No gender difference was found in the prevalence of the sleep problems studied here. This has been described by others [14, 24], although at least one study disagrees with this finding [25].

Agreement between parental and self-report was poor. Children generally rated sleep problems to occur more frequently, as also reported by others [1, 26, 27]. Higher frequencies reported by children may be due to misclassification, as children may have a different understanding of the descriptions used in the rating scales.

In addition, poor agreement may be due to parents underestimating their children’s sleep disturbance, especially as parents usually do not observe their school-aged children during sleep. Thus, both approaches, parental and self-report, potentially may not reveal the true number of affected subjects if used on their own. If the parental report alone is used, a considerable number of children may have sleep onset delays and nightmares that are unknown to their parents.

If we rely only on self reports, however, children may be unaware of some problems, e.g., sleepwalking. Whatever the best method to assess sleep problems in this age group, our findings suggest that parental questionnaires alone may not suffice to achieve a complete picture.

In previous studies, insomnia has been reported to be associated with poor academic performance [14, 28, 29]. In our study, no such association was found. This may be due to the type of assessment. In our questionnaire, insomnia was defined by only two questions. Furthermore, participants were not asked whether they regarded their insomnia as a problem affecting daily life. This might have diluted associations with poor academic performance, because our insomnia group may have included children with less severe sleep alterations. Sleepwalking and bedwetting have not been reported to be associated with poor academic performance in this and an earlier study [30].

Surprisingly strong associations between the frequency of nightmares and poor academic performance in several school subjects were found. Associations were even higher than that with snoring, another frequent and important sleep problem [21, 31], and independent of the latter problem and additional demographic confounders. Clear dose–response relationships and the fact that associations were found for parental *and* self-reports suggest a true causal relationship, not only a statistical association.

The association between academic achievement and nightmares has not yet been examined systematically. Other studies found hyperactive behavior and concentration deficits in children

suffering from nightmares [15, 29]. The etiology of nightmares is best explained by a vulnerability–stress model but one has to take cognitive avoidance as a maintaining factor into consideration [32].

Nightmares often contain themes such as threatening situations and aim to integrate past and recent learning contents. They can be interpreted as training situations for survival strategies. These dreams, which often interrupt sleep, are marked by intensified feelings of fear. In this situation the individual often experiences paralysis, a sense of imminent danger, and loss of control. Although the thematic content of nightmares may involve the intensification of any waking unpleasant emotion, fear is most commonly reported [33].

However, why nightmares were associated with poor academic performance in our study remains unknown. Four potential explanations can be offered:

- An underlying psychiatric entity may cause both nightmares and poor academic performance. Hence, the association does not in fact represent a causal relationship but a confounding relationship. This is partly supported by data from other studies, which suggest a relationship between nightmares and anxiety/affective disorders [34, 35, 36]. However, the high prevalence of nightmares in our study made it unlikely that anxiety/affective disorders were responsible for poor academic performance in all or most children.
- Assuming a causal relationship, nightmares may disrupt sleep or impair sleep quality, thereby leading to daytime sleepiness, concentration deficits, and finally poor academic performance. This is supported by studies reporting poor sleep quality and diminished daytime performance associated with nightmares [37].
- Nightmares may be a consequence, not a cause of academic problems. Academic problems may lead to an emotional dysbalance, thereby, causing nightmares. To solve this chicken or egg causality dilemma, further studies using prospective or intervention designs are required. For example, a longitudinal observation as part of ongoing cohort studies could elucidate whether nightmares or academic problems appear first.
- As our study was not primarily designed to investigate daytime consequences of nightmares, a chance finding cannot be excluded. As dream or fear status was not assessed, it is possible that night terrors were misclassified as nightmares, although our study population was beyond the age where night terrors typically occur.

Notwithstanding these concerns, the high prevalence of nightmares, the rather high risk of poor academic performance associated with them, and the availability of an effective treatment [32] may give priority to further studies into the relationship between nightmares and daytime performance in children.

We believe the association of the category “sometimes” in night awakenings and poor achievements in “spelling” to be a chance finding, given that there was no such association for the “often” category. Other sleep problems were not associated with poor academic performance. This finding disagrees with other studies. One found sleep onset delay and night awakenings to be associated with poor academic performance [14], while another study found children with sleep deprivation to perform worse at school [28]. However, no standardized questionnaire was used in those or the present study, which could explain the conflicting results.

Limitations

Several limitations have to be mentioned. First, sleep problems were assessed by unvalidated questionnaires. If sleep diaries or actimetry had been used, a more valid classification of affected subjects might have been possible. Second, the definition of sleep problems based on a single questionnaire may be inaccurate, especially as there is no consensus on this definition. Third, the scaling of questionnaire items into three response categories is weak. A better differentiated scaling could provide more detailed information on sleep problems and allow for a better classification of affected subjects. Fourth, using school grades is a rather rudimentary measure of cognitive abilities. Earlier

studies, however, have shown grades to be closely associated with biological risks [38, 39]. Data analysis was only explorative and, therefore, could not confirm any predefined hypotheses. Other limitations that have been discussed elsewhere [20, 21]. Further studies on the relationship between nightmares and daytime performance are required.

Conclusion

Sleep problems affected two thirds of children in this study. Nightmares were significantly associated with poor academic achievement. Thus, nightmares appear to be an important factor in the wellbeing and school success of primary school children.

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Conflict of interest

The corresponding author states that there are no conflicts of interest.

Appendix

Parental questionnaire

1. Does your child take more than 20 minutes to fall asleep?
2. Does your child awake during the night?
3. Does your child sleepwalk?
4. Does your child have nightmares?
5. Does your child wet the bed?

Children's questionnaire

1. Does it take you more than 20 minutes to fall asleep?
2. Do you wake up at night, when your parents think you are asleep?
3. Do you have trouble falling asleep again, after waking up at night?
4. Do you have nightmares?
5. Do you sleepwalk?

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Tables and Figures

Table 1. Frequency of parent-reported sleep problems stratified by gender ($n=1,144$)

Never/rarely 0–1 times per week, sometimes 2–4 times per week, often 5–7 times per week; mean age 9.6 years.

Sleep problem	Gender	Missing <i>n</i> (%)	Never/rarely <i>n</i> (%)	Sometimes <i>n</i> (%)	Often <i>n</i> (%)
Sleep onset delays	Male	7 (1.2)	296 (50.6)	180 (30.8)	102 (17.4)
	Female	11 (2.0)	269 (48.1)	180 (32.2)	99 (17.7)
Night awakenings	Male	3 (0.5)	387 (66.2)	159 (27.2)	36 (6.2)
	Female	7 (1.3)	343 (61.4)	174 (31.1)	35 (6.3)
Bedwetting	Male	6 (1.0)	551 (94.2)	21 (3.6)	7 (1.2)
	Female	10 (1.8)	532 (95.2)	11 (2.0)	6 (1.1)
Nightmares	Male	8 (1.4)	426 (72.8)	136 (23.2)	15 (2.6)
	Female	7 (1.3)	389 (69.6)	154 (27.5)	9 (1.6)
Sleepwalking	Male	10 (1.7)	545 (93.2)	28 (4.8)	2 (0.3)
	Female	10 (1.8)	526 (94.1)	19 (3.4)	4 (0.7)

Table 2. Frequency of self-reported sleep problems stratified by gender ($n=1,144$)

Never/rarely 0–1 times per week, sometimes 2–4 times per week, often 5–7 times per week; mean age 9.6 years.

Sleep problem	Gender	Missing <i>n</i> (%)	Never/rarely <i>n</i> (%)	Sometimes <i>n</i> (%)	Often <i>n</i> (%)
Sleep onset delays	Male	16 (2.7)	169 (28.9)	229 (39.1)	171 (29.2)
	Female	12 (2.1)	145 (25.9)	274 (49.0)	128 (22.9)
Night awakenings	Male	16 (2.7)	369 (63.1)	147 (25.1)	53 (9.1)
	Female	15 (2.7)	311 (55.6)	192 (34.3)	41 (7.3)
Sleep onset delays following night awakenings	Male	18 (3.1)	271 (46.3)	183 (31.3)	113 (19.3)
	Female	12 (2.1)	229 (41.0)	198 (35.4)	120 (21.5)
Nightmares	Male	17 (2.9)	296 (50.6)	233 (39.8)	39 (6.7)
	Female	13 (2.3)	234 (41.9)	249 (44.5)	63 (11.3)
Sleepwalking	Male	18 (3.1)	509 (87.0)	49 (8.4)	9 (1.5)
	Female	14 (2.5)	501 (89.6)	36 (6.4)	8 (1.4)

Table 3. Average stratified by type and frequency of parent-reported sleep problem and school subject

Never/rarely 0–1 times per week, sometimes 2–4 times per week, often 5–7 times per week; mean age 9.6 years; missing data were excluded from this analysis; all p values were calculated using analysis of variance and adjusted for gender, age, maternal and paternal education, and class membership; SD standard deviation. *indicates a p value < 0.05.

Sleep problem	Frequency (n)	Mathemat-ics	Science	Spelling	Reading	Handwrit-ing
		Average grade mean ± SD	Average grade mean ± SD	Average grade mean ± SD	Average grade mean ± SD	Average grade mean ± SD
Sleep onset delays	Never/rarely (565)	2.6 ± 1.0	2.6 ± 0.9	2.6 ± 0.9	2.8 ± 0.9	2.6 ± 0.8
	Sometimes (360)	2.6 ± 1.0	2.6 ± 0.9	2.6 ± 1.0	2.7 ± 0.9	2.7 ± 0.8
	Often (201)	2.7 ± 1.0	2.6 ± 0.8	2.6 ± 0.9	2.7 ± 0.9	2.8 ± 0.8
Night awaken-ings	Never/rarely (730)	2.6 ± 1.0	2.5 ± 0.9*	2.5 ± 0.9*	2.7 ± 0.9	2.6 ± 0.8*
	Sometimes (333)	2.7 ± 1.0	2.7 ± 0.9*	2.7 ± 1.0*	2.8 ± 0.9	2.7 ± 0.8*
	Often (71)	2.9 ± 1.1	2.6 ± 0.9*	2.6 ± 1.0*	2.8 ± 0.9	2.8 ± 0.9*
Bedwet-ting	Never/rarely (1083)	2.7 ± 1.0	2.6 ± 0.9	2.5 ± 0.9	2.7 ± 0.9	2.7 ± 0.8
	Sometimes (32)	3.2 ± 1.0	2.9 ± 0.9	3.0 ± 1.2	3.1 ± 0.8	2.8 ± 0.8
	Often (13)	2.8 ± 0.8	2.5 ± 0.5	2.5 ± 0.7	2.7 ± 0.7	2.5 ± 0.8
Night-mares	Never/rarely (815)	2.6 ± 1.0*	2.5 ± 0.9*	2.5 ± 0.9	2.7 ± 0.9*	2.6 ± 0.8
	Sometimes (290)	2.8 ± 1.0*	2.7 ± 0.8*	2.6 ± 1.0	2.8 ± 1.0*	2.7 ± 0.8
	Often (24)	3.4 ± 0.9*	3.3 ± 0.8*	3.5 ± 1.2	3.4 ± 0.7*	3.0 ± 0.9
Sleep-walking	Never/rarely (1071)	2.7 ± 1.0	2.6 ± 0.9	2.6 ± 0.9	2.7 ± 0.9	2.6 ± 0.8
	Sometimes (47)	2.7 ± 1.0	2.7 ± 0.7	2.7 ± 1.0	2.9 ± 0.8	3.0 ± 0.8
	Often (6)	2.3 ± 0.8	–	2.3 ± 1.5	2.3 ± 0.8	2.8 ± 1.0

Figure 1. 7 Percentage of children with poor academic performance stratified by parent-reported frequency of nightmares and school subject; $n = 1,128$; mean age 9.6 years; missing data were excluded from this analysis

