Title: Correspondence of maternal and paternal perception of school-aged children's sleep with in-home sleep-electroencephalography and diary-reports of children's sleep

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Abstract (248/250)

Objective: Parents are often the first to report children's sleep difficulties. The aim of the present study was to evaluate the accuracy of parent reports by examining the correspondence of maternal and paternal reports of children's sleep with in-home electroencephalography (EEG) sleep assessment and sleep diary reports.

Methods: A total of 143 children (57 formerly very preterm born children) aged 7–12 years underwent one night of in-home sleep-EEG, mothers and fathers reported children's sleep-related behavior by using the German version of the Children's Sleep Habits Questionnaire, and children and parents together completed a sleep diary of children's sleep.

Results: Less EEG-derived total sleep time (TST) was associated with increased mother questionnaire reports of sleep duration problems, while less sleep efficiency (SE) and longer sleep onset latency (SOL) were associated with increased mother questionnaire reports of sleep onset delay. For fathers, only longer SOL was related to increased father questionnaire reports of sleep onset delay. The above-mentioned associations did not change with children's increasing age and did not differ for boys and girls. More parent questionnaire reports of sleep duration problems, sleep onset delay, and night wakings were related to shorter diary-reports of sleep duration, increased sleep latency, and more nocturnal awakenings, respectively.

Conclusions: Mother questionnaire reports of children's sleep corresponded moderately with objective measures of TST, SE, and SOL assessed with in-home sleep-EEG. Both mother and father questionnaire reports of children's sleep duration problems, sleep onset delay, and night wakings were related to diary-reports of children's sleep.

Keywords: Children's Sleep Habits Questionnaire; parent questionnaire reports; in-home sleep electroencephalography; diary-reports of children's sleep; sleep continuity; school-aged children

Abbreviations: PSG, polysomnography; EEG, electroencephalography; CSHQ, the Children's Sleep Habits Questionnaire; CSHQ-DE, the German version of the Children's Sleep Habits Questionnaire; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; SE, sleep efficiency; SWS, slow wave sleep; REM, rapid eye movement.

1. Introduction

Sleep problems are common in children [1] and are associated with impaired cognitive and behavioral functioning [2]. In particular, short sleep duration and poor sleep continuity including sleep onset latency and night wakenings have been shown to be related to poor cognitive and behavioral functioning [2]. Therefore, accurate assessment of children's sleep is important. Often parents are the first to observe their children's sleep problems and to seek for help. Moreover, to evaluate sleep problems in children, parent reports are usually used [3]. In order to evaluate the accuracy of parent reports, they have to be compared to children's objectively assessed sleep, e.g. to polysomnography (PSG), the gold standard to measure sleep duration, sleep continuity, and sleep architecture. Only few studies have examined the association between parent reports and objective measures of children's sleep such as actigraphy or PSG. Previous research for example showed that parents often overestimated total sleep time (TST) [4,5] and underestimated sleep disturbances such as night wakings when compared to actigraphic sleep measures [5]. Holley et al. (2010) [6] for instance compared parent reports of children's sleep with actigraphy. Parents of 91 children, aged 6–11 years reported their children's sleep (measured with the Children's Sleep Habits Questionnaire, CSHQ; [7]). Shorter actigraphy total sleep time (TST) was associated with more parent-reported sleep duration problems, longer sleep onset delay, more night wakings, as well as more bedtime resistance and parasomnias. In addition, longer actigraphy sleep onset latency (SOL) was related to more parent-reported sleep onset delay, sleep disordered breathing, and daytime sleepiness. Further, only one study has compared parent ratings of child's sleep assessed by the CSHQ with PSG [8]. This study applied laboratory-based PSG in 30 children aged 6–12 years and showed no associations between parent-reports and PSG sleep measures. However, additional actigraphy assessments showed that less actigraphic TST and more wake after sleep onset (WASO) were associated with more parent-reported night wakings.

To date no studies have compared parent questionnaire reports with school-aged children's sleep measured with in-home sleep–electroencephalography (EEG). Thus, the aim of the present study was to address this gap of research by comparing parent questionnaire reports of children's sleep measured with the German version of the CSHQ (CSQH-DE; [9]) with home-based sleep-EEG-recordings.

Another approach to validate parent questionnaire reports of children's sleep involves comparison with sleep diary reports. Sleep diary records showed acceptable concordance when compared to actigraphy and are considered to be reliable and valid tools to assess children's and adolescents sleep patterns [5,10,11]. One existing study on children aged 4 to 7 years [10] comparing a parent-reported sleep diary with actigraphy showed strong correspondence regarding sleep timing and sleep duration but not regarding night awakenings which might be more difficult to identify with diaries particularly if reported by parents. An additional aim of the present study was therefore to compare parent questionnaire reports of children's sleep with diary-reports of children's sleep.

First, we hypothesized that more mother and father reports of CSHQ-DE sleep duration problems (e.g., items such as: child sleeps too little) are related to less children's TST assessed with in-home sleep-EEG and shorter diary-reports of children's sleep duration. Second, we hypothesized that more mother and father questionnaire reports of sleep onset delay (e.g., items such as: child falls asleep within 20 minutes after going to bed; reverse coded) are associated with less sleep-EEG sleep efficiency (SE) and more sleep-EEG SOL and increased diary-reports of children's sleep latency. Third, we hypothesized that more mother and father questionnaire reports of night wakings (e.g., items such as: child awakens more than once during the night) are related to more sleep-EEG WASO and more diary-reports of children's nocturnal awakenings. Further, we expected that the above-mentioned associations changed with children's age. Based on the notion that parents' knowledge of their children's habits and behaviors decrease with children's increasing autonomy during the transition to adolescence [12], we also expected an age-related decrease in correspondence of parent questionnaire reports with sleep-EEG indices and diary-reports of children's sleep. In addition, we examined whether the association of parent questionnaire reports with sleep-EEG indices and diary-reports of children's sleep are different in boys and girls. There is evidence that mothers and daughters tend to spend more time together as well as more likely talk about various topics and that fathers are more involved with their sons than daughters [13,14]. In line with this research, we expected that mothers more accurately report their daughters' than their sons' sleep and that fathers more accurately report their sons' than their daughters' sleep. Finally, we also reported associations between sleep architecture assessed with sleep-EEG and parent questionnaire reports of children's sleep for an exploratory purpose.

2. Material and methods

2.1. Study population and procedure

The study involved a reanalysis of data from the second wave of the Basel Study of Preterm Children (BSPC; see Maurer et al., 2016 [15], Urfer-Maurer et al., 2017 [16], Urfer-Maurer et al., 2018 [17] for reports on the second study wave of that study). In total 143 children had sleep-EEG assessments and mother- and/or father-reports of sleep related problems (thereof 57 were born very preterm, i.e., <32 weeks of gestation, and 86 were born full-term; see Table 1 for descriptive statistics). Additionally, all children had diary-reports of sleep of which 137 had reports of 7 nights, 1 had reports of 6 nights, and 6 had reports of 1 night. For the present study only nights before school days were used to build average scores. The 57 healthy children born very preterm were recruited from an initial cohort of 260 prematurely born children treated at the University Children's Hospital Basel (Switzerland) between June 2001 and December 2006. The 86 children born full-term (>37 weeks of gestation) were recruited from official birth notifications and were invited specifically for the BSPC as a term born comparison group (see Maurer et al., 2016 [15] for more details of the recruiting process). Very preterm children differed in gestational age (30.09 weeks vs. 39.39 weeks, $t(140) = -31.61$, $p < .001$) and birth weight (1384.81g vs. 3300.06g, $t(140)= -25.51$, $p < .001$) from full-term children, while they did not differ from full-term children with regard to age, sex, height, weight, frequency of use of visual aids/glasses and hearing aids, and levels of behavioral/emotional difficulties (all p-values > 0.05). However, during infancy, very preterm children more frequently suffered from infant respiratory distress syndrome (24 vs. 0 children, Fisher's exact test, $p < .001$) and apnea of prematurity (27 vs. 0 children, Fisher's exact test, $p < .001$). Further, during infancy, they did not differ from full-term children regarding periventricular leukomalacia (0 vs. 0 children), cerebral palsy (0 vs. 0 children), intraventricular hemorrhage grade 1 and 2 (2 vs. 0 children, Fisher's exact test, $p = .157$), and bronchopulmonary dysplasia (2 vs. 0 children, Fisher's exact test, $p = .157$).

The majority of children ($n = 141$, 98.6% of the total sample) were living together with both parents, while 2 (1.4%) children were living with their mothers only. Children underwent one night of in-home sleep-EEG, which was also the first of seven nights of sleep diary recording, and parents completed the CSHQ-DE during the afternoon before sleep-EEG assessment. Since children born very preterm and full-term differ in various sleep indices [15,18] related to pre- and perinatal adversities [19] statistical analyses controlled for prematurity status. All children attended compulsory school in Switzerland. The study was approved by the Ethics Committee of Basel (Switzerland) and performed in accordance with the Declaration of Helsinki and its later amendments. Assent was obtained from children and written informed consent was obtained from parents.

To evaluate the statistical power, post-hoc power analysis using G*Power was conducted [20]. Regarding correlations post-hoc calculations (based on the total sample size of $N = 143$) revealed a power of 0.96 to detect a medium effect size (i.e., $r = 0.30$), 0.67 to detect small to medium effect sizes (i.e., $r = 0.20$), and 0.22 to detect small effect sizes (i.e., $r = 0.10$) at a 0.05 alpha level (two-sided).

(Insert Table 1 about here)

2.2. Parent questionnaire reports of children's sleep-related behavior

Parent-reported children's sleep was measured with the CSHQ-DE (German version of the CSHQ; [9]), which assesses sleep-related behavior regarding a "typical" recent week. Eight subscales and one overall sleep disturbance score were calculated: bedtime resistance, sleep onset delay, sleep duration problems, sleep anxiety, night wakings, parasomnias, sleep disordered breathing, and daytime sleepiness. Higher scores indicate greater sleep-related behavior problems. Parents completed the CSHQ-DE in the afternoon before the sleep-EEG night, which was also the first sleep diary night. Existing studies comparing the CSHQ-DE with children's self reports of their sleep (using the German version of the Sleep Self Report (SSR-DE; [21]), a self-rated sleep questionnaire for children aged 7-12 years) were reported by Schwerdtle et al., 2010 [21] and ranged from $r = 0.21$ to $r = 0.66$ [21].

Cronbach's alpha, intraclass correlations (ICC) between mother and father reports, t-values for differences between mother and father reports, and numbers of children above the cut-off scores (as defined by Schlarb et al. (2010) [9]) are displayed in Table 2. ICCs ranged from .44 to .89 indicating fair to excellent inter-rater agreements between mothers and fathers. Mothers reported more children's sleep duration problems, parasomnias, and overall disturbance scores compared to fathers.

(Insert Table 2 about here)

2.3. Sleep-EEG assessment

Sleep was assessed using the Somté PSG device (Compumedics, Singen, Germany) during one night during the school week. C3/A2 and C4/A1 signals, right and left electrooculogram and bipolar submental electromyogram were recorded. Two experienced raters analyzed the sleep-EEG reports using standard procedures [22]. We report TST (time in bed minus time spent awake in hours), sleep continuity (SE (TST/time in bed × 100), SOL (min), WASO (the amount of time awake from the initial sleep onset to the last awakening; min)), and sleep architecture (stage 1 sleep, stage 2 sleep, slow wave sleep (SWS; stages 3 and 4 sleep), rapid-eye-movement (REM) sleep, and REM latency (min)). In addition, sleep onset time and awakening time were evaluated. In-home sleep-EEG TST showed high correspondence with sleep diary-reports of weekday nights (excluding diary-reports of the sleep-EEG night) regarding sleep duration ($r = .57$, $p < .001$), moderate correspondence regarding EEG-derived SOL and diary-reports of sleep latency ($r = .33$, $p < .001$), and no significant correlation regarding EEG-derived WASO and diary-reports of number of nocturnal awakenings ($r = -.06$, $p = .514$). Reported bedtime for the sleep-EEG night was 20:59 and awakening time was 6:33. The following weekday nights children reported an average bedtime of 20:59 and awakening time of 6:54. Children's reported sleep latency in the diary was 15.8 min for the sleep-EEG night and 14.7 min for the following weekday nights. During the sleep-EEG night children reported 1.2 awakenings, while for the following nights they reported on average 0.4 awakenings. While one child (0.7%) took a daytime nap the day before the sleep-EEG night, the following days on average 1.5% of children took a daytime nap. Eighty-eight percent reported that they had a quiet sleep-EEG night and on average 95% reported that they had a quiet sleep during the following nights.

A previous report showed that in-home sleep EEG with school-aged children has a high long-term stability over an 18 months period regarding TST, stage 2 sleep, and SWS as well as a moderate long-term stability regarding SE, SOL, WASO, and REM sleep [23].

2.4. Diary-reports of children's sleep

Children and parents were instructed to complete the sleep diary together. They reported the children's bedtime as well as awakening time, sleep latency (min), number of awakenings, number of daytime napping, and sleep quality (1 = very quiet night; 5 = very restless night) regarding the sleep-EEG night and during the following six nights. For the current study, averages of diary reports were built based on the nights before regular school days excluding diary-reports of nights before weekends, holidays, and vacations.

2.4. Statistical analysis

Multiple regression analyses were conducted with sleep-EEG and diary-reports of children's sleep as independent variables and CSHQ-DE scales as dependent variable. In addition, we tested whether children's age and sex moderated the correspondence between sleep-EEG and diary-reports of children's sleep with parental perception of children's sleep. If not stated otherwise, analyses controlled children's age, sex, and prematurity status and were performed with IBM® SPSS® Statistics 22 (IBM Corporation, Armonk NY, USA) for Apple Mac®.

3. Results

3.1 Preliminary analyses

More mother questionnaire reports of bedtime resistance ($r = -.18$, $p = .028$) and more mother and father questionnaire reports of sleep anxiety were found in younger children ($r = -.23$, $p = .005$). Girls had more father questionnaire reports of sleep onset delay ($t(120) = 2.34$, $p = .021$) and daytime sleepiness ($t(121) = 2.02$, $p = .046$) compared to boys. Very preterm children had less mother questionnaire reports of sleep duration problems ($t(141) = -2.37$, $p = .019$) and more mother and father questionnaire reports of sleep anxiety ($t(141) = 2.46$, $p = .015$; $t(121) = 2.13$, $p = .035$). There were no further significant associations of age, gender, and prematurity status with parent questionnaire reports of children's sleep-related behavior problems.

EEG-derived TST was negatively associated with child age ($r = -.46$, $p < .001$), and sleep onset time was positively associated with child age ($r = .38$, $p < .001$). Girls showed shorter REM sleep latency ($t(141) = -2.26$, $p = .025$), earlier sleep onset time ($t(141) = -2.13$, $p = .035$), and awakening time ($t(141) = -2.89$, $p = .004$) than boys. Additionally, very preterm children had earlier sleep onset times ($t(141) = -2.24$, $p = .027$) compared to full-term children. There were no further significant associations of age, sex, and prematurity status with sleep-EEG indices.

Diary-reports of children's sleep duration ($r = -.59$, $p < .001$) and awakening time ($r = -.28$, $p < .001$) were negatively associated with child age. Diary-reports of children's bedtime were positively related to child age (r = .52, p < .001). There were no further significant associations of age, sex, and prematurity status with diary-reports of children's sleep.

3.2 Associations of children's in-home sleep-EEG and diary-reports of children's sleep with maternal and paternal questionnaire reports of children's sleep-related behavior

Table 3 shows associations of sleep-EEG indices and diary-reports of children's sleep with mother and father questionnaire reports of children's sleep related-behavior. Consistent with our first hypothesis shorter EEG-derived TST was related to more mother questionnaire reports, but not father questionnaire reports of sleep duration problems (β = -.19, t = -2.07, p =.040; β = -.08, t = -.73, p = .466). Additionally, more mother and father questionnaire reports of children's sleep duration problems were related to diary-reports of shorter sleep duration (β = -.33, t = -3.30, p = .001; β = -.32, t = -3.05, p = .003). Considering clinical scores of the CSHQ-DE subscales, children above the cut-off score of mother questionnaire reports but not father questionnaire reports of sleep duration problems had significantly shorter EEG-derived TST than children below the cut-off score (F(1,137) = 5.10, p = .026; F(1,116) = 0.32, p = .575; see supplemental Tables S1-S5 for associations between clinical scores of the CSHQ-DE subscales and sleep-EEG indices) and significantly shorter diary-reports of sleep duration (F(1,136) = 9.70, p = .002; F(1,116) = 4.41, p = .038).

In accordance to our second hypothesis, less EEG-derived SE and longer SOL were related to more mother questionnaire reports of sleep onset delay (β = -.36, t = -4.46, p < .001; β = .23, t = 2.76, p = .007). For fathers, only longer EEG-derived SOL was associated with more father questionnaire reports of sleep onset delay (β = .20, t = 2.19, p = .031). Considering children's diary-reports of sleep, mother and father questionnaire reports of children's sleep onset delay were positively related with diary-reports of children's sleep latency (β = .48, t = 6.43, p < .001; β = .30, t = 3.50, p < .001). Regarding our third hypothesis, we found no association between EEG-derived WASO and mother and father questionnaire reports of night wakings (β = -.04, t = -.50, p = .621; β = .08, t = .81, p = .419). Considering diary-reports of sleep, mother's and father's questionnaire reports of children's night wakings were positively related with diary-reports of children's number of awakenings (β = .19, t = 2.29, p = .046; β = .20, t = 2.15, p = .034). Considering clinical scores of the CSHQ-DE subscales, children above the cut-off score of mother and father questionnaire reports of night wakings did not differ significantly in EEG-derived WASO (F(1,137) = 0.06, p = .821; F(1,117) = 0.46, p =

.498), but showed more diary-reports of children's number of awakenings ($F(1,136) = 5.03$, $p = .026$; $F(1,117) = 6.09$, $p = .015$).

All analyses concerning father questionnaire reports were rerun after exclusion of 2 children, who were living with their mothers only for sensitivity analyses. These analyses showed the same findings in terms of effect-sizes and significance of results (data not shown).

Exploratory analyses were conducted to study further associations of parent questionnaire reports of children's sleep-related behavior problems with sleep-EEG indices and children's diary-reports of their sleep. To account for alpha-level inflation due to multiple testing, the significance level was set to $p < .001$ for these exploratory analyses. Exploratory analyses revealed no significant association at this level regarding associations between sleep-EEG indices and parent questionnaire reports of children's sleep-related behavior. Considering diary-reports of children's sleep, diary-reports of lower sleep quality were associated with more mother questionnaire reports of bedtime resistance ($\beta = .32$, $t = 4.07$, $p < .001$) as well as sleep anxiety ($\beta = .31$, $t = 3.96$, $p < .001$) and more father questionnaire reports of parasomnias ($\beta = .33$, $t = 3.87$, $p < .001$). Further, diary-reports of later bedtimes were related to more mother questionnaire reports of sleep duration problems ($\beta = .36$, $t = 3.82$, $p < .001$) and more father questionnaire reports of overall sleep disturbance score ($\beta = .35$, $t = 3.59$, $p < .001$; see Table 3).

(Insert Table 3 about here)

3.3 Moderation of the relationship between children's in-home sleep-EEG with maternal and paternal questionnaire reports of children's sleep-related behavior

No significant age- and sex-moderations of the relationship of (a) EEG-derived TST with parent questionnaire reports of sleep duration problems, (b) EEG-derived SE and SOL with parent questionnaire reports of sleep onset delay, and (c) EEG-derived WASO with parent questionnaire reports of night wakings were found. Thus, the correspondence between parent questionnaire reports of and sleep-EEG indices did not decrease with child age, and associations were not significantly different between boys and girls. In addition, prematurity status did not moderate any of the hypothesized associations between sleep-EEG indices and parent questionnaire reports.

3.4 Moderation of the relationship between diary-reports of children's sleep with maternal and paternal questionnaire reports of children's sleep-related behavior

No significant age- and sex-moderations of the relationship of (a) diary-reports of children's sleep duration with parent questionnaire reports of sleep duration problems and (b) diary-reports of sleep latency with parent questionnaire reports of sleep onset delay were found. However, there was a significant age-moderation of the relationship of (c) diary-reports of number of children's awakenings with mother questionnaire reports of night wakings ($\Delta R^2 = .038$, $F(1,135) = 5.68$, $p < .001$). As expected, the association between mother questionnaire reports of night wakings and diary-reports of number of nocturnal awakenings was stronger in younger than in older children. Prematurity status did not moderate the associations between diary-reports of children's sleep and parent questionnaire reports.

4. Discussion

This is the first study that compared parent questionnaire reports of children's sleep with in-home sleep-EEG. As expected, children with longer EEG-derived TST, higher SE, and a shorter SOL had less parent questionnaire reports of sleep duration problems and sleep onset delay, which is in line with prior research using actigraphic sleep measures [6]. In particular our results show that children with objectively measured shorter sleep duration also had more sleep duration problems according to their mothers but not according to their fathers (hypothesis 1). Both mother and father questionnaire reports of sleep duration problems were also associated with diary-reports of shorter sleep of children. In line with our second hypothesis, children with longer SOL had more mother and father questionnaire reports of sleep onset delay, while there was only an association between children's SE and mother questionnaire reports of sleep onset delay. These findings are in contrast to a previous study by Markovich et al. (2015) [8] studying 30 children with PSG in the sleep laboratory and parent reports who found no such association. As an important difference the present study assessed children's sleep at the children's home in their natural environment, which increases the ecological validity of sleep measurement and presumably more accurately reflects children's usual sleep patterns. As a further difference compared to the study by Markovich et al., (2015) [8] the present report is based on a larger sample of children (i.e., $N = 143$ vs. $N = 30$) and therefore involves more statistical power to detect relations of moderate effect size. Both mother and father questionnaire reports of sleep onset delay were also associated with diary-reports of sleep latency.

Inconsistent with our third hypothesis, however we found no associations between WASO and mother as well as father questionnaire reports of night wakings. A possible explanation might be that it is more difficult for parents to estimate their children's WASO compared to TST or SOL because older children mostly sleep in their own bedrooms, awakenings may occur when parents are asleep themselves, and during middle and later childhood children may be less likely to inform their parents when they were awake [10,12]. While both mother and father questionnaire reports of night wakings were associated with diary-reports of number of awakenings, these associations were more modest than associations regarding sleep duration or sleep onset latency.

In general, we found stronger correspondence between mother questionnaire reports of children's sleep and EEG-measures of children's sleep compared to father questionnaire reports of children's sleep. A possible explanation for this result might be that mothers often spend more time with their children and that they are more involved in basic child care tasks than fathers [24,25,26]. Specifically, mothers are still more often involved in child care routines, which have to be completed at a certain time such as preparing meals and putting children to bed, while fathers are relatively more often involved in activities that are more joyful, voluntary, and do not have to follow a certain schedule such as playing with the kids [25,27,28,29]. Therefore, it is possible, that mothers more accurately know about children's actual sleep duration problems and sleep onset delay. However, mother and father questionnaire reports showed both similar levels of correspondence with diary measures of children's sleep. These associations were somewhat stronger than regarding EEG-measures of children's sleep. The stronger correspondence between parent questionnaires and diary reports could be due to the involvement of parents in completing the diaries; the parents were instructed to support their children in filling in the sleep diaries, which might have been a source of bias to the diary reports.

Our results did not confirm the assumption that the correspondence between in-home sleep-EEG and parental questionnaire reports of children's sleep decreases with children's age. A possible explanation might be that the age range in the present study (7 to 12 years) does neither include early childhood nor late adolescence. It is possible that at age 7 children's autonomy regarding their sleep behavior has already reached a relatively high level where parental knowledge of children's sleep no longer decreases till adolescence.

Another explanation might be that indicators of sleep quantity and quality during middle childhood remain relatively stable in terms of the rank-order stability [23,30]. Relatedly, pediatric sleep disturbances might already develop early in childhood and continue into adolescence [31]. Thus, parents with adolescent children may still be relatively accurate in reporting their children's sleep as they possibly remember their children's sleep during earlier childhood and may backup their judgments on a longer shared history.

With regard to the diary reports of children's sleep, a stronger association of mother's questionnaire reports of night wakings with diary-reports of night awakenings in younger children was found, which is in line with the hypothesis of an age-related decline in parental knowledge about children's sleep. However, with regard to this finding one has to keep in mind that previous research has criticized the validity of diary-reports of children's night wakings [10].

Moreover, our results did not confirm the assumption that mothers more accurately report their daughters' than their sons' sleep and that fathers more accurately report their sons' than their daughters' sleep. As already mentioned before, mothers spend more time with their children – regardless of their children's sex – compared to fathers [24,25,26]. This might be a possible explanation for an overall stronger association between mother questionnaire reports of children's sleep and children's objectively measured sleep. Thus, it seems that children's sex does not play a major role for parental knowledge of their school-aged children's sleep.

4.1. Strengths and Limitations

As a limitation to the present study, children's sleep-EEG was only measured during one single night, whereas the parent-questionnaire referred to one typical week. However, sleep-EEG TST and sleep onset latency showed moderate to strong correlation with diary measures of sleep duration and sleep latency lending support for their validity. Second, whereas the CSHQ-DE was constructed for parents of children up to 10 years, we also conducted the CSHQ-DE in parents of children above 10 years of age. However, as we did not find a decrease in correspondence of parent questionnaire reports of children's sleep with sleep-EEG indices and diary-reports of children's sleep duration and sleep latency, the findings of the present study seem to lend support for validity of parent reports of these variables also in older children. Third, we did not use self-reported sleep questionnaires for the children, as for example the SSR-DE. Thus, the only measure that involved children's self-report was the sleep diary for which children were supported by their parents. Finally, the study sample included children born very preterm, which might limit generalizability of the findings to other populations. However, as preterm status of children did not moderate the findings, we do not believe that this should have influenced the findings strongly. A strength of this study includes the multi-informant approach involving the availability of questionnaire reports from both parents on their children's sleep, sleep assessment with EEG at the children's home, and sleep diary reports.

5. Conclusions

Mother questionnaire reports of children's sleep duration problems and sleep onset delay reflect EEG-derived TST, SE, and SOL relatively well. Regarding father-reports, only an association between father questionnaire ratings of children's sleep onset delay and EEG-derived SOL was found. However, both mother and father-reports of children's sleep duration problems, sleep onset delay, and night wakings were related to diary-reports of children's sleep. The correspondence of parent-reported children's sleep with in-home sleep-EEG did not change across middle childhood and did not differ between children's sex.

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Conflicts of interest: none

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Table 1 Descriptive statistics (N = 143)

		M/N	*(SD/%)*
1	Age, years	9.67	(1.45)
2	Sex, male	86	(60.1)
3	Prematurity status, born very preterm	57	(39.9)
Sleep-EEG indices			
	Total sleep time (h)	8:56:35	(0:41:00)
	Sleep efficiency (%)	93.44	(2.85)
	Sleep onset latency (min)	18.55	(8.67)
	WASO (min)	18.54	(14.08)
	Stage 1 sleep (%)	3.48	(2.31)
	Stage 2 sleep (%)	47.50	(5.02)
	Slow wave sleep (%)	21.49	(4.84)
	REM sleep (%)	24.99	(3.88)
	REM latency (min)	111.01	(42.07)
	Sleep onset time	21:19:06	(0:39:36)
	Awakening time	6:34:10	(0:23:08)
Diary-reports of children's sleep			
	Sleep duration	9:33:21	0:36:14
	Bedtime	20:59:00	(0:31:00)
	Awakening time	6:48:00	(0:17:00)
	Sleep latency (min)	15.42	(11.61)
	Number of awakenings	0.59	(0.68)
	Number of daytime napping	1.01	(0.06)
	Sleep quality	1.91	(0.74)

EEG = electroencephalography; WASO = wake after sleep onset; REM = rapid eye movement.

Table 2 Descriptive statistics for parent questionnaire reports of children's sleep-related behavior

	Maternal report[1]				Paternal report[2]				Intra-class correlations	
	M	*(SD)*	α	Children above the cut-off score *n* (%)	*M*	*(SD)*	α	Children above the cut-off score *n* (%)	*ICC*	*t-value*
Children's sleep patterns (CSHQ-DE)										
Bedtime resistance	6.86	(1.44)	.56	13 (9.1)	6.84	(1.35)	.51	8 (6.6)	.87	-.85
Sleep onset delay	1.32	(0.56)	n/a	n/a[a]	1.30	(0.57)	n/a	n/a[a]	.66	.00
Sleep duration problems	3.70	(1.09)	.58	31 (21.7)	3.42	(0.83)	.62	12 (9.8)	.44	2.72**
Sleep anxiety	4.86	(1.34)	.57	14 (9.8)	4.74	(1.24)	.55	13 (10.6)	.74	.94
Night wakings	3.50	(0.90)	.58	20 (14.0)	3.55	(0.82)	.39	15 (12.2)	.78	-.37
Sleep disordered breathing	3.36	(0.92)	.76	n/a[a]	3.30	(0.82)	.74	n/a[a]	.89	1.19
Parasomnias	8.36	(1.36)	.42	n/a[a]	8.02	(1.23)	.42	n/a[a]	.70	3.07**
Daytime sleepiness	12.60	(2.41)	.60	45 (31.5)	12.26	(2.28)	.51	30 (24.4)	.69	1.69†
Sleep disturbance score	42.15	(4.90)	.69	n/a[a]	41.14	(4.67)	.69	n/a[a]	.79	2.87**

CSHQ-DE = the German version of the Children's Sleep Habits Questionnaire.
[1] refers to 143 children with maternal reports.
[2] refers to 123 children with paternal reports.
[a] there are no cut-off scores for the CSHQ-DE.
α = Cronbach's alpha
†$p < .1$, *$p < .05$, **$p < .01$ (two-tailed).

Table 3 Multiple regressions with sleep-EEG predicting maternal and paternal questionnaire reports of sleep-related behavior

	Maternal ratings of CSHQ-DE scales (*n* = 143)/Paternal ratings of CSHQ-DE scales (*n* = 123)								
	Bedtime resistance	Sleep onset delay	Sleep duration problems	Sleep anxiety	Night wakings	Sleep disordered breathing	Parasomnias	Daytime sleepiness	Sleep disturbance score
In home EEG-sleep									
Total sleep time (h)	-.01/-.07	-.13/-.22*	-.19*/-.08	.02/-.04	-.07/-.12	-.09/-.05	-.08/.14	-.03/-.07	-.13/-.08
Sleep efficiency	.01/.09	-.36***/-.16	.03/.10	.05/.11	.06/-.03	-.05/-.05	-.03/.13	-.04/-.06	-.06/.03
Sleep onset latency	-.06/-.08	.23**/.20*	-.07/-.05	.05/-.02	-.08/-.10	.05/.01	.08/-.05	-.02/-.05	.04/-.06
WASO (min)	.03/-.07	.26**/.00	-.03/-.09	-.08/-.13	-.04/.08	.01/.05	-.02/-.12	.05/.07	.03/-.04
Stage 1 sleep (%)	.03/.01	.26**/-.03	-.07/-.08	-.01/-.04	-.02/.07	-.06/-.13	-.01/-.09	.10/.17	.05/.03
Stage 2 sleep (%)	-.02/.05	-.04/.12	-.01/-.06	.04/.08	.10/-.01	-.06/-.18*	.09/-.08	-.12/-.13	-.03/-.07
Slow wave sleep (%)	.00/.00	-.08/-.03	.13/.17	-.01/-.01	.02/.19*	.11/.19*	.03/.13	.05/-.04	.08/.08
REM sleep (%)	-.01/-.09	-.02/-.08	-.10/-.08	-.05/-.07	-.14/-.29**	-.05/.07	-.15/-.03	.03/.11	-.11/-.05
REM latency (min)	-.05/.01	-.12/.04	-.01/.06	-.04/.02	-.03/.11	.14/.23*	.05/.09	-.06/-.09	-.03/.06
Sleep onset time	.02/.14	.00/.11	.27*/.13	.04/.09	.08/.02	.09/.10	.05/-.03	.13/.16	.18/.17
Awakening time	.02/.06	-.04/-.16	.11/.02	.02/-.01	.06/-.08	-.02/.11	-.06/.08	.16/.18*	.09/.12
Diary-reports of children's sleep									
Sleep duration	-.21*/-24*	-.14/-.28**	-.33**/-.32**	-.10/-.13	-.13/-.16	-.14/-.07	.00/.08	-.10/-.22*	-.25*/-.31**
Bedtime	.20*/.33**	-.08/.05	.36***/.29**	.17/.16	.08/.16	.06/.08	-.02/-.04	.13/.31**	.22*/.35***
Awakening time	.05/.15	.00/-.15	.04/.02	.11/.04	-.09/-.02	-.01/-.03	-.07/.06	.15/.18*	.06/.13
Sleep latency (min)	.11/.03	.48***/.30***	.04/.14	.01/-.02	-.01/-.03	.10/-.06	-.03/-.03	.12/.08	.16/.09
Number of awakenings	.06/.08	-.22**/-.17	-.06/-.11	.01/.05	.19*/.20*	.15/.21*	.01/.04	.03/-.06	.05/.02
Number of daytime napping	.05/.03	-.02/-.06	.03/.17	.07/-.09	.13/.06	-.06/.01	-.11/.01	-.01/-.01	.01/.02
Sleep quality	.32***/.25**	-.06/-.02	.00/.08	.31***/.24**	.17*/.23*	.11/.10	.23**/.33***	.03/-.02	.24**/.24**

EEG = electroencephalography; CSHQ-DE = the German version of the Children's Sleep Habits Questionnaire; WASO = wake after sleep onset; REM = rapid eye movement. Data are standardized regression coefficients. All values adjusted for children's age, sex, and prematurity status. *p < .05, **p < .01, ***p < .001 (two-tailed).