ELSEVIER

Sleep Medicine 2 (2001) 501–510

SLEEP MEDICINE

www.elsevier.com/locate/sleep

Original article

Clinical prediction of periodic leg movements during sleep in children

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Received 19 September 2000; received in revised form 30 October 2000; accepted 3 November 2000

Abstract

Objective: To assess the utility of several symptoms and a questionnaire-based scale in the identification of children with periodic leg movements during sleep (PLMS).

Background: PLMS may have important consequences in some children, but the extent to which a diagnosis can be established by clinical history is unknown.

Methods: Subjects were patients aged 2–18 years who underwent polysomnography to assess for sleep-disordered breathing (SDB). Parents completed a Pediatric Sleep Questionnaire which contained items under consideration for inclusion in the desired scale.

Results: Subjects ($n = 113$) had a mean age of 9.8 ± 4.0 (SD) and 73 (65%) were male; 59 (52%) had SDB and 29 (26%) had five or more PLMS per hour of sleep (PLMI ≥ 5). Severity of SDB was not different among those with and without PLMI ≥ 5. Yes/no responses to several question-items — about restless legs, growing pains, leaving the bed at night, waking more than twice per night, waking feeling unrefreshed, and morning headaches — showed some association with PLMI ≥ 5 and were combined into a composite PLMS score artificially weighted toward the first two items. The PLMS score averaged 0.40 ± 0.31 and ranged from 0.0 to 1.0; a 1 SD increase was associated with PLMI ≥ 5 (odds ratio = 1.87, 95% confidence interval (1.15, 3.13), $P = 0.014$) after adjustment for age, sex, and SDB severity. Sensitivity of a PLMS score > 0.33 for PLMI ≥ 5 was 0.79, specificity was 0.56, positive predictive value was 0.38, and negative predictive value was 0.89. Internal consistency was reasonable (Cronbach's $\alpha = 0.71$), as was test–retest reliability ($\rho = 0.62$, $P = 0.0026$, $n = 21$ separate subjects).

Conclusions: Restless legs, growing pains, sleep-maintenance insomnia, unrefreshing sleep, and morning headaches show moderate associations with polysomnographically-defined PLMS, but several other symptoms do not. These results require confirmation but suggest that clinical assessment and the PLMS score may be helpful but far from definitive.

Keywords: Child; Periodic leg movements during sleep; Periodic limb movement disorder; Pediatric Sleep Questionnaire; Scales; Obstructive sleep apnea; Sleep disorder; Polysomnography

1. Introduction

Periodic leg movements during sleep (PLMS) affect a large number of adults, about 45% of those older than 65 years, and about 80% of those who have restless legs syndrome, but PLMS are thought to be

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1389-9457/01/$ - see front matter
PII: S1389-9457(01)00069-7

rare among children [1–3]. Five or more PLMS per hour of sleep, a threshold often used to help define periodic limb movement disorder, is frequently found among adults with other sleep disorders, especially sleep-disordered breathing (SDB) [4], and may be frequent among children with SDB also.

The significance of PLMS in adults is often unclear [5–7], but recent findings in children suggest an association between PLMS and daytime inattention and hyperactivity. Children with restless legs syndrome and PLMS are often noted to have hyperactive behavior [8]; in one study 15 of 16 children with frequent PLMS (>25/hour of sleep) had attention-deficit/hyperactivity disorder (ADHD) [9]. Conversely, PLMS more frequent than five per hour may be common among hyperactive children [3]. In a study of 69 consecutive children with ADHD, parents were asked to observe their children for PLMS, and children reported to have them were studied with polysomnography: 18 (26%) of the children had five or more PLMS per hour of sleep [10]. Whether PLMS contribute to daytime hyperactivity in children is not known, but dopaminergic therapy given to seven ADHD children with restless legs syndrome and PLMS led to substantial improvement in specific behavioral measures such as the Test of Variable Attention, Connors Parent Rating Scale, Child Behavior Checklist, and visual memory subtest of the Wide Range Assessment of Memory and Learning [11].

These findings suggest that identification of undiagnosed PLMS may be important, but few children, even among those with disruptive behavior, are evaluated in sleep laboratories. Published studies have not assessed to what extent childhood PLMS can be identified by a clinical history of nocturnal leg restlessness, observed leg movements, sleepiness, insomnia, hyperactivity, or headaches, though all these symptoms have been reported in clinical series of children with PLMS [8,9]. We therefore studied the predictive value of these symptoms in a series of patients who underwent laboratory polysomnography. The indication for study was suspected SDB, as is usually the case when polysomnography is performed, but this sample provided a high frequency of PLMS and a valuable opportunity to test the effectiveness of several questionnaire items about restless legs and PLMS. These items are contained within a Pediatric Sleep Questionnaire (PSQ), parts of which have been validated previously [12]. In the current work we also sought to develop and test a PSQ subscale valid for the prediction of PLMS.

2. Methods

2.1. Subjects

Children were included in this prospective, observational, Institutional Review Board-approved study if they signed an assent, the parents or guardians signed an informed consent, and the subjects met the following criteria: (1) referral for laboratory-based nocturnal polysomnography between August 23, 1996 and March 29, 2000 to assess for suspected SDB, (2) age 2.0–18.0 years, (3) PSQ completed by a parent or guardian at the time of polysomnography. Patients were excluded if they had (1) tracheostomies normally open during sleep, or (2) cognitive, physical, or medical disability reported by a parent on the PSQ and judged likely to preclude interpretation of the child's behavior. The questionnaire included a medical history and an immediate family history for sleep or psychiatric problems. To preserve generalizability of results, subjects were still included if they were diagnosed with more than one sleep disorder. A total of 113 patients met criteria and were included in this study. These subjects are also the topic of another report, in preparation, on polysomnographic correlates of hyperactive behavior in children.

2.2. Measures

Nocturnal polysomnography included four electroencephalographic leads (C3–A2, C4–A1, O1–A2, O2–A1 of the 10–20 international electrode placement system), two electro-oculographic leads (right and left outer canthi), chin and bilateral anterior tibialis surface electromyograms, two electrocardiographic leads, nasal and oral airflow (thermocouples), thoracic and abdominal excursion (piezoelectric strain gauges), and finger oximetry. In a minority of cases ($n = 19$), and at the referring physician's request, esophageal pressure was monitored with a water-filled catheter [13] that does not have significant adverse effects on children's sleep [14]. Sleep stages were scored in 30-s epochs according to standard criteria [15] by technologists who, after an extensive training program, had

correctly scored at least 90% of epochs in a set of reliability records.

An apnea was defined as 10 or more seconds of complete airflow cessation during sleep, regardless of any change in oxygen saturation. An hypopnea was defined as a 10-s reduction in airflow, chest excursion, or abdominal excursion that led to either a 4% or greater oxyhemoglobin desaturation, an arousal, or an awakening. Some pediatric sleep laboratories score apneas or hypopneas less than 10 s long, due to high respiratory rates in young children, but this justification would not apply well to the older children and teenagers included in our sample. We suspect that in the current study, esophageal pressure monitoring allowed identification of subtle SRBDs in some of the younger children for whom shorter apneic event criteria might otherwise have been important. As an additional measure that might capture subtle sleep-disordered breathing undetected on polysomnography, we used the parental report, on the PSQ, of habitual snoring (snoring more than half the time).

For this study, we classified subjects as having SDB if they had a rate of apneas and hypopneas (apnea/hypopnea index, or AHI) that was at least five per hour of sleep, or if they had fewer apneic events but high upper airway resistance, as defined by a peak negative end-inspiratory esophageal pressure that was -20 cm of water or more negative [12]. These criteria were chosen to provide internally uniform limits that would be reasonably applicable to our wide range of subject ages, and with the realization that better cutoffs are difficult to define at present in the absence of the necessary outcome-based, age-stratified studies [16], and in the absence of normative data for hypopneas in children [17].

Arousal frequency was not scored in these studies. Although some clinicians believe that PLMS may exert any influence by disruption of sleep, a previous study failed to demonstrate that PLMS with arousals lead to daytime sleepiness in adults [6]. Other studies have shown that PLMS without EEG-defined arousals still lead to autonomic changes suggestive of sleep disturbance and indistinguishable from autonomic changes that accompany PLMS with EEG-defined arousals [18].

Periodic leg movements during sleep were scored when they met criteria for duration (0.5–5 s), periodicity (5–120 s between each movement), and number (at least three in a row). For this study, PLMS were considered to carry potential significance when their rate per hour of sleep (periodic limb movement index, PLMI) was at least five [8,19], which is a rare finding in normal children [3,10].

All historical data were collected with the PSQ. This instrument contains more than 70 closed-ended questions to which a parent, with help encouraged from the child, must answer *yes*, *no*, or *don't know*. The questions cover a wide range of subjects relevant to children's sleep, including items on SDB, parasomnias, insomnia, sleep schedules, daytime sleepiness, and sleep hygiene. These items are followed by daytime behavior rating scales derived from DSM-IV category A symptoms of ADHD, and by open-ended questions about medical and family history. An SDB scale within the PSQ was validated previously, as were subscales for snoring, sleepiness, and inattentive and hyperactive behavior [12]. The entire questionnaire is usually completed in about 20 min. For the question-items used in the current study, data on test–retest reliability was available from a separate set of 21 children who attended a general pediatrics clinic where their parents filled out PSQ once in the waiting room and again several weeks later by mail [12].

2.3. Analysis

Data were summarized by means and standard deviations (SD) or by frequencies. As the PLMI did not follow a normal distribution, even after several attempted transformations, the outcome variable was dichotomized and logistic regression was used to model PLMI ≥ 5 vs. PLMI < 5. Explanatory variables were PSQ question-item responses (yes $= 1$, no $= 0$, don't know $=$ missing), age, and gender. The PSQ items chosen to be tested against PLMI ≥ 5 were those that related to restlessness, restless legs, leg movements, growing pains, disrupted sleep, daytime sleepiness (sleepiness subscale items previously validated), inattentive and hyperactive behavior, and morning headaches (see Appendix A). One item about inattention and one about hyperactivity were chosen, from among those that best distinguished children with another sleep disorder (SDB), because these seemed most applicable over a broad age range [12].

Simple logistic regression was used to identify useful explanatory variables, which were then combined to produce a single PLMS score. Validity of the score was demonstrated by regression of PLMI ≥ 5 on the normalized PLMS score, before and after adjustment for potential confounders, such as age, gender, and apnea severity. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated, along with a receiver operator curve. Two forms of reliability were tested: internal consistency and test–retest stability. All analyses were performed with SAS, version 6.12 (SAS Institute Inc., Cary, NC). In tests of statistical significance, the level was set at 0.05.

3. Results

3.1. Subjects

Ages of subjects ranged from 2.8 to 18.0 years; the mean age was 9.8 ± 4.0 years, and 73 (65%) of the subjects were male (Table 1). Obstructive sleep apnea was found in 49 subjects (43%), and high upper airway resistance in the absence of OSA was found in an additional ten (9%) of the subjects. The mean PLMI was 4.9 ± 10.7, and the range was 0.0–72.6. Clinicians' impressions at the time of polysomnography suggested that most ($n = 40$) subjects without SDB as defined in this study had primary snoring, subtle SDB despite negative findings, or no sleep disorder. Other subjects without SDB received clinical diagnostic impressions of periodic limb movement disorder or restless legs syndrome ($n = 7$), parasomnias ($n = 2$), delayed sleep phase syndrome ($n = 2$), mild central sleep apnea ($n = 1$), unspecified insomnia ($n = 1$), and subtle SDB vs. narcolepsy ($n = 1$).

Psychiatric diagnoses reported by parents included ADHD ($n = 20$), anxiety disorders ($n = 3$), and bipolar disorder ($n = 3$). Neurological problems, reported in 29 subjects, included seizures ($n = 15$) and headaches ($n = 5$). Parents and siblings were reported to have obstructive sleep apnea ($n = 12$ relatives of ten children), restless legs syndrome ($n = 1$ relative), narcolepsy ($n = 1$), sleepwalking ($n = 1$), and bruxism ($n = 1$), but not periodic limb movement disorder. Current medications included methylphenidate ($n = 17$ subjects), pemoline ($n = 2$), a combination of dextroamphetamine and racemic amphetamine ($n = 1$), other psychoactive medications ($n = 13$), and other medications ($n = 30$).

3.2. PLMS scale development

In logistic regressions of PLMI ≥ 5 on PSQ items listed in Appendix A, items A13a, A13b, A16, A44, B1, and B7 were associated ($P < 0.05$) with the polysomnographic finding and items A13 and B6 showed trends ($P < 0.10$, Table 2). Spearman rank correlations between item responses showed that A13a was highly correlated with A13 ($\rho = 0.50$) and A13b ($\rho = 0.63$), and that B1 was highly correlated with B6 ($\rho = 0.41$). Variables A13a and B6 were therefore removed from the final PLMS score, which was defined and weighted as the mean value of the following item responses: A13, A13, A13b, A13b, A16, A44, B1, and B7. Items A13 and A13b were doubly weighted to improve the specificity of the scale for PLMS, as the remaining items might also apply well to other sleep disorders. The mean PLMS score was 0.40 ± 0.31 and the range was 0–1.0.

Table 1
Characteristics of all subjects, those with PLMI ≥ 5, and those with PLMI < 5[a]

Variable	All subjects ($n = 113$)	PLMI ≥ 5 ($n = 29$)	PLMI < 5 ($n = 84$)
Age (years)	9.8 ± 4.0	10.4 ± 4.3	9.6 ± 4.0
Male (%)	73 (65%)	22 (76)	51 (61)
Habitual snoring (%)	53 (47%)	15 (52)	38 (45)
AHI	8.1 ± 12.2	8.5 ± 10.0	8.0 ± 12.9
Minimum O_2	89.0 ± 8.8	90.4 ± 4.4	88.4 ± 9.8
PLMI	4.9 ± 10.7	16.6 ± 16.1	0.9 ± 1.4**

[a] PLMI, periodic leg movement index, or number per hour of sleep; AHI, apnea/hypopnea index; minimum O_2, minimum oxygen saturation.
**$P < 0.05$ (t-test) for the difference between those with and without PLMI ≥ 5.

Table 2
Logistic regression models of PLMI ≥ 5 (present vs. absent) as explained by each tested question-item[a]

Variable	Beta	SE	*P* value	Odds ratio	Area under ROC
A12 Restless sleep	− 0.069	0.579	0.9054	0.933	0.51
A13 Restless legs	**0.916**	**0.495**	**0.0632**	**2.500**	**0.61**
A13a Growing pains	1.003	0.478	0.0324	2.726	0.62
A13b Growing pains in bed	**1.085**	**0.510**	**0.0353**	**2.959**	**0.61**
A14 Brief kicks	− 0.385	0.454	0.3982	0.680	0.54
A14a Repeated kicks	− 0.593	0.691	0.3711	0.553	0.54
A16 Out of bed	**1.074**	**0.490**	**0.0217**	**2.927**	**0.62**
A40 Difficult sleep onset	0.747	0.459	0.1009	2.111	0.59
A44 Wakes at night	**0.945**	**0.474**	**0.0477**	**2.571**	**0.61**
B1 Unrefreshed	**1.937**	**0.776**	**0.0024**	**6.935**	**0.65**
B2 Sleepiness	− 0.027	0.455	0.9533	0.974	0.50
B4 Teacher comment	0.302	0.467	0.5174	1.353	0.54
B6 Difficult awakening	0.879	0.547	0.0899	2.408	0.58
B7 Morning headache	**1.193**	**0.515**	**0.0218**	**3.297**	**0.62**
C8 Easily distracted	0.641	0.442	0.1462	1.898	0.58
C18 On the go	− 0.030	0.451	0.9472	0.971	0.50

[a] Items listed in bold were retained in final PLMS scale. ROC, receiver operator curve.

3.3. PLMS scale validity

The PSQ-derived PLMS score showed some ability to distinguish children with and without PLMI ≥ 5 (Fig. 1). Logistic regression of PLMI ≥ 5 on the normalized PLMS score showed an odds ratio of 2.07 (95% confidence interval (CI) (1.33, 3.32)), and the association was significant ($P = 0.0010$, Table 3).

As suggested by the values shown in Table 1, the PLMS score showed no association with age, sex,

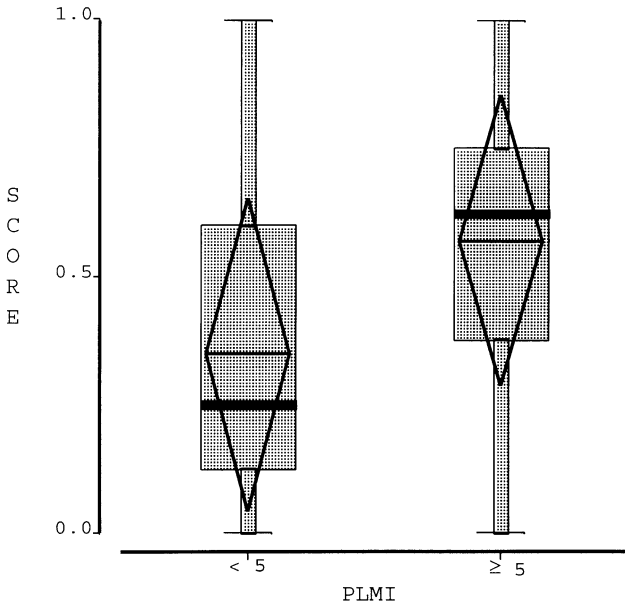

Fig. 1. The questionnaire-derived PLMS score is shown for subjects with and without PLMI ≥ 5. Boxplots show median and 10th, 25th, 75th, and 90th percentiles; diamonds show means and standard deviations.

Table 3
Logistic regression models of PLMI ≥ 5 (present vs. absent) as explained by normalized PLMS score, before and after adjustment for potential confounding variables[a]

Variable	Beta	SE	*P* value	Odds ratio	Area under ROC
PLMS score	0.727	0.231	0.0010	2.068	0.71
PLMS score, adjusted	0.623	0.254	0.0140	1.865	N.A.

[a] Variables are age, sex, habitual snoring, apnea/hypopnea index, and minimum oxygen saturation. N.A., not available.

habitual snoring, apnea/hypopnea index, or minimum oxygen saturation (Spearman correlation, $P > 0.10$ in each case). Adjustment for all of these potential confounds did not substantially change the association between PLMI ≥ 5 and PLMS score (odds ratio (OR) = 1.87 (1.15, 3.13)).

Logistic regression models of potential interaction between PLMS scores and age, sex, habitual snoring, apnea/hypopnea index, and minimum oxygen saturation showed that no such interactions approached significance ($P > 0.10$ for each): the extent to which the PLMS score predicted PLMI ≥ 5 did not differ according to age, sex, or apnea severity.

3.4. Prediction of PLMI ≥ 5

A receiver–operator (ROC) analysis (Fig. 2) suggested that the PLMS score was only moderately effective as a diagnostic tool. The effectiveness is reflected by the extent to which the curve deviates up and to the left from an imaginary straight diagonal line on which sensitivity = 1 − specificity. The area under the curve is 0.71, which is greater than 0.50 (no predictive value) but far from 1.00 (perfect prediction).

The ROC points that were farthest from the diagonal (Fig. 2), and accuracy calculations for nearby points, suggest that a criterion PLMS score > 0.33 leads to

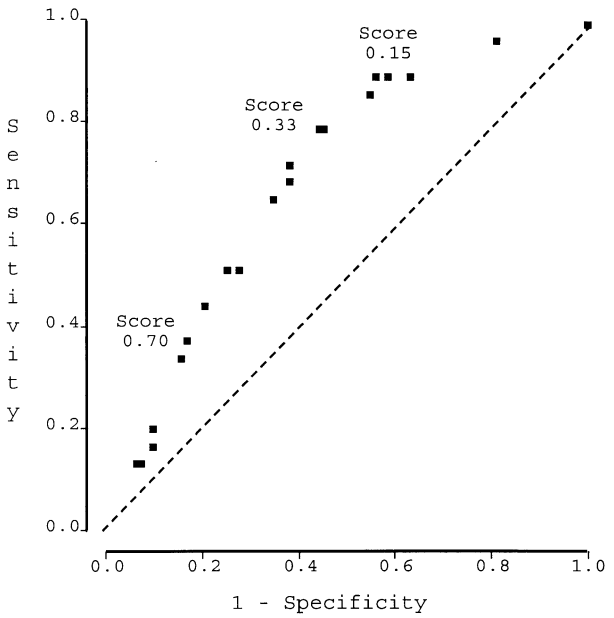

Fig. 2. Receiver–operator curve (ROC) for PLMS score as a test for PLMI ≥ 5. Positions on the curve for the three criterion scores discussed in the text are shown.

best overall accuracy, with a sensitivity of 0.79 and a specificity of 0.56. With this cut-off, the PLMS score correctly classified 70 (62%) of the 113 subjects; 23 (79%) of 29 subjects with PLMI ≥ 5 and 47 (56%) of 84 subjects with PLMI < 5. With this cut-off and a frequency of PLMI ≥ 5 equal to that found in the current sample, the positive predictive value of the PLMS score (PPV, probability that a patient has PLMI ≥ 5 given that the PLMS score is positive) was 0.38 and the negative predictive value (NPV, probability that a patient does not have PLMI ≥ 5 given that the PLMS score is negative) was 0.89.

Lower PLMS criterion scores increased sensitivity and might have been more suitable as a screen for PLMI ≥ 5, but specificity was quickly lost (Fig. 2). For example, a PLMS score > 0.15 correctly identified 61 (54%) of the 113 subjects and 26 (90%) of the 29 with PLMI ≥ 5, but was also positive in 49 (58%) of the 84 subjects without PLMI ≥ 5. Higher PLMS criterion scores improved the likelihood that a child scoring positive actually had PLMI ≥ 5 (PPV) only slightly, and caused many children with PLMI ≥ 5 to be missed. For example, a PLMS score > 0.70 correctly identified 81 (72%) of the 113 subjects, and 11 (44%) of 25 subjects with positive scores actually had PLMI ≥ 5, but 18 (62%) of 29 subjects with PLMI ≥ 5 were missed.

3.5. Reliability

Cronbach's α for the six question-items included in the PLMS score was 0.71 and suggested reasonably good internal consistency. Among the 21 subjects for whom test–retest data was available, the mean interval between PSQ administrations was 36 ± 14 days. A Spearman rank correlation between the PLMS scores on the two occasions showed reasonable reliability ($\rho = 0.62$, $P = 0.0026$). The mean difference between the scores was –0.04, which was not significantly different from zero (paired t-test, $P = 0.21$).

4. Discussion

The results of this study suggest that several questions about symptoms of periodic limb movement disorder have moderate predictive value for the identification of children with five or more periodic leg movements per hour of sleep. The questions that appeared to be most useful included those about restlessness of the legs, growing pains in bed, insomnia, and morning headache. Questions about observed leg movements during sleep, daytime sleepiness, and daytime behavior were less useful. A composite PLMS score constructed from symptoms associated with PLMI ≥ 5 showed some validity, internal consistency, and test–retest reliability, but also reflected what seem to be substantial limits to the diagnosis of PLMS by history. Finally, several study limitations must be recognized in the interpretation of these results.

Previous small clinical series of children with restless legs and PLMS have reported frequent complaints of restless legs, growing pains, and sleep-maintenance insomnia [8,20–22], but our study is among the first to confirm these observations by comparison of symptoms among children with PLMS to those of children without PLMS. Previous studies have not specified whether it is better to ask about growing pains without reference to time of day or to specifically ask about the time spent in bed. Our results suggest that a positive history of either symptom is similarly helpful, though more parents were able to report growing pains than growing pains that are worst in bed. Morning headaches were also more common among our subjects with PLMS. One previous series of 16 children with severe PLMS reported that 4 had a history of migraine, though referral bias could not be excluded [9]. Sleep-related headaches have been associated with PLMS in adults, and treatment of PLMS can improve the headaches [23].

We were not able to show an association between sleep onset difficulty and PLMS. Past studies have often reported sleep onset difficulty in children with PLMS [3,9,10], but most of these children also had comorbid ADHD, which is itself associated with sleep-onset insomnia [24–26]. A similar confound may underlie our inability to demonstrate previously suggested associations between restless sleep and PLMS [10,22]. We failed to demonstrate diagnostic utility of parental observation of PLMS, perhaps in part because only a minority of parents report this finding even when PLMS are present [3,9,22]. One past report did seem to suggest some utility in prospectively asking parents to observe their children's sleep for leg movements [10]. Other items that failed to predict PLMS in our sample included those that described daytime sleepiness. The PLMS,

like SDB, may be less likely to cause sleepiness in children than in adults [27], and some authors have argued that even in adults PLMS do not cause excessive sleepiness [7]. More unexpected, however, was our inability to confirm the reported association between PLMS and childhood inattention and hyperactivity [3,10,20,22]. The subjects in the current study were all referred for possible SDB, and an association between PLMS and the two behavioral question-items we tested may have been obscured by a relationship between SDB and hyperactive behavior [28].

This study is the first, to our knowledge, to report a high frequency of PLMS (26%) among children studied for suspected SDB, though the association is well known among adults. This frequency of PLMS matches that reported among children referred for ADHD (26%) [10]. Further study should address the possibility that frequent PLMS among children with SDB might account, at least in part, for the reported association of SDB with hyperactivity [28–31].

Interpretation of current results must take the source of subjects into account. In contrast to most previous reports, studied children were not selected for symptoms of restless legs or ADHD. An advantage of the current sample is its relatively large size and availability of many subjects without PLMS. However, the influence of concomitant SDB in many subjects cannot be ruled out. One recent report suggests that sleep architecture, at least, among children with SDB is not substantially different from that seen in children without SDB [32]. The effectiveness of our PLMS score appeared to bear no relationship to AHI or minimum oxygen saturation, but these parameters may not have adequately captured other pathophysiological aspects of SDB, such as hypoventilation. Most of our subjects did not have esophageal pressure monitoring, which is considered a gold standard for obstructive SDB. Alternative and potentially useful measures might have been nasal pressure monitoring and inductance plethysmography [33], but few published studies have used nasal pressure monitoring in children and one report suggests that the cannulae may obstruct small nostrils [34]. We used the historical report of habitual snoring to help control for subtle obstructive SDB that might have been missed on polysomnography, but we cannot completely exclude confounding from undetected SDB, which can be difficult to distinguish from PLMS.

Although this study is among only a small number that have examined PLMS in children, a significant limitation is the wide age range that still remained. Some PSQ items are likely to apply better to some age groups than others, despite our inability to demonstrate that the overall PLMS score showed any sensitivity to age. Other limitations include variability in frequency of PLMS from night to night, which may have made parental reports appear less useful than they really are. Finally, we had little opportunity to test the utility of a family history of restless legs or PLMS; the relevant section of the PSQ did not specifically ask about either condition, and such a history may be quite useful when children are unable to describe relevant symptoms [3].

In conclusion, our results help to define the clinical utility of several PLMS-related questions as decisively moderate. The usefulness of several other questions could not be demonstrated. The six-item differentially-weighted PLMS scale we developed shows some potential for use in clinical research to facilitate identification of children more likely to suffer from PLMS. The instrument has reasonable reliability. However, sensitivity is not high enough to permit effective screening of patients unless the criterion cutoff is made so low that more than half of unaffected patients also screen positive. In particular, the utility of the instrument for any particular patient in the clinical setting is likely to be small. Current results derive from a sample in which the PLMS scale was developed and therefore require replication. Additional study in larger and differently-defined samples also will be necessary before the utility of the PLMS scale can be described more definitively.

Acknowledgements

Supported by NINDS (K02-NS02009). The authors thank Judith Wiebelhaus, RPSGT, for expert technical assistance.

Appendix A

Pediatric Sleep Questionnaire items tested and retained (bold) in the PLMS subscale, and percent of sample for whom each item was positive.

A12 Does your child have restless sleep? (82%)
A13 Does your child describe restlessness of the legs when in bed? (38%)
A13a Does your child have 'growing pains' (unexplained leg pains)? (46%)
A13b Does your child have 'growing pains' that are worst in bed? (25%)
A14 While your child sleeps, have you seen brief kicks of one leg or both legs? (64%)
A14a While your child sleeps, have you seen repeated kicks or jerks of the legs at regular intervals (i.e., about every 20 to 40 s)? (20%)
A16 At night, does your child usually get out of bed (for any reason)? (57%)
A40 Does your child have difficulty falling asleep at night? (44%)
A44 Does your child wake up more than twice a night on average? (30%)
B1 Does your child wake up feeling *un*refreshed in the morning? (69%)
B2 Does your child have a problem with sleepiness during the day? (50%)
B4 Has a teacher or other supervisor commented that your child appears sleepy during the day? (44%)
B6 Is it hard to wake your child up in the morning? (69%)
B7 Does your child wake up with headaches in the morning? (24%)
C8 This child often is easily distracted by extraneous stimuli (42%)
C14 This child often is 'on the go' or often acts as if 'driven by a motor' (41%)

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