The Pediatric Daytime Sleepiness Scale (PDSS): Sleep Habits and School Outcomes in Middle-school Children

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Study Objectives: To develop a measure of daytime sleepiness suitable for middle-school children and examine the relationship between daytime sleepiness and school-related outcomes.

Design: Self-report questionnaire.

Participants: Four hundred fifty, 11- to 15-year-old students, from grades 6, 7, and 8 of a public middle school in Dayton, Ohio.

Measurements and Results: A pediatric daytime sleepiness questionnaire was developed using factor analysis of questions regarding sleep-related behaviors. Results of the sleepiness questionnaire were then compared across other variables, including daily sleep patterns, school achievement, mood, and extracurricular activities.

Results: Factor analysis on the 13 questions related to daytime sleepiness yielded 1 primary factor ("pediatric daytime sleepiness"; 32% of variance). Only items with factor loadings above .4 were included in the final sleepiness scale. Internal consistency (Chronbach's alpha) for the final 8-item scale was .80. Separate one-way analyses of variance and trend analyses were performed comparing pediatric daytime sleepiness scores at the 5 different levels of total sleep time and academic achievement. Participants who reported low school achievement, high rates of absenteeism, low school enjoyment, low total sleep time, and frequent illness reported significantly higher levels of daytime sleepiness compared to children with better school-related outcomes.

Conclusions: The self-report scale developed in the present work is suitable for middle-school-age children and may be useful in future research given its ease of administration and robust psychometric properties. Daytime sleepiness is related to reduced educational achievement and other negative school-related outcomes.

Key Words: Sleepiness, pediatric daytime sleepiness scale, PDSS, middle-school children, sleep deprivation, grades, sleep, children, adolescents

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INTRODUCTION

EVIDENCE IS ACCUMULATING TO SUGGEST THAT SLEEP NEED CHANGES ACROSS THE LIFE SPAN. Research suggests that adolescents need more than 8 hours of sleep per night.[1-3] When nightly sleep duration is reduced below this level, alertness and school performance become objectively impaired,[4,5] and this impairment can impact normal development and quality of life.[6,7] Specifically, lower-achieving high-school students report getting fewer hours of sleep, having later bedtimes, and having irregular sleep schedules compared to higher-achieving students.[6] Indeed, school systems in the United States have begun to implement programs[8] that utilize later school-start times to increase the opportunity for children to obtain adequate sleep.[9,10]

Despite mounting scientific evidence regarding the negative impact of sleep loss on grades and overall daytime functioning in children,[2,5,11] the majority of high-school students continue to report that they obtain fewer than 8 hours of sleep per night on weekdays.[6,12] Many children regularly attempt to compensate for this reduction in sleep by substantially increasing sleep time on weekends. However, Mercer and coworkers[3] found that even among children who believe they are getting adequate sleep, 54% report feeling sleepy during the day and 46% report that sleepiness interferes with homework.

While the impact of sleep loss in older adolescents has been elucidated, few studies have investigated the relationship between sleepiness, sleep habits, quality of life, and school achievement in younger populations. One study of 4- to 11-year-olds estimated that 15% have 1 or more "problem sleep behaviors."[12] These problem sleep behaviors included daytime sleepiness, parasomnias, sleep-disordered breathing, and others. While nightly total sleep time was estimated to be approximately 10.2 hours per night, the prevalence of problem sleepiness was still 11.8%. Sleep disorders are unlikely to fully account for this problem sleepiness, suggesting the possibility that many children may need more sleep than they regularly obtain.[6,9,10,13] With regard to sleep habits and resulting consequences, children remain an understudied population. Although sleep-disturbance scales have been developed and assessed in high-school-student samples,[6,14] few studies have assessed younger age groups.[13] The scarcity of psychometrically validated assessment instruments to measure sleepiness in younger age groups may be a contributing factor to the relative absence of sleep-related information available regarding this population.[12-15]

Although the assessment of sleepiness is possible using measures such as the Multiple Sleep Latency Test (MSLT),[16-18] practical difficulties inherent in laboratory testing, along with increasing interest in population-based research with large samples beyond laboratory capacity, have necessitated the development of validated self-report measures.[19,20] Self-report measures such as the Epworth Sleepiness Scale (ESS) are well-suited to such investigations and have increased our understanding of the etiology and morbidity of sleepiness.[21-23] A particularly useful aspect of recent self-report measures of sleepiness has been the incorporation of behavioral "anchors" that facilitate interindividual comparisons. For example, both the ESS and the Daytime Sleepiness Scale (DSS)[19,24] use commonly experienced situations (eg, driving, watching television) to assess the likelihood of the "behavior" of falling asleep or dozing rather than an introspective judgment as is the case with the Stanford Sleepiness Scale and visual-analog scales.[25]

Few self-report measures of daytime sleepiness similar to the ESS have been systematically investigated in children.[12-14] Parent-report questionnaires aimed at screening for specific sleep disturbances such as sleep-disordered breathing or behaviorally based sleep disorders have

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included measures of daytime sleepiness.[15] Such broad-based questionnaires may be prohibitively time consuming in some research situations. While shorter subscale measures of daytime sleepiness are available using these instruments, the reliability (internal consistency) of these subscales is below .74.[13,15] Thus, the development of a more succinct measure of daytime sleepiness with improved reliability could lead to a better understanding of the causes and consequences of daytime sleepiness in younger populations.

The development of valid self-report measures of daytime sleepiness in younger populations is important for several reasons. One is that currently available measures (DSS and ESS) used in adult populations are unlikely to be as useful in children given the often-differential responses to similar situations. For example, while common experiences such as watching television may unmask sleepiness in a sleep-deprived adult, a child may be aroused by the television.[16,26] Also, many situations used to assess sleepiness in adults (eg, driving, sitting in a meeting) would not be applicable to much younger age groups. Finally, a "hyperactive" response to sleep deprivation can be present in children,[2] while adults generally respond with subjective feelings of decreased vigor and increased fatigue.[18]

The purpose of the present study was to develop and validate a sleepiness questionnaire suitable for middle-school-aged children (11-15 years old) and examine the relationship between daytime sleepiness and school-related outcomes (eg, achievement and quality of life). Specifically, we hypothesized that the percentage of individuals reporting reduced sleep (less than 8 hours) in middle-school children would be substantial. In addition, we hypothesized that sleep duration would decrease and sleepiness would increase with each grade or age increment (sixth, seventh, eighth grades) as previous research has shown that reported nocturnal sleep time decreases with age.[6,27] We also hypothesized that sleepiness would be related to individual self-reported total sleep time and that both reduced total sleep time and daytime sleepiness would be associated with poor academic achievement and other negative outcomes (eg, poor mood).

METHOD

Participants

Four hundred fifty students, 11 to 15 years old, participated in the study (51.9% male, 48.1% female). The sample included students from sixth grade (n = 173, age range 11-15 years, mean age 11.8 ± .6 years), seventh grade (n = 125, age range 12-14 years, mean age 12.8 ± .4 years), and eighth grade (n = 144, age range 13-15 years, mean age 13.8 ± .5 years) within a public middle school in Dayton Ohio (8 students did not report grade level). The studied population (school-district data) was upper-middle class, with 5.2% Asian, 3.2% African American, 1.1% Hispanic, 0.4% multiracial, and 90.1% white. Each child in grades 6 through 8 was recruited for participation and completed the questionnaire during school hours with parental permission. The response rate for the questionnaire by grade level was sixth grade, 91%; seventh, 80%; and eighth, 81%.

Pediatric Daytime Sleepiness Scale Development

The entire questionnaire included 32 items related to daily sleep patterns, school achievement, mood, sleepiness, quality of life, and extracurricular activities. All questions were presented in a Likert-scale format (eg, never, seldom, sometimes, frequently, always). Thirteen candidate questions regarding sleepiness-related behaviors were used for the development of a pediatric daytime sleepiness scale (PDSS). These 13 candidate questions were scored according to the following procedures. Based on the Likert-scale ratings, items were scored from 0 to 4 (never = 0; seldom = 1; sometimes = 2; frequently = 3; always = 4). In order to reduce the possibility of response bias, responses to item number 3 (Are you alert most of the day? [appendix]) were reverse scored (ie, always = 0; frequently = 1; sometimes = 2; seldom = 3; never = 4). Higher scores indicated greater levels of sleepiness.

To ensure construct validity of the scale, factor analyses (split-half samples) were performed on these 13 sleepiness-related items. Factor analyses were conducted on each of two randomly selected split-half samples. Comparing the factor loadings for each split-half sample allowed assessment of the stability of each factor. Factor models were estimated using the generalized least-squares method, as few items had skewed distributions. A chi-square test of model fit was performed on each split-half sample with alpha set to .05. To allow for the possibility of correlated factors, promax rotation was used to determine each factor solution in the split-half samples. Scree plots were examined in each split-half sample to determine the appropriate number of factors to be extracted. Only items loading above .4 were included in the final PDSS. If items loaded below .4, they were excluded from all further analyses. After removing questions with low factor loadings (< .4), the remaining questions (8 items, see results) were used to determine scale reliability (Chronbach's alpha).

An additional 19 questions related to total sleep time, weekday bedtime, weekday wake time, extracurricular activities, school achievement, and mood ("I feel good about myself" and "Over the last 2 weeks how often did you get angry with yourself or others?") were included in the 32-item questionnaire. These 19 items were also assessed using a Likert-scale format and were intended to assess general sleep habits and school-related outcomes hypothesized to be related to daytime sleepiness. In order to simplify response options, total sleep time was measured by asking participants, "How many hours of sleep do you usually get on school nights?" Response choices were *ten or more*, *about 9*, *about 8*, *about 7*, and *less than 7*. School achievement was measured by asking participants "My grades in school are usually." The response choices were: *all A's*, *mostly A's and B's*, *all B's*, *mostly B's and C's*, and *all C's or less*. All questions were developed based on behavior frequently engaged in by this age group, and sleepiness-related questions were based on previous research in both children and adults regarding situations that may be sensitive to sleep loss (eg, falling asleep during class).

Table 1—Pediatric Daytime Sleepiness Scores, Demographics, and Sleep Habits by Grade

	Total Sample (n=442)	6th Grade (n=173)	7th Grade (n=125)	8th Grade (n=144)
PDSS score ± SD	15.3 ± 6.2	13.6 ± 6.4	15.4 ± 5.4	17.4 ± 6.1
Male (%)	52	50	56	50
Mean age ± SD (years)	12.8 ± 1.0	11.8 ± 0.6	12.9 ± 0.4	13.8 ± 0.5
TST (hours)				
>10	10%	17%	8%	4%
~9	30%	36%	32%	20%
~8	33%	28%	40%	35%
~7	18%	15%	14%	24%
<7	9%	4%	6%	17%
Bedtime*				
~8:00 PM	1%	1%	1%	0%
~9:00 PM	8%	13%	6%	5%
~10:00 PM	42%	49%	51%	25%
~11:00 PM	32%	23%	28%	49%
~12:00 PM	17%	14%	14%	21%
Wake time *				
~6:00 AM	4%	4%	4%	4%
~6:30 AM	13%	9%	11%	17%
~7:00 AM	41%	39%	44%	44%
~7:30 AM	27%	31%	23%	26%
>7:30 AM	15%	17%	18%	9%
Grades				
All A's	18%	20%	18%	15%
Mostly A's & B's	50%	49%	51%	50%
All B's	4%	5%	3%	4%
Mostly B's & C's	20%	19%	19%	24%
All C's or less	8%	7%	9%	7%

PDSS = Pediatric Daytime Sleepiness Scale; TST = total sleep time; * bedtimes and wake times are for weekdays only.

Morbidity and School Outcomes Analyses

Separate one-way analyses of variance were performed examining the degree of daytime sleepiness (total PDSS score) at each outcome variable level (school achievement, mood, etc.). Trend analysis using single-degree-of-freedom contrasts was performed to identify the presence of linear effects across levels of each variable. For categorical variables (ie, sleep-habit items: total sleep time, bedtime, wake time) the percentage of individuals endorsing a level of a specific item was analyzed using the chi-square test (eg, percentage of individuals endorsing a specific bedtime or wake time in each grade level).

RESULTS

Based on the scree plots, one but no more than two factors could be extracted from the items. The first factor accounted for 32% of the total variance in each of the split-half samples. Examination of each individual item factor loading for each split-half sample indicated that this factor was comprised of 8 items that loaded above .4. Factor loadings were comparable in each split-half sample. Examination of each item indicated that the first factor comprised a measure related to daytime sleepiness (see PDSS [appendix]). The second factor accounted for only 12% of the remaining variance. As the items loading above .4 on factor 2 included difficulty falling asleep and time needed to fall asleep, this factor may be related to difficulty initiating and maintaining sleep. The question with the next highest loading (.34) on factor 2 was frequency of awakening during night, providing additional support for this notion. However, because only 2 items loaded above .4 on factor 2, no further analysis of this factor was performed.

The PDSS included the 8 items with acceptable factor loadings (>.4). Internal consistency (Chronbach's alpha) for the total 8-item scale (factor 1, PDSS) was .81 and .80 in the split-half samples. Separate item-to-total-scale correlations were similar across the split-half samples. The PDSS scores were calculated (sum of each 0-4 item; PDSS score range, 0-32) for each individual in order to examine relationships between daytime sleepiness, school-related outcome measures, and sleep habits. Means and standard deviations for the PDSS across each grade level and the demographics of the sample are presented in Table 1, as are the percentage of individuals in each category of total sleep time, bedtime, wake time, and grades or school achievement. The frequency distribution of PDSS scores and selected corresponding percentile reference scores are displayed in Figure 1.

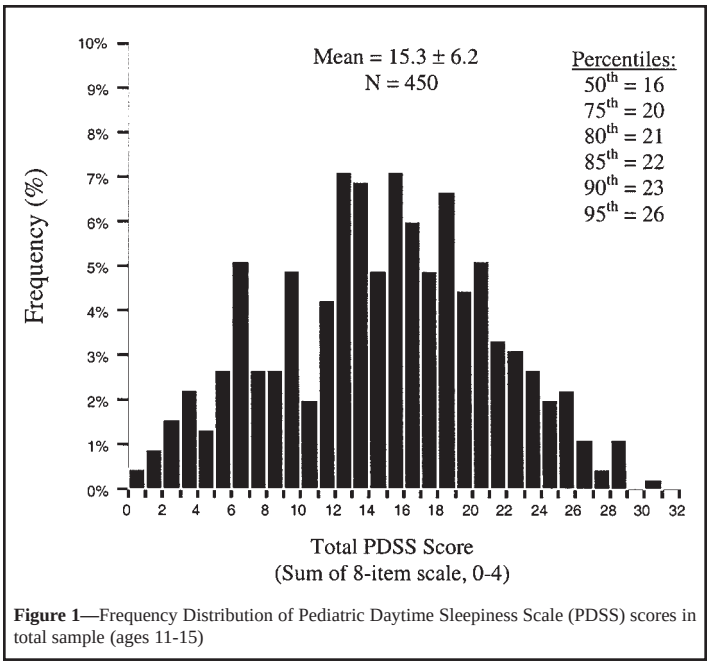

Figure 1—Frequency Distribution of Pediatric Daytime Sleepiness Scale (PDSS) scores in total sample (ages 11-15)

Daytime Sleepiness and School Achievement

The linear relationship between total sleep time and daytime sleepiness as measured by the PDSS was significant [F (1,410) = 41.26, $p < .001$], indicating the expected relationship between greater levels of sleepiness with reduced total sleep time. With regard to PDSS scores and school-related outcomes, there were significant linear effects for school achievement [F(1,405) = 5.96, $p = .02$] (Figure 2), anger towards self and others [F(1,406) = 61.91, $p < .001$], and more frequent illness [F(1,408) = 9.07, $p = .003$]. Significant linear effects were also present for measures of feeling good [F(1,405) = 18.89, $p < .001$] and school enjoyment [F(1,397) = 33.29, $p < .001$]. The direction of each relationship indicated that greater sleepiness was associated with more-negative outcomes. Other outcome variables such as extracurricular activities and hours of work or study per week were not significantly related to daytime sleepiness ($p > .05$ for all).

Analysis of sleepiness across grade levels indicated that the PDSS score increased significantly with grade level (linear trend, 6>7>8; Table 1) [F(1,406) = 38.27, $p < .001$]. Not surprisingly, 70% of eighth graders reported bedtimes of 11 PM or later on weekdays in comparison to only 43% of seventh graders ($\chi^2 = 19.68$, $p < .01$) and 38% of sixth graders ($\chi^2 = 31.90$, $p < .01$). Similarly, eighth-grade children were approximately twice as likely to report getting up at 7:30 AM or earlier on weekdays in comparison to their sixth-grade ($\chi^2 = 4.93$, $p < .05$) and seventh-grade ($\chi^2 = 5.25$, $p < .05$) schoolmates.

DISCUSSION

The present study reveals that higher daytime sleepiness is related to reduced educational achievement and to other negative school-related outcomes. These findings are consistent with previous research with older students[6] showing that poor grades were related to sleepiness. Middle-school children also showed a relationship between sleepiness and anger, feeling good, enjoying school, absenteeism, and illness. Again, these findings are consistent with previous research where depressive mood was related to reduced sleep in high-school students.[6]

In the present sample, more than 40% of children in the eighth grade (mean age = 13.8 years) reported getting about 7 hours or less of sleep per night on school nights. This was more than a twofold increase over the other 2 grade levels. Similarly, the percentage of children reporting more than 8 hours of sleep per night decreased from more than 50% in grade 6 to 24% in grade 8. Not surprisingly, daytime sleepiness increased linearly across the 3 grade levels along with later bedtimes. These data are consistent with other research on the sleep habits of older adolescents[6] and suggest, along with other studies,[6,10,12,27] that a substantial number of younger children may be chronically sleep deprived. Although further validation of the PDSS is needed using standard measures of sleepiness such as the MSLT, the current scale appears to be suitable for young age groups and may be useful in future research given

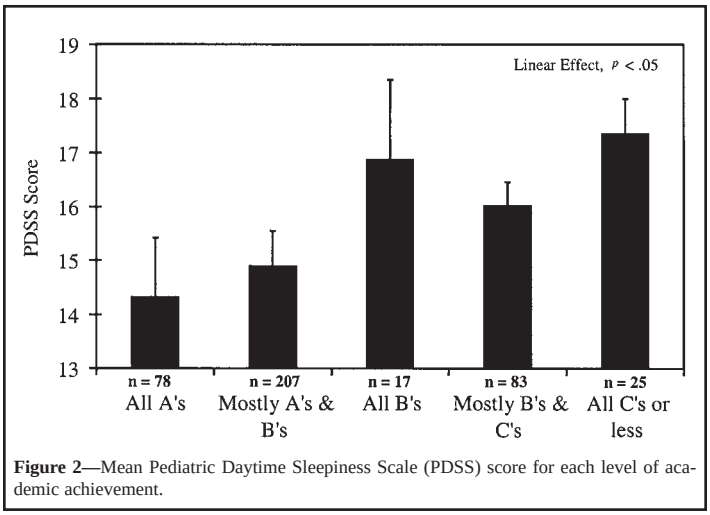

Figure 2—Mean Pediatric Daytime Sleepiness Scale (PDSS) score for each level of academic achievement.

its sound psychometric properties. The PDSS is easy to administer, score, and interpret. Thus, the PDSS provides a useful tool that may serve to broaden the ability of researchers, clinicians, parents, and teachers to assess sleepiness in middle-school-age children.

This study has several limitations that should be acknowledged. First, no time reference was included in the instructions to participants. Future research using the PDSS may benefit from including a reference to a specific timeframe, as utilized in similar questionnaires.[19,28] Also, the PDSS has not been directly compared to other sleep-related questionnaires suitable for this age group.[12-15] Although the response rates were high in the present study (80%-91%), administration to students in only one school limits the generalizability of our findings.

It is likely that reduced total sleep time contributed to sleepiness and poor academic achievement in this present study; however, the present work precludes any etiologic interpretation concerning sleep habits and school-related outcomes because other causes of excessive daytime sleepiness were not assessed (eg, sleep disorders, sedating medications, circadian phase delay or advance, etc.). These results add to the limited research regarding the sleep habits and school achievement of middle-school-age children. Future research aimed at determining the effect of adjusting school start times may provide additional insights regarding sleep habits and their direct effects on school-related outcomes and child development. Additional studies using objective measures of sleepiness (eg, MSLT) should investigate clinical samples as well as experimental manipulations of total sleep time to determine the sensitivity and specificity of the PDSS for identifying children with excessive daytime sleepiness.

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REFERENCES

1. Carskadon MA, Harvey K, Duke P, Anders TF, Litt IF, Dement WC. Pubertal changes in daytime sleepiness. Sleep 1980;2:453-60.
2. Carskadon MA. Patterns of sleep and sleepiness in adolescents. Pediatrician 1990;17:5-12.
3. Mercer PW, Merritt SL, Cowell JM. Differences in reported sleep need among adolescents. J Adolesc Health 1998;23:259-63.
4. Carskadon MA, Harvey K, Dement WC. Sleep loss in young adolescents. Sleep 1981;4:299-312.
5. Randazzo AC, Muehlbach MJ, Schweitzer PK, Walsh JK. Cognitive function following acute sleep restriction in children ages 10-14. Sleep 1998;21:861-8.
6. Wolfson AR, Carskadon MA. Sleep schedules and daytime functioning in adolescents. Child Dev 1998;69:875-87.
7. Dahl RE. The impact of inadequate sleep on children's daytime cognitive function. Semin Pediatr Neurol 1996;3:44-50.
8. Wahlstrom KL, Freeman CM. School start time study: technical report. Minneapolis, MN: Center for Applied Research and Educational Improvement; August 2001.
9. Epstein R, Chillag N, Lavie P. Starting times of school: effects on daytime functioning of fifth-grade children in Israel. Sleep 1998;21:250-6.
10. Carskadon MA, Wolfson AR, Acebo C, Tzischinsky O, Seifer R. Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. Sleep 1998;21:871-81.
11. Eliasson A, King J, Gould B. Association of sleep and academic performance. Sleep Breath 2002;6:45-8.
12. Owens JA, Spirito A, McGuinn M, Nobile C. Sleep habits and sleep disturbance in elementary school-aged children. J Dev Behav Pediatr 2000;21:27-36.
13. Carskadon MA, Seifer R, Acebo C. Reliability of six scales in a sleep questionnaire for adolescents. Sleep Research 1991;20:421.
14. Anders TF, Carskadon MA, Dement WC, Harvey K. Sleep habits of children and the identification of pathologically sleepy children. Child Psychiatry Hum Dev 1978;9:56-63.
15. Owens JA, Spirito A, McGuinn M. The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. Sleep 2000;23:1043-51.
16. Carskadon MA, Dement WC. Daytime sleepiness: quantification of a behavioral state. Neurosci Biobehav Rev 1987;11:307-17.
17. Carskadon MA, Dement WC, Mitler MM, Roth T, Westbrook PR, Keenan S. Guidelines for the multiple sleep latency test (MSLT): a standard measure of sleepiness. Sleep 1986;9:519-24.
18. Drake CL, Roehrs T, Burduvali E, Bonahoom A, Rosekind M, Roth T. Effects of rapid versus slow accumulation of eight hours of sleep loss. Psychophysiology 2001;38:979-87.
19. Johns MW. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. Sleep 1991;14:540-5.
20. Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. Sleep 1992;15:376-81.
21. Benbadis SR, Mascha E, Perry MC, Wolgamuth BR, Smolley LA, Dinner DS. Association between the Epworth Sleepiness Scale and the Multiple Sleep Latency Test in a clinical population. Ann Intern Med 1999;130:289-92.
22. Johns MW. Sleepiness in different situations measured by the Epworth Sleepiness Scale. Sleep 1994;17:703-10.
23. Johns MW. Daytime sleepiness, snoring, and obstructive sleep apnea. The Epworth Sleepiness Scale. Chest 1993;103:30-6.
24. Rosenthal L, Roehrs TA, Roth T. The sleep-wake activity inventory: a self-report measure of daytime sleepiness. Biol Psychiatry 1993;34:810-20.
25. Hoddes E, Zarcone V, Smythe H, Phillips R, Dement WC. Quantification of sleepiness: a new approach. Psychophysiology 1973;10:431-6.
26. Carskadon MA, Dement WC. The Multiple Sleep Latency Test: what does it measure? Sleep 1982;5:S67-72.
27. Sadeh A, Raviv A, Gruber R. Sleep patterns and sleep disruptions in school-age children. Dev Psychol 2000;36:291-301.
28. Johnson EO, Breslau N, Roth T, Roehrs T, Rosenthal L. Psychometric evaluation of daytime sleepiness and nocturnal sleep onset scales in a representative community sample. Biol Psychiatry 1999;45:764-70.

APPENDIX

Pediatric Daytime Sleepiness Scale (PDSS)

Please answer the following questions as honestly as you can by circling one answer only:

1. How often do you fall asleep or get drowsy during class periods?
Always Frequently Sometimes Seldom Never

2. How often do you get sleepy or drowsy while doing your homework?
Always Frequently Sometimes Seldom Never

*3. Are you usually alert most of the day?
Always Frequently Sometimes Seldom Never

4. How often are you ever tired and grumpy during the day?
Always Frequently Sometimes Seldom Never

5. How often do you have trouble getting out of bed in the morning?
Always Frequently Sometimes Seldom Never

6. How often do you fall back to sleep after being awakened in the morning?
Very often Often Sometimes Seldom Never

7. How often do you need someone to awaken you in the morning?
Always Frequently Sometimes Seldom Never

8. How often do you think that you need more sleep?
Very often Often Sometimes Seldom Never

Scoring	4	3	2	1	0

***Reverse score this item**