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Aggressive Behavior, Bullying, Snoring, and Sleepiness in Schoolchildren

Louise M. O'Brien, Ph.D.^{*,1,2}, Neali H. Lucas, Ph.D.¹, Barbara T. Felt, M.D.^{3,4}, Timothy F. Hoban, M.D.^{1,3}, Deborah L. Ruzicka, Ph.D.¹, Ruth Jordan⁵, Kenneth Guire, M.A.⁶, and Ronald D. Chervin, M.D., M.S.¹

¹Sleep Disorders Center, Department of Neurology; University of Michigan; Michigan

²Department of Oral & Maxillofacial Surgery; University of Michigan; Michigan

³Department of Pediatrics and Communicable Diseases; University of Michigan; Michigan

⁴Center for Human Growth and Development, University of Michigan; Michigan

⁵Ypsilanti Public Schools, Michigan

⁶Department of Biostatistics, School of Public Health, University of Michigan

Abstract

Background—To assess whether urban schoolchildren with aggressive behavior are more likely than peers to have symptoms suggestive of sleep-disordered breathing.

Method—Cross-sectional survey of sleep and behavior in schoolchildren. Validated screening assessments for conduct problems (Connor's Rating Scale), bullying behavior, and sleep-disordered breathing (Pediatric Sleep Questionnaire) were completed by parents. Teachers completed Connor's Teacher Rating Scale.

Results—Among 341 subjects (51% female), 110 (32%) were rated by a parent or teacher as having a conduct problem (T-score ≥ 65) and 78 (23%) had symptoms suggestive of sleep-disordered breathing. Children with conduct problems, bullying, or discipline referrals, in comparison to non-aggressive peers, more often had symptoms suggestive of sleep-disordered breathing (each $p < .05$). Children with vs. without conduct problems were more likely to snore habitually ($p < .5$). However, a sleepiness subscale alone, and not a snoring subscale, predicted conduct problems after accounting for age, gender, a measure of socioeconomic status, and stimulant use.

Conclusions—Urban schoolchildren with aggressive behaviors may have symptoms of sleep-disordered breathing with disproportionate frequency. Sleepiness may impair emotional regulation necessary to control aggression.

Keywords

schools; aggression; conduct disorder; bullying; sleep apnea; obstructive

*Corresponding Author/Reprint Requests: Louise M. O'Brien, Ph.D. Michael Aldrich Sleep Disorders Laboratory C728 Med Inn, Box 5845, 1500 East Medical Center Drive Ann Arbor, MI 48109-0845 Phone: 734-647-9064; FAX: 734-647-9065; louiseo@med.umich.edu.

Introduction

Aggressive behaviors are common among children and present a major challenge at schools. Conduct problems include destructive tendencies, quarreling, constant fighting, disobedience, and other related behaviors. Children who bully are often diagnosed with conduct disorder, affecting 2–9% of U.S. children.^{1, 2} Societal concern about aggressive behaviors has risen exponentially, as reflected by new local, state, and national programs to address it.^{3–5} The prevalence of such behavior among elementary schoolchildren is approximately 25%,^{6, 7} and higher in boys.⁸ Children who bully are at risk for later psychiatric symptoms, delinquency, substance abuse, antisocial behavior, violence, and criminal activity,^{9, 10} while childhood victims of bullying suffer impaired self-image, depression, and decreased quality of life.¹¹ Aggression, violence, and related problems are particular concerns in urban, low-income communities with a high representation of minority residents.¹² Causes of aggressive behaviors are heterogeneous and include well-studied social and cultural underpinnings. Strategies to address these challenges could benefit if understanding of their childhood antecedents could be improved.

One possible biological contributor to aggressive behaviors may be sleep-disordered breathing (SDB), a spectrum that includes habitual snoring at one end and obstructive sleep apnea at the other. Frank sleep apnea is estimated to affect 1–4% of young children¹³ and is characterized by repeated partial or complete upper airway obstruction during sleep, disruption of normal ventilation, hypoxemia, and sleep fragmentation. Sleep-disordered breathing has shown a robust association with hyperactive and inattentive behavior in multiple studies,^{14–18} and an early clinical series reported high frequencies of aggressive behavior in children referred for SDB.¹⁹ One cross-sectional study of 2–14 year-old children in general pediatric clinics found that even after adjustment for hyperactivity and stimulant use, children with SDB symptoms (e.g., habitual snoring), in comparison to others, were still more likely to be rated as bullies, constant fighters, quarrelsome, or cruel.²⁰ These observations are particularly important because childhood SDB, most often occult,²¹ can be readily diagnosed and treated. Furthermore, behavioral problems may improve substantially after SDB treatment, usually by adenotonsillectomy.^{22–25} However, whereas several studies have focused on aggressive behavior in referred children with and without SDB, none have examined SDB risk in a broader group of school-aged children with and without aggressive behavior. The extent to which aggressive behaviors may be explained by generally occult SDB in elementary schoolchildren, especially in urban community settings, remains largely unstudied, and was therefore the main question in this cross-sectional survey.

Methods

This study was approved by the Institutional Review Board and the School Board. The city of Ypsilanti, in Southeast Michigan, comprises about 24,000 people, including large numbers of immigrants and minorities. Approximately 30% of children live below the poverty line (US Census 2000), 52% of students are male and 58% qualify for school lunch assistance. The racial distribution is 63% African American and 30% Caucasian²⁶. In May 2006, parents of children in grades 2–5 of the Ypsilanti Public School System were mailed a letter describing the study; a consent form; and surveys about their child's sleep and behavior. On receipt of the completed surveys and written consent to obtain information from teachers, the latter were asked to complete a behavior rating scale for each subject. Families who participated received a \$20 gift card and teachers received a \$10 book token. The second and fifth grades were chosen for this study because second graders are at an age when adenotonsillar hypertrophy is typically prominent, fifth graders have had an additional 3 years to develop any consequences of SDB, and objective performance assessments were available for all students in these two grades.

Measures

The survey included demographic information (qualification for the school lunch assistance program was used as a proxy for socioeconomic status), followed by the sleep-related breathing disorder (SRBD) scale of the Pediatric Sleep Questionnaire²⁷ and the 48-item Conners' Parent Rating Scale²⁸. Teachers completed the Conners' Teacher Rating Scale²⁹ and items from the brief Child Social Behavior Rating Scale,³⁰ which includes a question about bullying. Teachers were asked to provide the number of discipline referrals each child received.

Pediatric Sleep Questionnaire SRBD Scale

The SRBD scale, validated in children aged 2–18 years, contains 22 items about snoring, sleepiness, and inattentive/hyperactive behaviors.²⁷ Responses are “yes”=1, “no”=0, or “don't know” (considered missing). The mean response on non-missing items is the total score. A threshold of 0.33, indicating that 33% of symptom-items are positive, is considered a positive screen for pediatric SDB.²⁷ Since its development, this scale has been used in a variety of research settings^{21, 31–36} and has been translated to other languages.³⁷ For the purposes of this study responses to the 6 behavioral items were not included in the scoring to avoid artificial associations with bullying behaviors. The question-item concerning habitual snoring (“Does your child snore more than half the time?”) was examined separately.^{20, 38}

4-item snoring subscale

This subscale comprises the following questions: While sleeping does your child 1) snore more than half the time?; 2) always snore?; 3) snore loudly?; 4) have “heavy” or loud breathing? and was scored as described above.

4-item sleepiness subscale

This is the only subjective pediatric measure validated against sleep laboratory tests for daytime sleepiness,³⁴ and includes the following questions: Does your child 1) wake up feeling un-refreshed in the morning?; 2) have a problem with sleepiness during the day?; 3) Has a teacher or other supervisor commented that your child appears sleepy during the day?; 4) Is it hard to wake your child up in the morning?. Scoring was as described above.

Conners' Parent Rating Scale (CPRS)

This well-validated tool identifies behavioral problems in children aged 3–17 years.²⁸ Each question is rated from 0–3, where 0=not true at all, 1=just a little, 2=pretty much, and 3=very much. The short version yields six factors: Conduct Problem, Learning Problem, Psychosomatic, Impulsive-Hyperactive, Anxiety, and Hyperactivity Index, all with an age and gender-adjusted mean T-score of 50 and a standard deviation (SD) of 10. This CPRS version (1989)²⁸ was used specifically because of a question-item on bullying, which does not appear in a more recent version (2002).³⁹

Conners' Teacher Rating Scale (CTRS)

This tool has been validated in children aged 3–17 years.²⁹ Each of 28 items asks for a rating from 0–3, where 0=not true at all, 1=just a little, 2=pretty much, and 3=very much. It yields four factors: Conduct Problem, Hyperactivity, Inattentive-Passive, Hyperactivity Index. All indices have a mean T-score of 50 and SD of 10.

Teacher Rating of Bullying Behavior and Discipline Referrals

As the CTRS does not inquire directly about bullying, teachers were asked to complete the Teacher's Aggression Rating Subscale from the Child Social Behavior Rating Scale.³⁰ One

item asked whether each child “threatens or bullies other children”, with responses 1=never, 2=hardly true, 3=sometimes true, 4=usually true, 5=almost always true. Teachers were also asked how many discipline referrals each child received in the academic year just ending. These referrals are generally for disruptive behavior at school. Children were classified as having disruptive behavior if they had ≥ 2 discipline referrals.

Identification of Children with Behavioral Problems

A conduct problem was considered present if the conduct problem domain on either the CPRS or the CTRS was ≥ 1.5 SD above the mean (T-score ≥ 65). Cut points of 2 SD or 1.5 SD are most commonly used; we chose 1.5 SD in this study to identify the maximum possible number of children whose behavior might be influenced in full or partial form by SDB. Similarly, bullying behavior was considered present if a parent endorsed the CPRS question-item, “Bullies others”, with either “pretty much” or “very much”, or if a teacher endorsed the item “threatens or bullies other children”, with either “usually true” or “almost always” true.

Analysis

All data were double-entered to ensure accuracy. Analyses were performed with SPSS, version 15. The main outcome variable was the presence of a conduct problem. Secondary analyses focused on question-items about bullying. Explanatory variables were provided by the SRBD score and its components. Demographic information was compared using T-tests or Chi-squared tests. Logistic regressions were used to model the conduct problem T-score (high vs. not high) or bullying behavior (present vs. absent) on SRBD score, snoring score, sleepiness score, or habitual snoring after controlling for potential confounds. Age, gender, and qualification for a school lunch assistance program were used as covariates, as they could confound associations between SDB and behavior.⁴⁰ All tests were two-tailed and were considered statistically significant if $p < 0.05$.

Results

A total of 1,221 families were approached, and parents of 341 children (28%) completed the surveys. The mean age of the sample was 9.0 ± 1.3 years and 167 (49%) were male. Information about height and weight that enabled calculation of body mass index (BMI) was available for 236 (69%) of the children and was therefore not entered into the statistical models shown below. However, addition of BMI did not appreciably alter the results. Mean BMI was $19.7 \pm 5.7 \text{ kg/m}^2$. The racial and ethnic composition of the sample was 41% Caucasian, 37% African American, 15% bi-or multi-racial, 3% Hispanic, 2% Asian, and 1% American Indian. The remaining participants (1.5%) declined to report their race. There was no significant difference in the proportion of African Americans who screened positive for SDB compared to Caucasians (27% vs. 21%; $p = 0.25$). Adding ethnicity to the models presented below did not alter the relationship with any of the outcomes. Stimulant use was reported in 7.5% of subjects. Teacher rating scales were completed for 240 (70%) participants.

Seventy-eight children (23%) were reported to snore more than half the time and were sleepier than those without habitual snoring (mean sleepiness score 1.5 ± 1.3 vs. 0.8 ± 1.1 ; $p < 0.001$). Scores on the sleepiness scale were correlated with scores on the snoring scale after adjusting for covariates ($p < 0.001$).

Conduct Problem

Seventy-three (21%) of 341 children were rated by parents as having a conduct problem while 57 (24%) of 240 were rated by teachers as having a conduct problem. Among the

latter 57 children, 20 (35%) were rated by both a parent and a teacher. Overall, 110 children were classified as having a conduct problem by either parents *or* teachers (32% of 341).

Children with conduct problems were more likely to screen positive for SDB than those without (30% vs. 14%, $p<0.001$; Table 1). Logistic regression of conduct problem (yes/no) on SRBD score, including covariates, found that SRBD score independently predicted conduct problems ($p=0.001$; O.R. 8.9 [95% C.I. 2.5–31.3]).

In regressions of conduct problems on the snoring score or the question about habitual snoring, neither measure of snoring predicted conduct problems. In contrast, in regressions of conduct problems on the sleepiness score, after controlling for covariates, the sleepiness score independently predicted conduct problems ($p<0.001$; O.R. 1.6 [1.3–1.9]). Regression of conduct problems on the snoring score and sleepiness score simultaneously showed that the sleepiness - but not snoring - score independently predicted conduct problems (Table 2). Results did not change appreciably after use of stimulant medications was also taken into account, though stimulants did predict conduct problems independently ($p=0.005$; O.R. 4.3 [1.6–12.0]).

Bullying

Twenty-six (7.6%) children exhibited bullying behavior according to parents; 14 (5.8%) according to teachers; and 3 (1.3%) according to both. Children classified as having bullying behaviors by either parents *or* teachers numbered 40 (12% of 341). These children appeared more likely to have SDB but this did not reach statistical significance (30% vs. 18%; $p=0.12$). Similarly, separate regression models of SRBD score, snoring score, sleepiness score, and the question-item about habitual snoring, controlling for covariates, failed to show any sleep variable as a predictor of bullying behaviors.

The analyses were then repeated using separate regression models of parent-identified and teacher-identified bullying behaviors on the same variables described above:

Parent-identified bullying behavior—Children with parent-identified bullying behaviors, in comparison to the remaining subjects, were more likely to have high SDB risk (42% vs. 17.5% respectively; $p=0.007$). The SRBD score showed a significant dose-response relationship with severity of parent-identified bullying behaviors ($p=0.001$; Figure 1).

In a logistic regression of parent-identified bullying behaviors (yes/no) on SRBD score, controlling for covariates, the SRBD score independently predicted bullying behaviors ($p=0.014$; O.R. 9.7 [1.6–59.4]; Table 3). In similar regressions on the snoring score or the snoring question, neither snoring measure predicted bullying. In contrast, sleepiness independently predicted bullying behaviors ($p=0.037$; O.R. 1.4 [1.0–1.9]). When use of stimulants was added, it was the only significant predictor of parent-identified bullying ($p=0.003$; O.R. 5.7 [1.8–17.9]).

Teacher-identified bullying behaviors—Children with teacher-identified bullying behaviors were not more likely than those without these behaviors to have SDB (14% vs. 19% respectively; $p=N.S.$). In separate logistic regression models of teacher-identified bullying behaviors (yes/no) on SRBD score, snoring score, sleepiness score, or habitual snoring (controlling for covariates), none of the sleep variables proved significant. The only significant predictor in all models was qualification for school lunch (O.R. approximately 5 [1, 25]; $p<0.05$).

Discipline Referrals

Teachers gave information on discipline referrals for 198 children. Thirty-three (17%) children had had 2 referrals. These children, in comparison to others, were older (9.9 ± 1.1 years vs. 8.9 ± 1.3 years; $p < 0.001$), had higher SRBD scores (0.26 ± 0.18 vs. 0.17 ± 0.18 ; $p < 0.05$), and were sleepier (1.59 ± 1.24 vs. 0.92 ± 1.16 ; $p < 0.001$). A larger proportion of children with 2 referrals screened positive for SDB (27% vs. 16%; $p = 0.14$) although this did not quite reach statistical significance. However, regression of discipline referrals (< 2 vs. ≥ 2) on SRBD score, controlling for covariates, showed that the SRBD score did independently predict discipline referrals ($p = 0.033$; O.R. 10.8 [1.2–95.6]; Table 4).

In regressions of discipline referrals on the snoring score or habitual snoring alone, along with covariates, neither snoring measure predicted the outcome. In contrast, regression of discipline referrals on the sleepiness score showed that sleepiness did independently predict discipline referrals ($p = 0.02$; O.R. 1.5 [1.1–2.1]; see Table 4). Results did not change appreciably after stimulant use was taken into account.

Discussion

This cross-sectional study in an urban public school district found that schoolchildren with conduct problems or school discipline referrals, in comparison to peers, have increased symptoms of SDB. The results were robust, in that high SDB risk on a well-validated questionnaire was twice as common among children with symptoms of conduct problems, as compared to children without. However, sleepiness rather than a symptom more specific to SDB -- snoring -- appeared to drive the association between SDB risk and aggressive behaviors. Parent-reported bullying, though not teacher-reported bullying, showed similar associations with SDB symptoms. Our study was cross-sectional and cannot prove causality, but dose-response findings were consistent with the hypothesis that SDB, and sleepiness in particular, could contribute to conduct problems in schoolchildren. Although previous literature has reported aggressive behavior as a possible symptom of SDB^{17, 19, 20}, we now suggest more broadly that common and frequently unrecognized daytime sleepiness, related perhaps in some but not all cases to SDB, could underlie a sizeable portion of aggressive behaviors within urban public schools.

If sleepiness does contribute to aggressive behavior, then calculation of the population attributable risk percentage from our data suggests that 39.5% of conduct problems in the population we studied could be ameliorated by eliminating sleepiness. The latter proportion is somewhat higher than the population attributable risk proportion that can be calculated from a previous study that used the same 4-item sleepiness scale (29%;⁴¹), but the current study targeted exclusively children from an urban school system rather than a more mixed sample from pediatric clinics. Lower socioeconomic status and lower maternal educational level are both associated with poor sleep hygiene in children⁴², and more than half (58%) of children in the present sample received school lunch assistance, which suggests lower socioeconomic status.

In our study, conduct problems and discipline referrals were associated with sleepiness even after adjustment for snoring and other confounders. The possibility that sleepiness may provide a mechanistic link between a nocturnal sleep disorder and daytime aggression is also supported by previous observations. Slowing of the EEG, which could reflect sleepiness, has been noted in aggressive children.⁴³ Interestingly, longitudinal studies have suggested that EEG slowing may predict future criminality.⁴⁴

Inadequate sleep in children, whether due to poor sleep hygiene, sleep restriction, or an underlying sleep disorder, is associated with a wide range of behavioral, cognitive, and

mood impairments⁴⁵. Many young children in urban settings do not obtain enough sleep, probably for a variety of reasons that can include family schedules, chaotic living arrangements, nocturnal use of electronics in the bedroom, or after-school activities⁴⁶. If sleepiness does facilitate aggressive behavior, impairment of pre-frontal cortical function is likely the reason. The prefrontal cortex is the main generator of slow EEG waveforms and this brain region is among the most sensitive to sleep disruption.¹⁸ It plays a critical role in emotional control, decision making, and social behavior. Impairment of any of these functions could promote aggression.⁴⁷ Neuropsychological studies of adolescents and adults indicate that aggressive behavior is associated with impairment in executive function.⁴⁸ Children subjected to sleep deprivation show deficiencies in executive functioning, regulation of impulsivity, and emotional control.^{47, 49} Insufficient or short sleep may play a role in ADHD.^{50, 51} A modest but chronic reduction by 1 hour of sleep in early childhood is associated with worse cognitive performance at school entry, and higher hyperactivity scores despite improved and stable sleep duration between the ages of 3–6 years.⁵² A critical window during development may create vulnerability to lack of sleep, with detrimental consequences even if sleep duration subsequently improves.

Anatomical and physiological alterations have also been reported in aggressive individuals. Lesions of prefrontal cortical areas can disinhibit aggressive behaviors⁵³ and individuals with frontal lobe damage sometimes use physical intimidation and threatening behaviors in conflict situations.⁵⁴ Reductions in prefrontal grey matter have been reported in people with antisocial behavior and borderline personality disorder.⁵⁵ Functional neuroimaging suggests deficient prefrontal activity in both sleep-deprived and aggressive individuals.^{56, 57} Furthermore, aggressive children display altered levels of autonomic responses. Low resting heart rate is a robust finding in aggressive children,^{58, 59} who also have high levels of autonomic reactivity to stressful situations.⁶⁰

Accumulating evidence suggests that hyperactive children are sleepier than their peers.^{38, 61} Use of stimulant medications improves behavior; the paradoxical effect of stimulants also supports the hypothesis that underlying sleepiness could play a critical role in behavioral manifestations. Similarly, stimulants may help rather than exacerbate conduct disorder in children.⁶²

Evidence is growing to support the idea that SDB may cause or contribute to disruptive behavior disorders. Hyperactive and inattentive behavior is robustly associated with SDB symptoms^{15, 17, 38} and follows SDB symptoms in longitudinal studies.⁶³ Follow-up assessments after treatment for SDB have documented improvement in disruptive behaviors.²⁵ A randomized-controlled clinical trial is now underway to determine whether expedited adenotonsillectomy for SDB, in comparison to watchful waiting, improves attention and other neurobehavioral outcomes at 6 months. Interestingly, several studies suggest that hyperactive behavior in childhood may be a precursor of later aggression.^{64, 65}

A limitation of our study was the inability to recruit more than 30% of students. This level of participation is significantly higher than a previous study in the same school district⁴⁰ and is commendable for a public school survey in an urban area. In comparison to other published mailed survey studies requiring active consent in urban settings, our participation was similar or better^{66, 67}. Although selection bias may nonetheless have influenced our findings, associations between variables, as we report, should be less vulnerable to such biases than raw prevalence estimates. Other limitations include that a questionnaire, though previously validated against polysomnography, was used to assess SDB risk. No other studies to date have applied full polysomnography in children with conduct disorder. The population attributable risk percentage noted above is presented as an approximation only, as the present study was not a true epidemiological sample. Additional limitations include

the inconsistency between parent and teacher reports of behaviors. The small number of children who were reported to bully or have conduct problems by both parents *and* teachers made it impossible to use dually confirmed definitions for analysis. However, these disparities were not unexpected. Multiple studies have found inconsistent relationships using teacher reports of behavior^{22, 68} but robust associations using parental reports.⁶⁹ Finally, sleepiness can occur for many reasons, and the present study was designed to assess SDB risk using a composite of snoring and sleepiness scores, rather than all possible causes of sleepiness. Actigraphy or other objective measures of sleep quantity were not used.

Nonetheless, our data now raise the possibility that sleepiness, whether or not caused by SDB, could play an important role in aggressive behavior among schoolchildren.. Given the high prevalence of aggressive, bullying, and disruptive behaviors in schools, and long-lasting consequences for both perpetrators and victims, identification of modifiable biological contributors should be a high priority. Our findings do not prove a cause-and-effect relationship, but raise the possibility that addressing the underpinnings of childhood sleepiness may offer a largely untapped opportunity to reduce the common problem of aggressive behavior in schoolchildren.

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ANOVA: $F(5.3)$ $p=0.001$

1. .
Association between SRBD score and severity of parent-identified bullying behaviors (mean $\pm$ 95% Confidence Intervals)

Table 1

Demographic and other data for children with and without conduct problems

	Conduct Problems (n=110)	No Conduct Problems (n=231)
Age (years)	9.0±1.3	9.0±1.3
Male (%)	49%	49%
BMI (kg/m ²)	20.3±6.1	19.4±5.6
African American (%)	44.5% ¶	33%
SRBD-scale score	0.25±0.19 **	0.16±0.18
High SRBD score (%)	30% **	14%
Snoring subscale	0.92±1.16 *	0.60±1.11
Sleepiness subscale	1.52±1.38 **	0.79±1.02
Snores > half time (%)	31% *	20%
Stimulant medications (%)	16% **	4%
School lunch program (%)	73% **	50%

*
p<0.05;**
p<0.001;¶
p=0.06

Table 2

Logistic regression of conduct problem (present vs. absent) on snoring score, sleepiness score, and three covariates.

	Explanatory Variables				Total Model	
	Beta	SE	p-value	O.R [95%C.I]	100 × R ²	p-value
Age	−0.061	0.102	0.55	0.94 [0.77–1.15]	14.8	<0.001
Male Gender	0.071	0.258	0.78	1.07 [0.65–1.78]		
Subsidized lunch	0.849	0.277	0.002	2.34 [1.36–4.03]		
Sleepiness subscale	0.425	0.113	<0.001	1.53 [1.23–1.91]		
Snoring subscale	0.080	0.114	0.48	1.08 [0.87–1.35]		

Table 3a

Logistic regression of parent-identified bullying behavior on SRBD score and 3 covariates.

	Explanatory Variables			Total Model	
	Beta	SE	p-value	100 × R ²	p-value
Age	0.039	0.166	0.820	7.4	0.03
Male Gender	−0.181	0.420	0.670		
Subsidized lunch	0.791	0.491	0.107		
SRBD-scale score	2.272	0.925	0.014		

Table 3b

Regression of parent-identified bullying behavior on sleepiness score and 3 covariates.

	Explanatory Variables			Total Model	
	Beta	SE	p-value	100 × R ²	p-value
Age	0.029	0.167	0.860	6.5	0.05
Male Gender	−0.227	0.418	0.590		
Subsidized lunch	0.743	0.496	0.134		
Sleepiness score	0.333	0.160	0.037		

Table 4a

Logistic regression of discipline referrals (2 vs. <2) on SRBD score and three covariates.

	Explanatory Variables			Total Model	
	Beta	SE	p-value	100 × R ²	p-value
Age	0.606	0.180	0.001	29.8	<0.001
Male Gender	−0.725	0.442	0.101		
Subsidized lunch	1.849	0.578	0.001		
SRBD-scale score	2.378	1.114	0.033		

Table 4b

Logistic regression of discipline referrals (2 vs. <2) on sleepiness score and three covariates.

	Explanatory Variables			Total Model	
	Beta	SE	p-value	100 × R ²	p-value
Age	0.698	0.195	0.000	34.1	0.000
Male Gender	−0.701	0.454	0.122		
Subsidized lunch	2.105	0.652	0.001		
Sleepiness score	0.405	0.177	0.022		