

SCIENTIFIC INVESTIGATIONS

Adolescent Sleep Disturbance and School Performance: The Confounding Variable of Socioeconomics

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Study Objectives: To assess how selected socioeconomic variables known to affect school performance alter the association between reported sleep disturbance and poor school performance in a contiguous middle school/high school population.

Methods: A school district/college IRB approved questionnaire was distributed in science and health classes in middle school and high school. This questionnaire included a frequency scaled pediatric sleep disturbance questionnaire for completion by students and a permission and demographic questionnaire for completion by parents (completed questionnaires n=238 with 69.3% including GPA).

Results: Sleep complaints occur at high frequency in this sample (sleep onset insomnia 60% > 1 x /wk.; 21.2% every night; sleepiness during the day (45.7% > 1 x / wk.; 15.2 % every night), and difficulty concentrating (54.6% > 1 x / wk.; 12.9% always). Students with lower grade point averages (GPAs) were more likely to have restless/aching legs when trying to fall asleep, difficulty concentrating during the day, snoring every night, difficulty waking in the morning, sleepiness during the day, and falling

asleep in class. Lower reported GPAs were significantly associated with lower household incomes. After statistically controlling for income, restless legs, sleepiness during the day, and difficulty with concentration continued to significantly affect school performance.

Conclusions: This study provides additional evidence indicating that sleep disturbances occur at high frequencies in adolescents and significantly affect daytime performance, as measured by GPA. The socioeconomic variable of household income also significantly affects GPA. After statistically controlling for age and household income, the number and type of sleep variables noted to significantly affect GPA are altered but persistent in demonstrating significant effects on school performance.

Keywords: Adolescent, sleep, income, sleepiness, restless legs, insomnia

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Adolescents reporting inadequate sleep, irregular sleep patterns, and/or poor sleep quality do not perform as well in school as students without sleep complaints.^{1,2} This finding is supported by a series of studies from 1989 to 2005 analyzing the association of academic performance with a variety of sleep variables.^{1,3-7} The majority of these studies define academic performance as self-reported grade point average (GPA).^{1,3,4,7} Students with lower GPAs report a higher frequency of daytime sleepiness.⁶ Indicators of poor sleep, such as sleep latency (SL) > 30 minutes, and more than one complete arousal or awakening per night at least 2 nights/week (as per questionnaire) are associated with an increase in school failure rates.⁵ Reported insomnia and daytime sleepiness have been found to be significantly more common in students with low school performance.⁶ Better school performance is associated with more time in bed, better sleep qual-

ity, fewer nighttime arousals, less napping, and less difference between weekday and weekend sleep times.⁴⁻⁸ These findings are supported by laboratory studies that demonstrate negative effects for sleep deprivation, sleep restriction, and sleepiness on laboratory measures of motor skill, memory, attention, and problem solving in children and adolescents.⁹⁻¹² These studies are limited, however, by their focus on the association of sleep disturbance with poor school performance.

Lower family income, low maternal education, and family dysfunction have been found to have significant correlates with poor school performance.^{13,14} Youth from homes in which the adults are employed in low-income occupations are more likely to have lower levels of school performance.¹⁵ Parental income also has an effect on general academic test performance. Mean scores on the Medical College Admission Test and the United States Medical Licensing Examination – Step 1 significantly correlated with parental income, independent of ethnicity and sex.¹⁶

Sleep disturbance has also been shown to significantly increase with a decline in socioeconomic status. Lower levels of education and household income were significantly correlated with reported insomnia in a large Canadian study (n = 11,924) that included adolescents.¹⁷ Marital conflict has been shown to disrupt both the quality and quantity of children's sleep.¹⁸ Low family income and divorce, separation, or loss of parent were found to be significant correlates for reported sleep difficulty and the use of sleeping medications in a United States population study (n=5622).¹⁹

Disclosure Statement

This was not an industry supported study. Drs. Pagel, Forister, and Kwiatkowi have indicated no financial conflicts of interest.

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Table 1—Frequencies for All Demographic Variables (n=165)

Variable	N	Percent or Mean \pm SD
Grade Point Average	165	
≤ 2.49	31	18.8%
2.5 through 2.99	22	13.3%
3.0 through 3.49	31	18.8%
≥ 3.5	81	49.1%
Age	165	14.15 \pm 1.48
Body Mass Index	141	21.64 \pm 4.37
Grade	165	
6	26	15.8%
7	23	13.9%
8	49	29.7%
9	33	20.0%
10	23	13.9%
11	11	6.7%
Sex	165	
Female	84	50.9%
Male	81	49.1%
Ethnicity	155	
Hispanic	84	54.2%
White	56	36.1%
Other	15	9.7%
Parental marital status	149	
Single	48	32.2%
Married	76	51.0%
Divorced, separated, or widowed	25	16.8%
Parents combined income	127	
Under \$49,999	66	52.0%
\$50,000-\$74,999	25	19.7%
\$75,000 or more	36	28.3%
Number of children in household	155	2.66 \pm 1.29
Number of people in household	156	4.63 \pm 1.51
Schoolday bedtime	126	
8-8:45 p.m.	6	4.8%
9-9:45 p.m.	39	31.0%
10-10:45 p.m.	59	46.8%
11-11:45 p.m.	22	17.5%
Schoolday up time	165	
Before 6:00 a.m.	18	10.9%
6-6:29 a.m.	55	33.3%
6:30-6:59 a.m.	67	40.6%
7:00 a.m. or later	25	15.2%

A Brazilian study (n=1221) found significant correlation between lower family income and prevalence of reported insomnia and daytime sleepiness.²⁰

This study assesses the frequency of sleep-associated complaints in a contiguous middle school/high school population and the association of those complaints with school performance as assessed by self-reported GPA. Socioeconomic variables assessed in this population included household income, number of children in household, ethnicity, number of individuals in household, and marital status of parents. The effects of these variables on school performance are addressed to determine if the expected association of adolescent sleep disturbance with lower school performance still exists after controlling for socioeconomic effects.

METHODOLOGY

The research methodology and questionnaire used in this study were approved by the research IRB at Colorado State University

– Pueblo and by the school board for the school district studied. This questionnaire was distributed in science and health classes at two contiguous and associated middle and high schools in Pueblo Colorado near the end of the 2005 school year. This questionnaire included a frequency scaled pediatric sleep disturbance questionnaire based on validated and indexed questions^{21,22} for completion by students (Table 1), and a permission and demographic questionnaire for completion by parents. Students responded to the sleep questions using the following 5 point scale: 1 = Never; 2 = Rarely/Once a month; 3 = Sometimes/Once a week; 4 = Occasionally/ Twice a week; 5 = Always/Every night. In order to simplify interpretation of the data and reduce categories with small numbers of responses, we aggregated the sleep data in two different ways. First, we compared Categories 3-5 to Categories 1 and 2 to differentiate those who reported having the sleep problem at least once a week from those who had it less often. Second, we separated Category 5 (“every night”) from the rest of the categories in order to identify students with the most severe sleep problems.

In preliminary analyses we determined that the GPA variable was not normally distributed, therefore, GPA data were categorized into 4 groups: 2.49 or less; 2.5 through 2.49; 2.5 through 2.99; 3 through 3.49; and 3.5 or higher. Of 500 distributed questionnaires, completed questionnaires were received from 238 students (response rate 47.6%) with 165/238 (69.3%) including a reported GPA that could be utilized for the statistical analysis of this study.

In order to assess whether those who provided GPA data were different from those who did not, chi-square tests were run on all the sleep variables, comparing the 165 with GPA data with the 73 without it. None of the sleep variables were significantly different for the two groups, allowing us to infer that our conclusions are most likely valid for the entire sample. The following analysis reports results from the 165 who did report their GPA. The analysis includes descriptive information on all demographic and sleep variables, followed by univariate analyses (chi-square and ANOVA) of the relationship between those variables and GPA. Finally, separate logistic regression analyses were run using each sleep variable as a dichotomous dependent variable in order to assess the relationship between sleep variables and GPA while controlling for significant demographic variables.

RESULTS

Frequencies for the 4 categories of GPA are as follows: 2.49 or lower=18.8%; 2.5 through 2.99 = 13.3%; 3 through 3.49 = 18.8%; 3.5 or higher = 49.1%.

Table 1 presents frequencies for the demographic variables for all students providing GPA data. Over half of the students had GPAs of 3.5 or higher. Age averaged 14 years, and the average body mass index was 21.64. The sample of students was normally distributed across the 6 grades assessed. Half were male; over half were Hispanic, and most of the remainder were white. Half of them reported that their parents were married and half had a combined parental income under \$49,000. They averaged 4-5 people in their household with 2-3 of them being children. Schoolday bedtimes were normally distributed between 8pm and 11:45pm. Schoolday wake times were normally distributed between 6 a.m. or earlier and 7 a.m. or later.

Table 2 presents frequencies for sleep variables completed by

Table 2—Frequencies for Sleep Variables (n=165)

Variable	Total n	Percent responding “At least once a week” or more ¹	Percent responding “Always/Every night”
Do you have difficulty falling asleep	165	60.0	21.2
Do you have restless/aching legs when falling asleep	165	25.5	5.5
Do you snore	160	25.6	10.0
Do you stop breathing or have trouble breathing when sleeping	162	3.7	0.0
Do you have leg kicks or twitches at night	165	34.5	10.3
Do you wake at night and have trouble falling back to sleep	165	33.9	10.3
Is it hard to wake up in the morning	165	72.7	37.0
Do you wake unrefreshed/tired in the morning	164	82.3	36.0
Do you have trouble with sleepiness during the day	164	45.7	15.2
Do you fall asleep in class	165	16.4	3.0
Do you have difficulty concentrating during the day	163	54.6	12.9
Do you take naps	164	43.3	6.7
Do you take sleep or alerting medications	165	4.2	1.2

¹Note that this column includes responses from those responding ‘every night’.

Table 3—Variables Associated (p<.10) With GPA (n=165)¹

	Grade Point Average				Chi-square or F-test ²	p-value
	≤2.49	2.5-2.99	3-3.49	≥3.5		
Demographic Variables						
Household income					28.84	<.001
Under \$49,999	76.9%	33.3%	72.7%	39.3%		
\$50-74,999	19.2%	44.4%	13.6%	14.8%		
\$75,000 or more	3.8%	22.2%	13.6%	45.9%		
Average age	14.71	14.36	14.03	13.93	2.36	.074
Sleep Variables						
‘At least once a week’ or more						
Do you have restless/aching legs when falling asleep?	35.5%	31.8%	41.9%	13.6%	12.57	.006
Do you have difficulty concentrating during the day?	70.0%	81.8%	45.2%	45.0%	13.53	.004
Do you fall asleep in class?	25.8%	31.8%	6.5%	12.3%	9.04	.029
‘Always/Every night’						
Do you have restless/aching legs when falling asleep?	12.9%	13.6%	6.5%	0.0%	10.92	.012
Do you have difficulty concentrating during the day?	26.7%	18.2%	19.4%	3.8%	12.73	.005
Do you snore?	13.8%	18.2%	19.4%	2.6%	9.91	.019
Is it hard to wake up in the morning?	48.4%	50.0%	41.9%	27.2%	7.01	.072
Do you have trouble with sleepiness during the day?	29.0%	19.0%	16.1%	8.6%	7.55	.056

¹This table shows column percents, for example, 35.5% of those with a GPA of 0-2.49 have restless legs, compared to only 13.6% of those with a GPA of 3.5 or higher who have restless legs.

²Chi-sq□

the students, using both of the previously described categorization schemes. In addition to the sleep problems reported in Table 2, students were asked if they felt that they got enough sleep. Out of 165 responses, 22.4% of the students reported that they never got enough sleep, and 8.5% reported that they rarely got enough sleep.

Statistical tests (Chi-square and ANOVA) were run to compare all the variables reported in Tables 1 and 2 with GPA. Demographic and sleep variables that were significantly associated with GPA (p<.10) are reported in Table 3. A lenient significance cutoff was used in reporting these relationships in order to present all the variables that would be included in the subsequent logistic regression model (which typically uses a more lenient inclusion criteria for model building).

In general, students with lower GPAs were older and report-

ed lower household incomes than students with higher GPAs, although the relationship between income and GPA is complex and not linear. When the sleep variables were assessed by the “at least once a week” categorization method, 3 sleep variables were significantly related to GPA. Although again the relationship is complex, those with the highest GPAs were less likely to have restless/aching legs when trying to fall asleep, difficulty concentrating during the day, and were less likely to fall asleep in class. Five variables were significant using the “always/every day/night” method. Students with higher GPAs were less likely to have restless/aching legs when trying to fall asleep and were less likely to have difficulty concentrating during the day. They were also less likely to snore every night, did not find it hard to wake up in the morning, and did not have trouble with sleepiness during the day (although the statistical significance of these two

Table 4—Logistic Regression Results for Sleep Variables Significantly Associated With GPA, Controlling for Age and Income.

Variable	Odds Ratio	95% CI	p-value
'At least once a week' or more			
Do you have difficulty concentrating during the day?	0.61	0.43-0.86	.005
'Always/Every night'			
Do you have restless/aching legs when falling asleep?	0.39	0.18-0.83	.014
Do you have difficulty concentrating during the day?	0.53	0.34-0.83	.006
Do have trouble with sleepiness during the day?	0.64	0.41-0.99	.050

relationships was marginal). The variable “do you feel you get enough sleep” was also compared with GPA. Those with higher GPAs were less likely to report that they did not get enough sleep, but the difference was not significant.

Because age and income were significantly associated with GPA, separate logistic regression analyses were performed to assess the association between each of the sleep variables and GPA, when age and income were controlled. Note that all of the sleep variables were assessed using logistic regression, not just those that were significant in the chi-square analyses. Table 4 shows the variables that were significant, controlling for age and income. Restless legs and difficulty concentrating remained significant using both categorization methods. Sleepiness during the day and having difficulty concentrating during the day continued to significantly effect school performance for the group reporting having these problems “always /every night.”

DISCUSSION

Adolescent Sleep Disturbances – Population Frequency

Sleep disturbance and daytime sleepiness were extremely common in this adolescent population, with sleep onset insomnia reported in 60% of respondents at a frequency of ≥ 1 x /wk. (21.2% every night); hard to wake in the morning in 72.7% ≥ 1 x / wk.(37.0% every day); waking tired and unrefreshed in 82.3% at ≥ 1 x / wk.(36% every day); sleepiness during the day in 45.7% ≥ 1 x / wk.(15.2 % every day); and difficulty concentrating in 54.6% ≥ 1 x / wk.(12.9% always). The results of this study indicate a higher frequency of sleep complaints in this population than that reported in a meta-analysis of studies of reported frequency of sleep disturbance in older adolescents (age 15-18): difficulty initiating sleep (12.4%), non-restorative sleep (13.8%), and daytime sleepiness (19.9%).¹⁹ The values for sleep onset insomnia (30%) and reported insufficient sleep (30%) obtained in a study of senior high students in Greece are closer to the frequencies obtained in this study.²³ These studies demonstrate the same pattern of most frequent sleep complaints in adolescents (sleep onset insomnia and daytime sleepiness) with differences in result frequency likely secondary to differences in the manner in which questions are asked and obtained. This study supports previous studies indicating a high frequency of reported sleep complaints in the adolescent population.

The frequency of sleep complaints reported by adolescents exceeds the values obtained in epidemiological population studies of adults.^{1,7,17,19} This finding has been postulated to be due to a complex interplay of factors that are known to affect sleep in ado-

lescents including sleep disorders, genetic predisposition, obesity, delayed sleep phase syndrome, hormonal changes, substance abuse, and social stressors.²⁴

The Effects of Socioeconomic Variables on School Performance in This Adolescent Grouping

A variety of socioeconomic variables have been shown to affect the frequency of reported sleep disturbances and school performance.¹³⁻²⁰ The variables assessed in this adolescent grouping included household income, number of children in household, ethnicity, number of individuals in household, and marital status of parents. Of these variables, only household income was found to have significant effect on GPA, however, that variable had a highly significant effect on school performance ($p < 0.001$). In this study, there were no individuals with household incomes $> \$75,000$ who had GPAs ≤ 2.0 . Although there were children from low income families with high GPAs, 27% (18/66) students reporting a household income of less than \$50,000 reported a GPA ≤ 2.0 .

Sleep Variables Affecting School Performance

The sleep variables significantly affecting school performance in this study are primarily those associated with daytime sleepiness (difficulty concentrating and falling asleep in class). Snoring on an every night basis is significantly more common in students with GPAs less than 3.5 (no correlation was found in this study between school performance and BMI). These are variables that have been consistently associated with pediatric obstructive sleep apnea in previous studies.^{21,25}

In this study there was a strong correlation between the complaint of restless/aching legs at sleep onset and poorer school performance. This sleep complaint has not generally been addressed in previous studies. Both restless legs and difficulty concentrating during the day are symptoms associated with the diagnosis of Attention Deficit Hyperactivity Disorder (ADHD), a diagnosis that can be associated with poor school performance.²⁶ Activating and sleep medication use was addressed in this study with sleep or activating medication use reported by 4.2% of students, indicating that the number of children being treated for sleep complaints and/or AD/HD is low in this study population. Restless legs are reported by 34.5% of students, The correlation between the complaint of restless/aching legs in adolescence and poor school performance deserves further study in the adolescent population.

Sleep Variables Affecting School Performance – Controlling for Household Income

In this study, household income has significant power as a variable affecting reported GPA. When we assess effects of sleep variables on school performance (GPA) while controlling for this socioeconomic variable, some of the sleep variables were found to lose their significance as effects on school performance. When logistic regression analysis is utilized to control for age and household income, snoring and falling asleep in class lose their statistical significance in relationship with GPA (Table 4). Having restless/aching legs at sleep onset every night remains significantly associated with GPA, even when age and income are controlled, as does difficulty concentrating (whether reported as occurring at least once a week or every night). Students reporting

always having daytime sleepiness continue to show significantly lower GPAs. These findings demonstrate that socioeconomic factors significantly affect the association in adolescents between the frequency of reported sleep disturbance and GPA. Socioeconomic variables, particularly household income, should be assessed in further epidemiological studies of sleep disturbance and school performance in this population. This study also suggests that socioeconomic factors should be included in the factors known to negatively affect sleep in adolescents.²⁴

CONCLUSION

This study provides additional evidence to support the contention that sleep disturbances occur at high frequencies in adolescents and significantly affect daytime performance as measured by GPA. Daytime sleepiness variables, every night snoring, and the complaint of restless/aching legs at sleep onset were significantly correlated with poor school performance. The socioeconomic variable of household income is also noted to have a significant effect on GPA. The number and type of sleep variables noted to significantly affect GPA were altered after statistically controlling for age and household income. The every day complaint of sleepiness, restless aching legs at sleep onset, and difficulty concentrating persist in demonstrating significantly negative affects on school performance. Further studies are required to address the association of restless leg complaints in adolescents with school performance. Future studies addressing sleep complaints and school performance in adolescents should control for the socioeconomic variable of household income.

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