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Sleep complaints affecting school performance at different educational levels

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The clear association between reports of sleep disturbance and poor school performance has been documented for sleepy adolescents. This study extends that research to students outside the adolescent age grouping in an associated school setting (98 middle school students, 67 high school students, and 64 college students). Reported restless legs and periodic limb movements are significantly associated with lower GPA's in junior high students. Consistent with previous studies, daytime sleepiness was the sleep variable most likely to negatively affects high school students. Sleep onset and maintenance insomnia were the reported sleep variables significantly correlated with poorer school performance in college students. This study indicates that different sleep disorder variables negatively affect performance at different age and educational levels.

Keywords: adolescent, college, sleep, restless legs, school, insomnia, GPA

INTRODUCTION

A growing body of work documents the association between disordered sleep and school performance. Students who report insomnia, inadequate sleep, daytime sleepiness, irregular sleep patterns and/or poor sleep quality do not perform as well in school as others (Blum et al., 1990; Link and Ancoli-Israel, 1995; Hoffamn and Steenhof, 1997; Wolfson and Carskadon, 1998, 2003; Shin et al., 2003; Millman, 2005). Children enrolled in remedial school programs report significantly more sleep problems (Blunden and Chervin, 2008). Reported abnormalities in sleep including sleep latency [SL] > 30 min and more than one arousal per night at least two nights/week have shown an association with an increase in school failure rates (Kahn et al., 1989). A large study in the Spanish secondary school system ($N = 1155$, mean age 14) found a significant correlation between class failure and sleep complaints, and morning sleepiness (Salcedo et al., 2005).

Better school performance is associated with more time in bed, better sleep quality, fewer nighttimes arousals, less napping and less difference between weekday and weekend sleep times (Link and Ancoli-Israel, 1995; Hoffamn and Steenhof, 1997; Wolfson and Carskadon, 1998). The association between sleep complaints and poor school performance is supported by in-lab experimental 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 (Sadeh et al., 2002; Takser et al., 2002; Carskadon et al., 2004). Experimental restriction of sleep in students (ages 6–12) has been shown to lead to academic difficulty in the classroom as well as increased severity of school related attention problems (Fallone et al., 2005).

There are suggestions in the literature that sleep variables affecting school performance differ based on age and educational level. In seven year olds, short sleep duration is associated with higher emotional liability (Nixon et al., 2008). Adolescent aged delayed sleep phase develops at the onset of puberty with the associated daytime sleepiness affecting school performance in the high school aged population (Wolfson and Carskadon, 2003; Millman, 2005). In a large study of Canadian high school students ($N = 3,235$, mean age 16.3) twenty-three percent of students felt that their grades had dropped in high school because of daytime sleepiness (Gibson et al., 2006). A similar study in Korean high school students ($N = 3,871$, mean age 16.8) reported excessive daytime sleepiness (EDS) to be present in 15.9% of students. EDS was significantly associated with perceived sleep insufficiency, two or more insomnia symptoms and low school performance (Joo et al., 2005). The proportion of students reporting insomnia appears to increase with increasing age and higher educational level. Among Japanese adolescents, both difficulty initiating sleep and reported insomnia gradually increase from 7th to 12th grade (Kaneita et al., 2006). Up to 30% of college students report chronic severe sleep difficulties including both daytime sleepiness and insomnia with 11% meeting criteria for delayed sleep phase syndrome (DSPS) (Brown et al., 2001, 2006). Sleep disturbances are likely to continue to affect school performance in adults. Cognitive function test scores have been noted to fall in both medical students and residents after sleep deprivation (Hallbach et al., 2003).

Disordered sleep has also been noted to effect behaviors other than school performance. For example, daytime sleepiness was shown to negatively affect student participation in extracurricular activity (Gibson et al., 2006). Studies have documented the effect of disordered sleep on the behavioral and emotional performance of elementary school children (Mahendrean et al., 2006; El-Sheikh et al., 2007). Children with fragmented sleep score lower on tests of neurobehavioral functioning and have increased parent-reported levels of behavior problems (Sadeh et al., 2002). In adolescent boys reported tiredness and sleepiness associated with lower perceived

academic performance is also associated with negative mood states, problematic alcohol use, perceived mistreatment or abuse, antisocial behavior, intention to use or current use of illegal drugs, and feelings of isolation (O'brien and Mindell, 2005; Ahonen et al., 2007).

TREATMENT PROTOCOLS PROPOSED AND UTILIZED IN THE TREATMENT OF SLEEP DISTURBANCE IN STUDENTS

A variety of treatment protocols have been proposed for general application in student populations. The finding that early high school start times are associated with student reports of less sleep and increased sleepiness has led to proposals for changes in school start times (Dexter et al., 2003; Joo et al., 2005). In some states and communities school start times have been changed based on legislation. It is currently unclear whether this approach leads to an improvement in school performance (Eliasson et al., 2002). In elementary students treatment suggestions for sleep complaints include attempts to resolve the marital conflicts (El-Sheikh et al., 2007). Emphasis on the behavioral basis of daytime sleepiness in high school students has led to the development and application of psychoeducational programs emphasizing sleep hygiene (Joo et al., 2005; Gibson et al., 2006). Melatonin used as a pharmacological treatment for adolescents aged 10–18 years in the treatment of DSPS has been shown to result in fewer of these students reporting school difficulties (Szeinberg et al., 2006). Some studies have suggested, based on data derived from high school studies, that psychoeducational treatment approaches and delayed class start times be utilized in the treatment of college students (Brown et al., 2006; Gibson et al., 2006).

In the effort to improve school performance at all educational levels, there appears to be a tendency to apply one-size-fits-all programs for the treatment of sleep disturbance based on data from high school studies (Brown et al., 2006). This study presents data evaluating the association between questionnaire-reported sleep disturbances and school performance in three separate groups of students extending from grade 6 through college (age range 10–54). It is the authors' hypothesis that the sleep variables affecting school performance in elementary school and junior high differ from those affecting school performance in high school, and those affecting college students. If this hypothesis is correct, it becomes increasingly important that future research studies and treatment protocols should clarify the age and educational level association of sleep disorder variables with school performance.

MATERIALS AND METHODS

Three samples of students were analyzed for this study: middle school (grades 6–8), high school (grades 9–11) and college students. The first two samples were assessed in the science and heath classes at associated middle and high schools in Pueblo, Colorado near the end of the 2005 school year. The college sample was assessed in psychology, nursing and medical classes at the local community colleges as part of an invited presentation on "Sleep in Young Adults" in 2007. Although all three studies used the same questionnaire instrument, because of differences in the settings, statistical comparisons were made within, but not across the three educational levels.

An IRB approved, 18-question frequency-based pediatric sleep disturbance questionnaire, based on validated and indexed questions (Chervin et al., 2000, 2003; Pagel et al., 2007), was used for all three samples. The questionnaire consisted of five ordinal response categories: 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 to compare response categories 3–5 to categories 1 and 2. This differentiated those who reported having the sleep problem at least once a week from those who had it less often.

Assessment of school performance was based on self reported GPA (Range 2.0–4.0), which is a common method for defining academic performance in sleep research (Blum et al., 1990; Hoffamn and Steenhof, 1997; Wolfson and Carskadon, 1998; Millman, 2005). Although questionnaires were distributed to 238 middle and high school students, only 165 (69.3%) reported their GPA. While only the students reporting GPA could be analyzed for this study, chi-square analyses revealed that none of the sleep variables differed significantly between those who provided GPA data and those who did not. In addition, a proportion of post-secondary school students were enrolled in either nursing or medical training programs that did not rate performance based on GPA and therefore could not be included.

This study included 98 junior high students (Grades 6–8), 67 high school students (grades 9–11) and 64 college students (mean age 27.8, range 17–59). GPA was not normally distributed and therefore was split at the median to form two groups within each educational level: Low GPA and High GPA. Within each of the three educational levels, chi-square analyses, using Fisher-exact one-sided tests, were run to compare each of the sleep disturbance variables by GPA (low or high).

RESULTS

Table 1 displays descriptive information for demographic and sleep variables for the three groups. Notably, there were more Hispanic students in the two younger groups and more African American and white students in the college group. There were also substantially more males in the college group than the two younger groups. However, within each educational group, there were no significant differences in age, ethnicity or gender by GPA. For all three groups, the most common sleep associated problem was feeling unrefreshed/tired in the morning, followed by having trouble waking up in the morning. The least common behaviors were trouble with breathing when sleeping and taking sleep medication.

For the analyses of sleep behaviors by school performance, GPA was divided into "Low" and "High" GPA at the median split for each grade level. The median for grades 6–8 was 3.5, for grades 9–11 it was 3.0, and for college students it was 3.4. As shown in **Table 2**, for the junior high students, the complaint of restless/aching legs when falling asleep was significantly more common in the lower GPA grouping ($p = 0.004$). In high school, lower GPA was significantly associated with falling asleep in class ($p = 0.010$), difficulty concentrating ($p = 0.011$), and napping ($p = 0.009$). In college lower GPA was significantly associated with difficulty falling asleep ($p = 0.017$), difficulty returning to sleep after waking at night ($p = 0.028$), and difficulty concentrating during the day ($p = 0.017$).

When the college students were divided into two age groups to analyze those who were 21 years or younger ($n = 25$) separately from those who were 22 years or older ($n = 36$), analyses indicated

Table 1 | Demographic and sleep variables for all three groups.

Variable	6th–8th Grade (*n* = 98)	9th–11th Grade (*n* = 67)	College (*n* = 64)
Grade point average	3.3 (0.7–4.0)	3.0 (0.5–4.0)	3.4 (2.0–4.0)
Average age (range)	13.2 (11–15)	15.5 (14–18)	27.8 (17–59)
Gender			
Female	49.0	53.7	26.6
Male	51.0	46.3	73.4
Ethnicity			
Hispanic	54.9	53.1	9.4
White	37.4	34.4	54.7
African American	0.0	1.6	23.4
Other	7.7	10.0	12.5
Do you feel you get enough sleep?			
Never or rarely (one time per month)	26.5	37.3	42.2
Sometimes/occasionally (1–2 times/wk)	40.8	40.3	51.6
Always (every night)	32.7	22.4	6.2
Do you have difficulty falling asleep?	60.2	59.7	56.2
Do you have restless/aching legs when falling asleep?	24.5	26.9	28.1
Do you snore?	31.2	17.9	36.5
Do you stop breathing or have trouble breathing when sleeping?	3.1	4.6	17.5
Do you have leg kicks or twitches at night?	37.8	29.9	41.3
Do you wake at night and have trouble falling back to sleep?	38.8	26.9	53.2
Is it hard to wake up in the morning?	76.5	67.2	71.9
Do you wake unrefreshed/tired in the morning?	82.7	81.8	82.8
Do you have trouble with sleepiness during the day?	40.2	53.7	71.9
Do you fall asleep in class?	15.3	17.9	29.7
Do you have difficulty concentrating during the day?	53.6	56.1	57.8
Do you take naps?	34.0	56.7	34.4
Do you take sleep medication?	4.1	4.5	17.2

that the three significant variables described above held only for the older group. There were no significant sleep variables by GPA for those who were 21 years and younger, although this could have been due to the low number of students in this analysis.

An age analysis was also performed on the junior high and high school groups. All students in both groups were combined and then divided according to age: younger (11–14 years; $n = 99$) and older (15–17; $n = 66$). Analyses for the older group were similar to that of the high school students (9th–11th grade) presented in **Table 2**. The younger group, however, differed slightly from the junior high (6th-8th grade) analyses in **Table 2** in that some variables that were significant at $p < 0.10$ became significant at $p < 0.05$ when the analysis was based on age instead of grade. These variables included the following: waking at night and having trouble falling back to sleep ($p = 0.018$); waking unrefreshed or tired in the morning ($p = 0.036$); and the marginally significant variable of difficulty concentrating during the day ($p = 0.051$).

DISCUSSION

This study demonstrates that in students from 6th grade through college, disordered sleep is correlated with poor school performance. Despite this being a small study, it was conducted in a community school population utilizing the same methodology for each educational grouping. Significant differences between low and high GPA for the different education levels were based on different sleep variables. The sleep variable reported to affect school performance in junior high students was the complaint of restless legs. In high school, daytime sleepiness negatively affected school performance as demonstrated by significant negative associations between napping, falling asleep in class and difficulty concentrating. The sleep variables leading to significant negative affects on GPA for college students were difficulty concentrating, sleep onset and sleep maintenance insomnia.

There was a significant correlation between the complaint of restless/aching legs at sleep onset (RLS) and poorer school performance in the junior high students included in this study. Both restless legs and difficulty concentrating during the day are symptoms associated with the diagnosis of Attention Deficit/Hyperactivity Disorder, a diagnosis that can be associated with poor school performance (Faraone et al., 1993; Gruber and Sadeh, 2004). Restless legs and periodic limb movements are also more frequent in individuals with known deficiencies in iron stores (Kryger et al., 2002). Iron deficiency anemia has documented effects on cognitive skills and neuromaturation in infancy and childhood (Walter, 2003). The correlation between RLS and poor school performance deserves further study, particularly since pharmacological treatments exists for RLS that have not been studied or approved for treatment for pediatric age populations. ADHD and iron deficiency anemia would be important variables to include in such research.

Table 2 | Percent among low and high GPA groups exhibiting sleep behaviors at three levels of education[1].

	6th–8th Grade (*n* = 98)			9th–11th Grade (*n* = 67)			College (*n* = 64)		
Sleep behavior exhibited at least once a week or more	**Low GPA**	**High GPA**	***p***	**Low GPA**	**High GPA**	***p***	**Low GPA**	**High GPA**	***p***
Do you have difficulty falling asleep	57.1	63.3	0.340	66.7	52.9	0.185	69.7	40.0	0.017
Do you have restless/aching legs when falling asleep	36.7	12.2	0.004	30.3	23.5	0.363	33.3	20.0	0.183
Do you snore	39.1	23.4	0.079	21.2	14.7	0.354	33.3	37.9	0.455
Do you stop or have trouble breathing when sleeping	4.2	2.0	0.492	6.5	2.9	0.465	24.2	10.3	0.136
Do you have leg kicks or twitches at night	42.9	32.7	0.202	36.4	23.5	0.189	53.1	30.0	0.056
Do you wake at night and have trouble falling back to sleep	46.9	30.6	0.073	36.4	17.6	0.073	65.6	37.9	0.028
Is it hard to wake up in the morning	83.7	69.4	0.076	75.8	58.8	0.112	63.6	80.0	0.123
Do you wake unrefreshed or tired in the morning	89.8	75.5	0.054	84.4	79.4	0.421	87.9	76.7	0.201
Do you have trouble with sleepiness during the day	47.9	32.7	0.092	57.6	50.0	0.353	72.7	70.0	0.515
Do you fall asleep in class	18.4	12.2	0.288	30.3	5.9	0.010	36.4	23.3	0.198
Do you have difficulty concentrating during the day	61.2	45.8	0.094	71.9	41.2	0.011	72.7	43.3	0.017
Do you take naps	34.7	33.3	0.529	72.7	41.2	0.009	39.4	30.0	0.303
Do you take sleep medication	2.0	6.1	0.309	0.0	8.8	0.125	18.2	16.7	0.570

[1]Sleep variable responses were collapsed to form a group indicating "at least once a week" or more. GPA was divided into "Low" and "High" GPA at the median split for each grade level; Grades 6–8 = 3.5; Grades 9–11 = 3.0; College = 3.4. Fisher's Exact one-sided tests were used for all comparisons; significant comparisons ($p < 0.05$) are in bold.

Daytime sleepiness, as reflected by waking tired and unrefreshed in the morning, having difficulty waking in the morning, and having trouble with sleepiness during the day, affects the large majority of students included in this study and is their most common set of complaints. For the high school students included in this study, daytime napping, falling asleep in class and difficulty concentrating during the day are associated with lower GPA. These findings are consistent with a multiplicity of studies showing that daytime sleepiness is commonly reported as a sleep variable affecting school performance in the high school aged population (Kahn et al., 1989; Link and Ancoli-Israel, 1995; Hoffamn and Steenhof, 1997; Wolfson and Carskadon, 1998, 2003; Joo et al., 2005; Millman, 2005; Gibson et al., 2006). Daytime sleepiness in adolescents is multi-factoral reflecting behavioral (chronic sleep deprivation), social (early school start times) and biological factors (the occurrence of delayed sleep phase at the onset of puberty) that affect the high school aged population (Link and Ancoli-Israel, 1995; Wolfson and Carskadon, 1998, 2003; Millman, 2005). Treatment approaches including changes in school start times, cognitive behavioral therapies and pharmacologic approaches have been proposed to address the problem of daytime sleepiness for this grouping as well as in college students (Brown et al., 2006). These approaches have resulted in variable results on school performance (Eliasson et al., 2002). The results of this study support this previous work. There is little question that for the high school population, as documented by reports of napping and falling asleep in class, EDS is the most significant sleep variable affecting school performance. However, daytime sleepiness is a significant sleep variable affecting GPA only for the high school students included in this study. For junior high students, reported daytime sleepiness variables were not noted to significantly affect school performance.

Difficulty falling asleep (sleep onset insomnia) is reported by 50–60% of students in this study. Waking at night and having difficulty falling back asleep (sleep maintenance insomnia) is reported by 38.8% of junior high, 26.9% of high school and 53.2% of college students. For college students, both sleep onset and sleep maintenance insomnia are significantly associated with lower GPA. These findings are consistent with other work, such as increases in school failure rates noted among teen-agers reporting insomnia (Blum et al., 1990). In a study of Japanese adolescents from 7th to 12th grade, the proportion of students reporting insomnia increased with increasing age and educational level. Insomnia is reported by many college students complaining of sleep disturbance (Brown et al., 2001, 2006).

The association between insomnia and poor school performance is likely age related, with older college students performing at lower GPA levels more likely to report problems with insomnia. In the current study, junior high students with lower GPAs actually less likely to report sleep onset insomnia than those with higher GPAs. This finding that sleep onset insomnia is not associated with poor school performance for junior high students and is more likely to

affects school performance with increasing age in college students, strongly suggests that approaches to treating sleep disturbances that affect school performance may need to account for differences in the types of sleep disturbances that occur at different age and/or educational levels, and the one-size-fits-all approach may be less effective.

In this study, reported difficulty with concentrating during the day was significantly correlated with poor school performance for both high school and college students and was reported at a higher by lower performing junior high students. Several studies have demonstrated that difficulty concentrating, associated with poor school performance, is also associated with both EDS and reported insomnia (Carey et al., 2005; Millman, 2005; Blunden and Chervin, 2008). Difficulty concentrating is likely the daytime correlate of disordered sleep, resulting in affects on waking school performance regardless of the specific type of sleep complaint reported.

This study has limitations. The study group is small and the methodology utilized in evaluating the college grouping differed in both timing and protocol of respondent selection.. While the population studied included individuals living in a contiguous geographical location, this study could have been affected by both social and economic variables that were not controlled for in this study (Pagel et al., 2007). RLS affects on GPA could potentially be explained by the presence of co-morbid diagnoses such as AD/HD and iron deficiency anemia. However, if as this study indicates, the sleep variables affecting school performance in elementary school and junior high differ from those affecting school performance in high school, and college, future research studies and particularly treatment protocols will need to be adapted to address different age and educational level associations of sleep disorder variables with school performance.

SUMMARY AND CONCLUSION

A clear association exists between reports of sleep disturbance and poor school performance. This study suggests that sleep disturbance negatively affecting student performance varies based on age and educational level. Reported restless legs and periodic limb movements are associated with lower GPA's in junior high students, daytime sleepiness negatively affects high school students, and sleep onset and maintenance insomnia are significantly correlated with poorer school performance in college students. Impaired waking concentration is the likely waking correlate of sleep disturbance that negatively affects school performance. Future studies and treatment protocols for assessing the association of sleep disturbance with school performance should be tailored to assess and treat the different sleep disorder variables negatively affecting performance at different age and educational levels.

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