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### Abstract

In January 2003 the High School Late Start Committee of the Northville Public Schools sent surveys to all families, faculty, and middle and high school students. The descriptive results of this survey can be found at [www.northville.k12.mi.us/hr/late\\_start\\_committee\\_surveysummary.htm](http://www.northville.k12.mi.us/hr/late_start_committee_surveysummary.htm). This study focuses on the responses of the high school students, the identification of sleep groups among the students, and the association of the groups to their responses regarding behaviors and affect. The discussion looks at alternative intervention strategies for teenagers with sleep disorder problems.

Keywords: Adolescents, High School, Sleep

## **Association of Sleep Groups and Sleep Survey Results of High School Students**

### Background

Studies of adolescents and sleep report that as students mature, melatonin secretion that prepares a body for sleep is delayed along with a delay in circadian sleep phases (Mitru, Millrood, and Mateika, 2002; Board on Children, Youth, and Families, 2000; National Sleep Foundation Sleep and Teens Task Force, 2000). Because of puberty demands on the human body, the need for sleep increases. However, as they mature, adolescents tend to sleep less and as a result are excessively sleepy (Mitru, Millrood, and Mateika, 2002; Board on Children, Youth, and Families, 2000; National Sleep Foundation Sleep and Teens Task Force, 2000; Carskadon, 1999; Minnesota Medical Association, 1994). External influences such as greater social obligations, a decrease in parental involvement in bedtimes, greater academic requirements, and work obligations are factors in the decrease of sleep (Carskadon, 1999; Mayo Clinic; 1996; Bachman and Schulenberg, 1987). While recommendations for sleep for teenagers varies between 8.5 and 10 hours per night, a survey of US students reports that they average 7-7.5 hours of sleep per night (Board on Children, Youth, and Families, 2000). Several studies report fewer hours of sleep for teenagers during the week and greater sleep on the weekend. However, this did not make up for lost sleep since circadian patterns are very resistant to change (Board on Children, Youth, and Families, 2000; Carskadon, 1999; Wahlstrom et al, 1997).

There are several potential medical and psychological consequences for teenage sleep deprivation. The prefrontal cortex is the last to develop and most sensitive to sleep deprivation. There is a positive correlation between sleepiness and sleep disorder scales and anxiety and

depression scales. Students who report shorter sleep periods report increased sleepiness, lapses of attention, irritability, decreased socialization and humor, and hyper-sexuality. Various adolescent disorders are associated with sleep disorders: sleep apnea, narcolepsy, asthma, conduct/aggressive disorders, and anorexia nervosa. Students with less sleep are more vulnerable to stimulant use, drugs, alcohol, and risky driving. Sleep deprivation suppresses immunity making students more susceptible to infections (Wahlstrom, 2003; Mitru, Millrood, and Mateika, 2002; Board on Children, Youth, and Families, 2000; Onderko, 1999; Allen, 1991).

There are also several academic consequences associated with sleep deprivation. Sleep deprivation creates a drop in attentiveness, reduced ability to focus and study, and a decreased ability to stay awake (Gozal and Pope, 2001; Gozal, 1998). Various reports suggest that sleep deprivation appears to have a negative effect on memory, creativity, information processing, divergent thinking, reaction time, and the ability to handle complex tasks. (Wahlstrom, 2003; Mitru, Millrood, and Mateika, 2002; Board on Children, Youth, and Families, 2000; Carskadon, 1999; Onderko, 1999).

As a result of these concerns the Minnesota Medical Association passed a resolution in 1994 urging school districts to eliminate early starting hours for teenagers. Several school districts around the Minneapolis area implemented a later start time for their high schools. Evaluation reports indicated that students reported getting an hour's more sleep per day, less reports of sleepiness, student reports of higher grades (though not significantly related to actual GPA), significantly greater attendance pattern, less depressive feelings, and less counselor referrals (Wahlstrom et al, 1997).

## Method

Because of these reports Northville Public Schools and other schools in their athletic conference launched local and regional committees to study the problem. One of the results of the work of Northville's committee was to survey all high school students. Northville would be considered an upper-middle to middle class suburban school in the Detroit, Michigan area. The student population is primarily white, not Hispanic (91.4%). Other racial/ethnic groups include Asian/Pacific (6.3%); black, not Hispanic (1.2%); and Hispanic (1%). High school students returned 1,422 surveys, representing 81.6% of the high school enrollment.

## Data Analysis

In order to analyze the descriptive data from the survey, responses were disaggregated based upon the students' report of average sleep during the week. The Severe Deprivation (SD) group was defined as those students who reported 6 hours or less sleep per night (n=121, 9.3%). The Moderate Deprivation (MD) group was defined as those students who reported 6.5 or 7.0 hours of sleep per night (n=487, 37.4%). The Adequate Sleep (AS) group was defined as those who reported 7.5 or greater hours of sleep each week day (n=695, 53.3%).

Because the response categories for questions produced ordinal data, a Chi-square analysis was applied to compare the responses of these three groups to their responses on other questions.

Questions chosen for analysis were those that focused on student behavior and affect to determine if a significant difference in responses existed between the sleep groups.

## Findings

Students were asked about various behaviors that might be associated with sleep deprivation: whether they had fallen asleep in class, whether they had fallen asleep during other activities (e.g. watching TV, driving, taking a test, studying, sleep behaviors), and their use of caffeine.

Table 1 shows the various behavior questions, the percentage of response by group, and the Chi-square level of significance for the difference in responses (See Table 1).

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Place Table 1 about here

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In each case, the response of the “severe deprivation” group was a greater report of these behaviors than the “moderate deprivation” group which was greater than the “adequate sleep” group ( $p < .01$ ). An example of this trend is found in the response of question 1. The Severely Deprived Group had the largest percentage of their group that reported that they fell asleep in class daily (12%) or once a week (26%). The Moderately Deprived group had the next highest response and the Adequate Sleep Group had the lowest response in these categories and the highest response (51%) of never falling asleep in class. As expected, once the responses were disaggregated by sleep group, the response of the Severely Deprived group was highest for falling asleep, struggling to stay awake, or both for performances, watching TV, reading, studying, homework, and taking a test. The exception was the response on driving a car. The Moderately Deprived Group had a slightly higher report of falling asleep, struggling to stay

awake, or both. In all cases for questions 1-8 the Adequate Sleep Group had the highest report of never falling asleep or struggling to stay awake. In Questions 9-20, the Adequate Sleep Group had the highest response for never arriving late to class, falling asleep in class (a.m. or p.m.), waking up too early, staying up all night, sleeping past noon, needing morning reminders, having a hard time falling asleep, having nightmares, going to bed because they couldn't stay awake, or drinking coffee or tea with caffeine. Like the other questions, the Severely Deprived Group usually had the greatest report of these behaviors with the Moderately Deprived Group somewhere in the middle. It is interesting to note the regarding the use of caffeine, the Moderately Deprived Group had a higher response of frequent use.

High school students were also asked various questions that probed their feelings and opinions about when they fell asleep, the quality of their sleep, being bothered by feeling tired, feeling unhappy/depressed, feeling hopeless, feeling nervous, and worrying. Table 2 shows the questions asked of high school students, their response opportunities, the percentage response by sleep group, and the Chi-square level of significance for the difference in responses.

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Like the responses for questions regarding behaviors, once responses were disaggregated by sleep groups, a similar trend emerged. The first question asked students when they felt sleepy and provided the response opportunities of never, in the afternoon, and in the morning. The

severe deprivation group had more (93% vs. 89% and 84%) responses in the morning and afternoon with less “never” responses than the other two sleep groups.

Questions 2-5 asked for students feelings about what they perceived as the quality of their sleep. On each question the responses were significantly different than expected by chance ( $p < .001$ ). As before, once the responses were disaggregated by sleep groups, an expected trend emerged. The Severely Deprived group had the greatest response for never feeling satisfied with their sleep, reporting greater feelings of being tired, and having more difficulties going to sleep or staying asleep. This group also had the greatest percentage reporting that they never had a good night’s sleep (27% vs. 16% and 10%). The Adequate Sleep group had the highest responses for feeling satisfied with their sleep, the least response on never having a good night’s sleep, and the greatest response for receiving a good night’s sleep several times or every night. This group also had the least response about feeling tired. The responses for the Moderately Deprived group fell somewhat in the middle.

Questions 6 through 10 asked for student’s responses about feeling bothered about being too tired; unhappy, sad, or depressed; hopeless; nervous; and worried. Students were given the response opportunities of a lot, somewhat, and not at all. In all cases, the groups responded significantly different than expected. The pattern of responses indicated that Severe Deprivation group had a large portion of their group (range 17% to 35%) that responded that they felt this way a lot. Compare this to the adequate sleep group that had a much smaller proportion that responded a lot (range 6% to 15%) with the moderate deprivation group responding somewhat in the middle that they felt this way a lot (range 11% to 27%). If one combines the “a lot” response



with the “somewhat” response, then the 88 percent of Severely Deprived group responded that they were bothered by feeling too tired; 63 percent felt unhappy, sad, or depressed; 46 percent felt hopeless about the future, 64 percent felt nervous or tense, and 68 percent felt they were worrying too much about things. Compare this to the Adequate Sleep group where 65 percent were bothered by feeling tired; 44 percent felt unhappy, sad, or depressed; 38 percent were troubled by feeling hopeless; 54 percent were troubled by feeling nervous or tense; and 57 percent felt they were worrying too much about things.

### Discussion

The responses from the survey further the current literature on the loss of sleep amongst teenagers. Like other surveys, teenagers respond with a consistent picture of students receiving less than optimal sleep during the week and then crashing on the weekend. Their responses indicate that loss of sleep has a negative effect on student behaviors, the quality of sleep they receive, and their affect which may have psychological consequences.

Assuming as Wolfson et al (2003) have reported that student self-reports of sleep are reliable, then student reports of sleep may be used to differentiate responses on surveys. Once done, the picture that emerges indicates that descriptive responses can be more meaningful in interpretation. While other surveys have shown that sleep deprivation does result in large responses implying effects on behavior, quality of sleep, and affect, this study shows a larger impact for those students who may be more affected by the loss of sleep.

The results of this study demonstrate that there is a high prevalence of sleep problems in our high school population. We found that many students fall asleep in class and other academic activities, and many students have late bedtimes. Perhaps the most alarming discovery is the number of students who reported struggling to stay awake while driving a car. Even a single death related to driving while sleepy would be disastrous and tragic. Sleep problems in our high school students thus have both academic and serious health consequences.

The incidence of falling asleep during school was similar to that described by other investigators (Shinkoda et al, 2000), but still striking. Twelve percent of students in the most sleep deprived group reported falling asleep in school on a daily basis, and 26 percent of those students admitted to doing it once per week.

A striking number of students reported staying up very late which exacerbates the problem given early start time (Pelayo, Thorpy, and Govinsky, 1988). The Severely Deprived Group was three times more likely to stay up until 3 a.m. several times than the Adequate Sleep Group and twice as likely to stay up all night several times in the past two weeks.

In our study 13 percent of students who slept less than 7 hours per night reported struggling to stay awake while driving. In our original survey report, only 9 percent of the high school student body reported this which shows how identifying sleep deprivation students can have a greater impact on interpretation. We are unaware of any other studies noting such a high incidence of driving while sleepy in a high school population. There is a well documented association between sleep disorders and automobile accidents (Board on Children, Youth, and Families,

2000; Sleep Foundation Sleep and Teens Task Force, 2000; American Medical Association, 1996). Because of excessive sleepiness, patients with obstructive sleep apnea are several times more likely than those without to become involved in an automobile accident. Patients with narcolepsy are similarly affected. Restriction of sleep hours limits vigilance and performance on simulated automobile driving. Many states have instituted mandatory reporting of individuals with excessive daytime sleepiness in order to limit motor vehicle privileges. Professional bodies dealing with sleep disorders have considered this issue as well, stating that health professionals are obligated to advise patients regarding the safety issues associated with sleepy driving. The high incidence and potentially disastrous consequences of this problem argue for an aggressive approach to finding and helping sleepy high school drivers.

Efforts to detect ill health in a population may be fruitful. This is especially true if early detection allows for an intervention with an associated improvement in some outcome. Associations of sleep disorders, especially sleep disordered breathing, with cardiovascular disease has prompted investigation into the effect of intervention on cardiovascular illness. There is increasing evidence that the natural history of some diseases may be altered through the treatment of sleep problems. Elimination of obstructive sleep apnea is associated with reversal of left ventricular hypertrophy, lower blood pressure, diminished autonomic nervous system hyper-reactivity, decreased systemic catecholamine production, and perhaps lower mortality. Some treatments have shown promise in this regard. The association between sleep, sleep disease, and academic achievement raises the exciting analogous possibility that treatment of sleep disorders may improve learning outcomes.

To our knowledge the only intervention shown to have an association with improved school grades is the use of tonsillectomy / adenoidectomy for sleep apnea in 1<sup>st</sup> graders with low grades (Gozal, 1998). Wide scale, district-wide imposition of altered schedules did not result in statistically significant grade improvement (Wahlstrom et al, 1997). Literature regarding implementation of specific sleep interventions to improve academic performance for students with other sleep disorders is sparse and largely anecdotal. Treatment of delayed sleep phase syndrome has resulted in altered sleep schedule and presumably circadian rhythm, but no effect on grades has been described (Okawa M, et al., 1998). Voluntary adoption of later start times in an Israeli school district was associated with better grades in an uncontrolled study (Epstein, Chillag, and Lavie, 1998). Our population appears to have a high incidence of insufficient sleep and perhaps delayed sleep phase syndrome. Sleep extension has been demonstrated to increase alertness. (Roehs, Timms, and Zwyghuizen-doorenbos, 1989). It seems reasonable to assume that measures such as increased sleep time or therapy for delayed sleep phase such as light exposure or chronotherapy might allow for improved learning. To our knowledge, there has been no systematic evaluation of how interventions for these problems might affect academic performance.

In summary, there may be improvements in academic performance and health associated with the treatment of sleep problems. We believe that the magnitude of potentially remediable disorders identified in this study warrants further investigation and an attempt at treatment.

While some schools have been able to make a change in their schedules to affect all students resulting in more positive survey results and significantly better attendance, none have been able

to show a statistically significant relationship to student achievement (Wahlstrom et al, 1997). For some school districts like Northville Public Schools, various political factors have hindered schools from making the complete change. If such a school district is able to identify students who are most affected by sleep deprivation, then would it be possible to provide an accommodation for that smaller group? If so, would this help to raise the overall achievement level of the school and avoid the political pitfalls associated with a major schedule change?

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Table 1

Responses to Behavior Questions

Question	Group	Response in Percentage of Group					Chi-square level of significance
		Daily	Once a Week	Once a Month	Once a Semester	Never	
1. Fallen asleep in class this year	SD	12	26	14	18	29	p<.001
	MD	8	18	18	23	34	
	AS	5	13	13	18	51	
2. Struggle to or fallen asleep while traveling	SD	23	26	36	15		p<.001
	MD	32	25	28	15		
	AS	47	23	21	9		
3. Fallen asleep attending performance	SD	64	21	6	9		p<.001
	MD	72	20	5	3		
	AS	84	13	2	1		
4. Fallen asleep while watching TV or listening to music	SD	22	26	41	11		p<.001
	MD	32	21	31	17		
	AS	49	24	20	7		
5. Fallen asleep while reading, study, or homework	SD	22	33	25	17		p<.001
	MD	33	32	19	16		
	AS	48	31	14	8		
6. Fallen asleep during a test	SD	57	34	4	5		p<.001
	MD	69	26	3	2		
	AS	76	22	1	1		
7. Fallen asleep in class during last two weeks	SD	28	39	13	20		p<.001
	MD	35	41	9	14		
	AS	53	33	7	8		

Table 1 (Continued)

Responses to Behavior Questions

Question	Group	Response in Percentage of Group					Chi-square level of significance
		No	Struggled to stay awake	Fallen Asleep	Both		
8-while driving a car	SD	87	13	0	0		p<.001
	MD	85	13	1	2		
	AS	93	6	1	0		
				Several	Every day/ Night		
		<u>Never</u>	<u>Once</u>	<u>Twice</u>	<u>Times</u>	<u>Night</u>	
9-Arrive late to class.	SD	57	17	14	11	1	p<.001
	MD	63	17	7	13	1	
	AS	74	11	4	9	1	
10-asleep in morning class	SD	44	19	13	19	6	p<.001
	MD	54	19	8	18	2	
	AS	62	17	7	12	2	
11-asleep in afternoon class	SD	50	24	8	14	4	p<.012
	MD	60	18	8	13	1	
	AS	66	15	8	9	2	
12-awakened too early in morning	SD	58	8	8	22	4	p<.001
	MD	57	15	12	15	2	
	AS	62	17	8	12	1	
13-stayed up until 3 a.m.	SD	28	26	21	24	1	p<.001
	MD	47	22	16	15	1	
	AS	67	16	9	7	1	
14-stayed up all night	SD	60	20	11	7	2	p<.001
	MD	80	13	3	4	0	
	AS	86	8	4	3	0	

Table 1 (Continued)

Responses to Behavior Questions

Question	Group	Response in Percentage of Group					Chi-square level of significance
		Never	Once	Twice	Several Times	Every day/ Night	
15-slept past noon	SD	17	24	18	37	4	p<.001
	MD	23	36	16	23	3	
	AS	23	50	13	14	1	
16-needed more than one reminder	SD	28	11	10	29	22	p<..001
	MD	35	11	10	28	17	
	AS	45	14	11	19	11	
17-hard time time falling asleep	SD	35	9	16	28	13	p<.001
	MD	41	17	15	23	5	
	AS	47	18	15	16	4	
18-had night- mares or bad dreams	SD	57	18	11	13	2	p<.001
	MD	62	17	9	10	3	
	AS	70	14	8	7	1	
19-gone to bed, couldn't stay awake	SD	16	23	17	36	9	p<.001
	MD	28	19	17	33	4	
	AS	37	16	16	28	3	
20-drink coffee or tea w/ caffeine	SD	23		9	12	57	p<.001
	MD	26		5	13	56	
	AS	19		4	11	66	

Table 2

Responses to Affect Questions

Question	Group	Response in Percentage of Group					Chi-square level of significance
		Never	In the afternoon	In the morning	Several times	Everyday/ night	
1. I feel sleepy	SD	7	39	54			p<.019
	MD	11	28	61			
	AS	16	28	56			
2. Felt satisfied with your sleep	SD	38	16	17	21	8	p<.001
	MD	19	15	25	32	9	
	AS	15	12	19	40	15	
3. Felt tired, dragged out or sleep during the day	SD	7	6	9	49	29	p<.001
	MD	12	8	11	47	23	
	AS	17	15	14	40	14	
4. In past two weeks how often had good night sleep	SD	27	24	17	24	8	p<.001
	MD	16	20	24	30	10	
	AS	10	15	21	37	18	
5. Have trouble going to sleep or staying asleep	SD		<u>A lot</u>	<u>Somewhat</u>	<u>Not at all</u>		p<.001
	MD	24	39	37			
	AS	12	36	53			
6. Bothered by feeling too tired to do things	SD	8	32	60			p<.001
	MD	35	53	12			
	AS	23	54	23			
	AS	15	50	36			

Table 2 (Continued)

Responses to Affect Questions

Question	Group	Response in Percentage of Group			Chi-square level of significance
		<u>A lot</u>	<u>Somewhat</u>	<u>Not at all</u>	
7. Troubled feeling unhappy, sad, or depressed	SD	18	44	38	p<.001
	MD	13	41	46	
	AS	9	35	56	
8. Troubled by feeling hopeless about the future	SD	17	29	54	p<.001
	MD	11	26	63	
	AS	6	22	72	
9. Troubled by feeling nervous or tense	SD	18	46	36	p<.014
	MD	16	47	38	
	AS	12	42	47	
10. Worrying too much about things	SD	28	40	32	p<.001
	MD	27	40	33	
	AS	14	43	43	

