

Sleep and Risk-Taking Behavior in Adolescents

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The primary purpose of this study was to examine the relationship between adolescents' sleep-wake patterns and risk-taking behavior. A second goal was to replicate the results obtained by Wolfson and Carskadon (1998) regarding adolescents' sleep habits. Three hundred eighty-eight adolescents (217 males, 171 females) completed the Sleep Habits Survey and the Youth Risk Behavior Survey. The results indicated that adolescents who reported longer weekend delay and higher levels of sleep problems also reported significantly higher levels of risk-taking behaviors, and students' weekend delay was also related to their academic performance in this sample. As in the sample studied by Wolfson and Carskadon (1998), the adolescents in this study exhibited changes in both weekday and weekend sleep habits across grade/age. However in the present study, only school-night total sleep time and weekend delay were related to adolescents' daytime functioning, with no significant relationships being found between weekend oversleep and daytime functioning. This provides partial support for the findings of Wolfson and Carskadon (1998). Overall, sleep-wake patterns were found to relate to risk-taking behavior during adolescence in this study.

Adolescence is a time of physical, cognitive, social, and emotional changes (Wolfson & Carskadon, 1998). These changes can have a significant impact on adolescents' sleep patterns and behaviors, which, in turn, have implications for adolescents' daytime functioning. Although many studies have examined the relation-

ship between sleep and various aspects of daytime functioning in adolescence, little research has been done on risk-taking behavior.

Studies (e.g., Allen, 1992; Carskadon, 1999; Manber et al., 1995; Strauch & Meier, 1988) have repeatedly shown that adolescents do not get enough sleep, especially during the week. Carskadon (1990) reported that studies of adolescent sleep habits show a pattern of decreased total sleep time (TST), a tendency to delay the timing of sleep, and an increased level of daytime sleepiness. This is an important finding in light of the fact that individuals actually need more sleep during adolescence than prepubertally (Carskadon, 1990; Carskadon et al., 1980). Furthermore, many studies have shown that there are significant differences between the bedtimes, rise times, and TSTs of adolescents on weekdays versus weekends, which can result in insufficient sleep and eventually accumulate as a sleep debt (Andrade, Benedito-Silva, Domenice, Arnhold, & Menna-Barreto, 1993; Strauch & Meier, 1988; Wolfson, 1996).

Adolescents' sleep patterns undergo a phase delay, that is, a tendency toward later times for both sleeping and waking (Carskadon & Davis, 1989; Carskadon, Vieira, & Acebo, 1993). This shift in phase preference may have its basis in the biological mechanism of the circadian timing system; however, environmental factors can possibly play a role in exacerbating this problem. Consequently, sleep-related problems likely result from a conflict between biological sleep needs and behavioral and social factors (Wolfson & Carskadon, 1998).

Sleep affects numerous aspects of daytime functioning. Fluctuations in sleep quantity and/or quality are associated with cognitive (Thorpy, Korman, Spielman, & Glovinsky, 1988), social (Carskadon, 1989–1990), and emotional changes (Kirmil-Gray, Eagleston, Gibson, & Thoresen, 1984). Several studies have shown that there is a relationship between insufficient sleep and lowered academic performance (Allen, 1992; Kowalski & Allen, 1995; Schuller, 1994; Wolfson & Carskadon, 1996, 1998). Wolfson and Carskadon (1998) conducted a study examining the sleep patterns and waking behaviors in a sample of 3,120 high school students. Overall, they found that the students in their study did not obtain enough sleep and that there was a relationship between inadequate sleep and daytime functioning in their sample. Specifically, they found that TST amounts (on both school nights and weekend nights) decreased across age and that worse grades and failing school were associated with later bedtimes, less sleep on school nights, and greater weekend delays of sleep schedules. Also, those students who reported short school-night TST (≤ 6 hr 45 min) and long weekend delay (≥ 2 hr) reported poorer daytime functioning in the form of increased daytime sleepiness, depressed mood, and sleep-wake behavior problems, compared to students who obtained long school-night TST (≥ 8 hr 15 min) and short weekend delay (≤ 1 hr). This study thus suggested a relationship between the way adolescents sleep and how they feel and behave during the daytime hours.

Insufficient sleep has also been shown to be associated with a variety of emotional difficulties. Wolfson and Carskadon (1998) found that short school-night TST and/or large weekend bedtime delay were associated with depressive mood. Controlled laboratory studies have also been conducted to examine the relationship between insufficient sleep and emotional responses. For example, Leotta, Carskadon, Acebo, Seifer, and Quinn (1997) noted that negative affect responses of anger, sadness, and fear increased following acute sleep restriction (4 hr of sleep) but that positive responses did not change.

Insufficient sleep has also been linked to behavior problems in several studies. Wolfson and Carskadon (1998) indicated that students with short school-night TST and/or large weekend bedtime delay reported more sleep-wake behavior problems and increased daytime sleepiness. Adolescents reporting sleep problems also indicated more anxious, depressed, inattentive, and conduct disorder behaviors than those who show no, or only occasional, sleep problems (Morrison, McGee, & Stanton, 1992).

One behavioral issue that has been understudied is the relationship between sleep and risk-taking behavior. Because studies have shown that sleep can affect overall daytime functioning in adolescents, it is hypothesized that sleep might also play a role specifically in risk-taking behavior. For example, in a sample of 2,293 adolescents, Carskadon (1989–1990) found a relationship between amount of time spent in extracurricular activities and/or working and several risky/dangerous behaviors, including engaging in alcohol use, engaging in drug use, and struggling to stay awake or falling asleep while driving. Students who had greater time commitments because of extracurricular activities and/or work obtained less sleep than those with fewer time commitments.

Risk-taking refers to those behaviors that increase the risk of morbidity and/or mortality (Irwin & Millstein, 1986). These risk-taking behaviors increase the chance for immediate threats, such as motor/recreational vehicle accidents with resultant injury and disability, unplanned pregnancy, infectious diseases, and addiction, as well as future health problems in adulthood, such as such chronic diseases as cardiovascular disease and cancer (Basen-Engquist, Edmundson, & Parcel, 1996). Although generally viewed negatively, risk-taking in middle and late adolescence may serve to fulfill developmental needs related to autonomy as well as needs for mastery and individuation (Irwin & Millstein, 1986). For example, many adolescents alter their conceptions of and feelings about themselves and experiment with a range of exploratory behaviors that may be developmentally functional but nonetheless carry substantial risk of harm (Baumrind, 1987).

Risk-taking in adolescents is a complex phenomenon, encompassing a wide range of behaviors with many precipitating factors. However, an emerging theory is that many of these risk behaviors share a common underlying process. Although many factors have been shown to play a contributory role in risk-taking behavior

(e.g., peers, parenting style), other, as yet unidentified, factors may be influential as well. One such factor may be sleep, which has received little consideration. Previous research has overwhelmingly supported the notion that adolescents do not obtain a sufficient amount of sleep for optimum functioning, leading to detriments in academic/intellectual functioning and to emotional and behavioral difficulties. Therefore, it is expected that insufficient sleep also leads to a greater frequency of risk-taking behavior in adolescents via reduced intellectual, emotional, and behavioral abilities. Thus, this study examined the relationship between adolescent sleep patterns and risk-taking behaviors with the expectation that those students who report poorer sleep habits would also exhibit higher levels of risk-taking behavior. A secondary purpose of this study was to replicate the results obtained by Wolfson and Carskadon (1998).

METHOD

Participants

Participants in this study were 388 high school students (217 males, 171 females), ages 14–19 ($M = 16.62$ years), in Grades 9–12. Students were recruited from four high schools in the Philadelphia area. Schools 1 ($n = 47$) and 2 ($n = 73$) were private, Catholic, all-boys schools (urban, rural); School 3 ($n = 200$) was a public, coeducational school (suburban); and School 4 ($n = 61$) was a private, Catholic, all-girls school (suburban). The majority of the sample described themselves as White/Caucasian (78.1%), with the remainder of the sample identifying themselves as Black/African American (7.2%), Asian/Asian American (9.0%), multiracial (1.5%), and other (3.1%); 1.0% did not specify their race.

Procedure

This study was approved by a university institutional review board. After we obtained permission from the administration at the high schools, signed informed consent was obtained from all students' parent or guardian. In addition, students were asked to complete informed assent forms at the time of the study. All students anonymously completed a demographic questionnaire; the Sleep Habits Survey (SHS) as presented in Wolfson and Carskadon (1998); and the Youth Risk Behavior Survey (YRBS), developed by the Division of Adolescent and School Health, Centers for Disease Control and Prevention (Kolbe, 1990). Following the study, the students were provided with contact information for resources related to alcohol, drugs, sexual behavior, rape, violence/abuse, depression, and suicidal feelings.

Demographic Questionnaire

All students completed a demographic questionnaire, which obtained general information, including gender, age, grade, and race.

Sleep Habits Survey

The SHS was used to assess the usual sleeping and waking behaviors of the participants over the past 2 weeks. The SHS is a comprehensive questionnaire querying respondents about a variety of sleep problems and behaviors and is intended for adolescent samples. In addition, each of the three scales of the SHS has been shown to have high internal reliability and validity (Wolfson & Carskadon, 1998).

Six sleep-wake pattern variables are included in the SHS (all scoring is consistent with that outlined by Wolfson & Carskadon, 1998):

- *School-night TST* and *weekend-night TST*. Self-reported TSTs were obtained and categorized into three groups: low (less than or equal to 6 hr 45 min of sleep), moderate (between 6 hr 45 min and 8 hr 15 min of sleep), and high (greater than or equal to 8 hr 15 min of sleep).
- *School-night bedtime* and *weekend-night bedtime*. These variables were self-reported.
- *Weekend delay*. Weekend delay is the difference between self-reported weekend-night bedtime and self-reported school-night bedtime, categorized into three groups: low (weekend delay less than or equal to 1 hr), moderate (between 1 and 2 hr), and high (greater than or equal to 2 hr).
- *Weekend oversleep*. Weekend oversleep is the difference between self-reported weekend-night TST and school-night TST, again categorized into three groups: low (weekend oversleep less than 1 hr), moderate (between 1 and 2 hr), and high (greater than 2 hr).

The SHS includes a measure of self-reported academic performance, asking participants if their grades are mostly “As, As and Bs, Bs, Bs and Cs, Cs, Cs and Ds, Ds, or Ds and Fs.” Responses are then collapsed into four categories: mostly As or As/Bs, mostly Bs or Bs/Cs, mostly Cs or Cs/Ds, and mostly Ds/Fs. In addition, the SHS includes three subscales assessing daytime sleepiness, sleep-wake behavior problems, and depressive mood.

The Daytime Sleepiness scale includes questions asking participants if they struggled to stay awake (fought sleep) or fell asleep in 10 different situations, such as during conversation or while studying, in the last 2 weeks. Participants rate answers on a scale of 1 (*no*) to 4 (*both struggled to stay awake and fallen asleep*). Total scores for this scale range from 10 to 40. Average scores were calculated to account for items left blank, with higher scores indicating higher levels of daytime

sleepiness. The Daytime Sleepiness scale has high internal reliability, with a coefficient alpha of .70 (Wolfson & Carskadon, 1998).

The Sleep-Wake Behavior Problems scale consists of 10 items regarding the frequency of indicators of erratic sleep-wake behavior over the last 2 weeks, such as arrived late to class because of oversleeping, stayed up past 3 a.m., needed more than one reminder to get up, and had an extremely hard time falling asleep. Participants rate the frequency of a particular behavior on a scale ranging from 1 (*never*) to 5 (*every day*). Total scores range from 10 to 50. Average scores were calculated to account for items left blank, with higher scores indicating more problems. The Sleep-Wake Behavior Problems scale also has high internal reliability, with a coefficient alpha of .75 (Wolfson & Carskadon, 1998).

The Depressive Mood scale (Kandel & Davies, 1982) asks how often participants were troubled or bothered by certain situations in the last 2 weeks. There are six items, including feeling unhappy/sad/depressed and feeling hopeless about the future. Three response categories are provided, ranging from 1 (*not at all*) to 3 (*much*), and the index of depressive mood is based on the total score. Average scores were calculated to account for items left blank, with higher scores indicating a higher level of depressed mood. An average score was calculated for each participant provided that he or she answered at least four of the questions of this scale. The Depressive Mood scale has also been shown to have high internal reliability, with a coefficient alpha of .79 (Wolfson & Carskadon, 1998). The Pearson correlation between the Depressive Mood scale and the Symptom Checklist-90 scale is .72, as reported by prior studies, and the Depressive Mood scale has a high test-retest reliability with adolescent samples over 5- to 6-month intervals ($r = .76$; Kandel & Davies, 1982).

Youth Risk Behavior Survey

The YRBS assesses several areas of self-reported behavior estimated to result in the greatest mortality and morbidity for adolescents. Only 7 of 12 subscales that are specific to risk-taking were administered in this study: (a) safety behaviors (5 items), (b) violence behaviors (10 items), (c) tobacco use (12 items), (d) alcohol use (5 items), (e) marijuana use (4 items), (f) drug use (i.e., drugs other than marijuana; 9 items), and (g) sexual behaviors (8 items). Most questions ask how often the participant engaged in a particular behavior, and responses are grouped into ordinal categories within a multiple-choice format. As an example, a sample question is, "During the past 30 days, on how many days did you smoke cigarettes?" The range of scores for this item is 0 (0 days) to 6 (all 30 days). Lower scores indicate less risk. Scores are tallied for each category, and a subscale score is derived for each category by calculating the average of the items in that scale. This test is comprehensive and covers a wide variety of risk behaviors.

The reliability of the YRBS was measured in a study by Brener, Collins, Kann, Warren, and Williams (1995). They used a test-retest format to investigate the reli-

ability of the YRBS for 1,679 students in Grades 7 to 12 who were tested on two occasions, 14 days apart. Prevalence rates were found to be similar at both testing sessions. Kappa statistics were calculated for each of the 53 items on the YRBS, with values ranging from 14.5% to 91.1%. Brener et al. (1995) found that 71.1% of all the items were found to have “substantial” or higher reliability (defined as $\kappa = 61\%–100\%$). In the present study, the reliability of the YRBS was examined. Making an adjustment for the items not used in the present study, it was found that 71.1% of the items used in the present study had substantial or higher reliability.

Similarly, correlations among the risk-taking behavior subscale scores in this study were computed. Significant relationships were found between all risk-taking behavior subscales ($r = .10$ to $.69$, $p < .05$). Also, the Depressive Mood scale of the SHS significantly correlated with the suicide/depressive feelings category of the YRBS ($r = .43$, $p < .001$), which further validates the use of the suicide/depressive feelings subscale of the YRSB as an accurate measure of this construct.

Statistical Analysis

The results are presented in two sections. First, summary data for all measures in this study are presented across grade and gender. Multivariate analyses of variance (MANOVAs) were used to examine the sleep–wake variables and risk-taking behavior across grade. Univariate analyses were then conducted following any significant multivariate effects, with Tukey honestly significant difference (HSD) tests used to examine any significant findings. Second, the relationships between sleep variables and risk-taking behaviors were assessed. Three sleep variables were evaluated, TST on school nights, weekend delay, and weekend oversleep, in accordance with other studies in this area (e.g., Wolfson & Carskadon, 1998), as these variables represented problems with inadequate sleep or sleep schedule irregularity.

RESULTS

Summary Data

In an attempt to control the experiment-wise error rate in this study, only those analyses that reach a significance level of $p < .001$ are termed *significant* in this article.

Sleep–wake patterns. A 2×4 MANOVA was conducted to examine differences in the three main sleep variables of primary interest (school-night TST, weekend delay, and weekend oversleep) across gender and grade. Overall, there was no interaction effect, $F(9, 1092) = 1.27$, $p > .05$, and no main effect for gender, $F(3, 362) = 0.64$, $p > .05$, for the three main sleep variables. Therefore, all data were collapsed across gender. However, a significant difference, $F(9, 1092) = 7.41$, $p < .001$, was found across grade for the three main sleep variables. Further

univariate tests showed significant differences for school-night TST, $F(3, 364) = 11.99, p < .001$, and weekend delay, $F(3, 364) = 6.89, p < .001$, across grade with students in upper grades having a significantly shorter school-night TST and longer delay than students in lower grades. Results of additional analyses for each of the six sleep pattern variables across grade are presented in Table 1. For all variables, post hoc Tukey HSD tests revealed differences between lower and upper grades. Furthermore, the relationship between sleep on weekdays compared to weekends is presented in Figure 1.

Risk-taking. To assess the prevalence of self-reported risk-taking behaviors for the adolescents in this study, we calculated frequency distributions for each subscale. A score of zero indicated no participation in a particular risk-taking behavior, with scores greater than zero indicating that the student answered at least one question in the subscale affirmatively. In other words, even though a student was not a regular smoker, if he or she indicated having tried a cigarette at some time, he or she would have received a score greater than zero. Those students with higher scores engaged in a greater level of risk-taking or engaged in a risky behavior more frequently than those with lower scores. To assess the prevalence of risk-taking in this sample, a comparison of those who had never tried a particular risky behavior with those who had reported at least trying the risky behavior was made. Comparison of a portion of these results with those reported in the 1999 YRBS conducted by the Centers for Disease Control and Prevention (Kann et al., 2000) can be found in Table 2.

To determine if there were differences in self-reported risk-taking behavior across gender and grade in our sample, a 2×4 MANOVA was conducted. Overall, there was no interaction effect, $F(21, 1104) = 1.16, p > .05$. Individual multivariate analyses indicated a significant effect across grade, $F(21, 1104) = 2.93, p < .001$, but not across gender, $F(7, 366) = 1.85, p > .05$. Therefore, all data were collapsed across gender. Further univariate analyses revealed significant differences across grade for tobacco use, alcohol use, marijuana use, and sexual behavior (see Table 1). In addition, follow-up post hoc Tukey HSD tests were conducted on all findings, with results indicating risk-taking was increased in upper grades compared to lower grades.

Sleep–Wake Patterns and Daytime Functioning

Sleep–wake patterns and daytime behavior. A 2×4 MANOVA was conducted to examine participants' scores on the three daytime functioning scales (Daytime Sleepiness, Sleep–Wake Behavior Problems, and Depressive Mood) across gender and grade. No interaction effect was found, $F(9, 1107) = 1.12, p > .05$. Further individual multivariate analyses revealed that there was no gender difference for participants' scores on the three daytime functioning scales, $F(3, 367) = 0.44, p > .05$, but there appeared to be some effect for grade, although it did not reach significance, $F(9, 1107) = 3.05, p < .01$. Further univariate tests examining scores on the daytime functioning scales across grade showed a

TABLE 1
Overall Results for Sleep Variables and Risk-Taking Behaviors Across Grade

Variable	All Students		Grade 9 ^a		Grade 10 ^b		Grade 11 ^c		Grade 12 ^d		F
	M	SD	M	SD	M	SD	M	SD	M	SD	
Sleep											
School night											
TST (in minutes)	410	69	7.44 _{a,b,c}	.82	7.18 _{a,d}	.92	7.16 _{b,e}	1.06	6.58 _{c,d,e}	1.19	11.99***
Bedtime	11:13 p.m.	58 min	10:38 _{f,g,h}	41	11:07 _{f,i}	50	11:13 _g	38	11:24 _{h,i}	62	10.17***
Weekend night											
TST (in minutes)	538	111	9.63 _{jk}	1.37	9.38 _{lm}	1.50	8.85 _{jl}	1.54	8.70 _{km}	1.99	6.01**
Bedtime	1:04 a.m.	85 min	11:59 _{no,p}	56	12:42 _{nq,r}	47	1:15 _{o,q}	71	1:24 _{p,r}	88	22.51***
Weekend delay (in minutes)	110	70	1.36 _{st}	.79	1.55	.78	2.03 _s	1.14	2.00 _t	1.26	6.89***
Weekend oversleep (in minutes)	130	106	2.17 _u	1.51	2.20 _v	1.61	1.70 _{u,v,w}	1.58	2.20 _w	1.89	0.02
Risk-taking behaviors											
Safety Behavior	.21	.18	.17 _a	.12	.17 _b	.14	.16 _c	.17	.23 _{a,b,c}	.19	3.71*
Violence Behaviors	.04	.07	.04 _d	.06	.04 _e	.09	.06 _{d,e,f}	.10	.04 _f	.07	.05
Tobacco Use	.12	.15	.06 _{k,l}	.11	.05 _{mn}	.08	.17 _{km}	.14	.14 _{in}	.17	8.12***
Alcohol Use	.23	.19	.16 _{op}	.13	.18 _{op,r}	.17	.31 _{o,q,s}	.19	.25 _{p,t,s}	.20	6.29***
Marijuana Use	.13	.19	.03 _{tu,v}	.09	.07 _{l,w,x}	.14	.23 _{u,w,y}	.22	.15 _{v,x,y}	.19	10.52***
Drug Use	.02	.07	.01 _z	.01	.01 _{aa}	.02	.02	.03	.03 _{z,aa}	.08	2.90*
Sexual Behaviors	.16	.22	.08 _{bb,cc,dd}	.19	.03 _{bb,ee,ff}	.11	.13 _{cc,ee,gg}	.21	.21 _{dd,ff,gg}	.23	13.60***

Note. Means in a row sharing subscripts are significantly different. TST = total sleep time.

^an = 71. ^bn = 37. ^cn = 29. ^dn = 243.

*p < .05. **p < .01. ***p < .001.

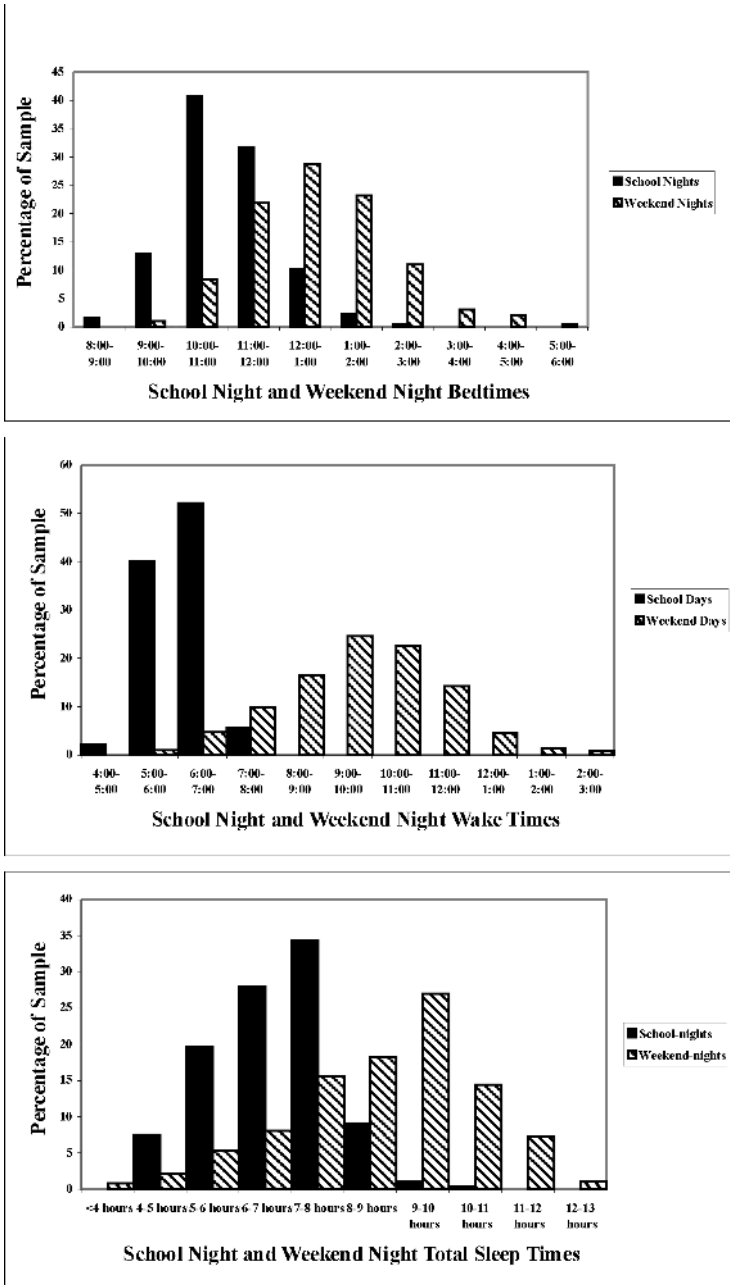


FIGURE 1 School-night versus weekend-night sleep habits.

TABLE 2
 Frequency of Selected Self-Reported Risk-Taking Behaviors in the Present Sample and the Centers for Disease Control and Prevention (CDC) Sample From the 1999 Youth Risk Behavior Survey (YRBS)

<i>Risk-Taking Behaviors</i>	<i>Present Sample (%)</i>	<i>CDC Sample—YRBS 1999 (%)^a</i>
Tobacco Use	62.1	70.4
Alcohol Use	83.4	81.0
Marijuana Use	39.6	47.2
Drug Use	35.0	41.1
Sexual Behaviors	38.7	49.9

^aPercentages for the 1999 YRBS CDC sample can be found in Kann et al. (2000).

significant difference only for scores on the Sleep–Wake Behavior Problems subscale, $F(3, 369) = 6.22, p < .001$, with students in upper grades having more sleep problems than students in lower grades. Because no gender differences were found, all data were collapsed across gender.

Results of analyses for scores on each of the daytime functioning scales across the low versus high groups of each of the three main sleep pattern variables (school-night TST, weekend delay, and weekend oversleep) are presented in Table 3. For each of the three main sleep pattern variables, a one-way MANOVA was conducted to compare subscale scores between the low and high groups (consistent with analyses conducted by Wolfson & Carskadon, 1998). A significant overall result was found for school-night TST, $F(3, 199) = 13.46, p < .001$, and weekend delay, $F(3, 288) = 7.01, p < .001$, but not weekend oversleep, $F(3, 259) = .50, p > .05$. Univariate analyses revealed a significant difference between scores in the low versus high groups of school-night TST for Daytime Sleepiness and Sleep–Wake Behavior Problems. Differences on the Depressive Mood subscale between the low and high groups of school-night TST did not reach the level of significance set in this study. A significant difference was found between scores in the low versus high groups of weekend delay for the Sleep–Wake Behavior Problems scale only. There were no significant differences between scores in the low versus high groups of weekend oversleep for any of the three subscales.

Sleep–wake patterns and risk-taking behavior. To determine whether weekday sleep deprivation and poor sleep habits (as measured by shorter school-night TST, longer weekend oversleep, and longer weekend delay) were related to increased self-reported risk-taking and decreased academic performance, two types of analyses were conducted, as appropriate. To determine whether there were differences in scores for each of the risk-taking behavior subscales of the YRBS across the low versus high levels of the three main sleep variables (school-night TST, weekend delay, and weekend oversleep), one-way MANOVAs were conducted. A significant overall result was found for weekend delay only,

TABLE 3
Means, Standard Deviations, and Results of Analyses of Variance for Daytime Behavior Scales for Low Versus High Groups

Daytime Functioning Variables	School-Night TST		Weekend Delay		Weekend Oversleep		F Values (Sleep Variables)		
	≤405 min (n = 172)	≥495 min (n = 36)	≤60 min (n = 109)	≥120 min (n = 189)	<60 min (n = 82)	>120 min (n = 188)	School-Night TST	Weekend Delay	Weekend Oversleep
Daytime Sleepiness									
M	1.81	1.40	1.68	1.70	1.65	1.71	24.40**	0.06	1.11
SD	0.46	0.32	0.52	0.48	0.48	0.45			
Sleep-Wake Behavior Problems									
M	2.44	1.79	2.06	2.37	2.18	2.26	34.25**	16.16**	0.94
SD	0.58	0.67	0.56	0.69	0.66	0.57			
Depressive Mood									
M	1.95	1.65	1.81	1.85	1.82	1.86	11.64*	0.36	0.55
SD	0.49	0.43	0.48	0.48	0.46	0.46			

Note. TST = total sleep time.

* $p < .01$. ** $p < .001$.

$F(7, 289) = 11.94, p < .001$. Results for school-night TST, $F(7, 197) = 1.44, p > .05$, and weekend oversleep, $F(7, 259) = .59, p > .05$, did not reach significance.

Univariate analyses revealed significant differences in scores in the low versus high groups of weekend delay for safety behaviors, tobacco use, alcohol use, marijuana use, and sexual behaviors. In addition, a nonsignificant trend was found across weekend delay for drug use as well. Regarding these risk-taking behaviors, students with a weekend delay of 2 hr or more had significantly higher risk-taking scores compared to students with a weekend delay of 1 hr or less. Univariate tests revealed a nonsignificant trend in scores in the low versus high groups of school-night TST for alcohol use. For this risk-taking behavior, students obtaining less than 6 hr 45 min of sleep per night had higher reported alcohol use scores compared to students obtaining at least 8 hr 15 min of sleep per night. No significant differences were found across length of weekend oversleep for any of the risk-taking behavior scores. Results of these analyses are presented in Table 4.

To determine if there was a significant difference in academic grades across the low versus high groups of the three main sleep variables, we conducted chi-square analyses. A significant difference was found for academic grades across weekend delay, $\chi^2(3, N = 294) = 19.39, p < .001$, but not across school-night TST, $\chi^2(3, N = 205) = 1.56, p > .05$, or weekend oversleep, $\chi^2(3, N = 266) = 3.16, p > .05$. The results of these analyses are presented in Table 5.

Daytime behaviors and risk-taking behavior. To evaluate whether daytime sleepiness was associated with risk-taking behavior, we performed linear regression analyses for composite scores for each of the seven risk-taking behavior subscales on the YRBS across scores on the Daytime Sleepiness Scale of the SHS. Although results revealed some predictive ability of Daytime Sleepiness scale scores for risk-taking behavior, none of these reached significance at the $p < .001$ level set for this study.

To evaluate whether sleep problems were associated with risk-taking behavior, we performed linear regression analyses for composite scores for each of the seven risk-taking behavior subscales on the YRBS across scores on the Sleep–Wake Behavior Problems Scale of the SHS. Results revealed that scores on the Sleep–Wake Behavior Problems Scale were predictive of scores for safety behaviors, tobacco use, alcohol use, marijuana use, and sexual behaviors. Results of these regression analyses are presented in Table 6.

DISCUSSION

Overall, the results obtained provide some support for the hypotheses of this study—namely, that those adolescents who reported sleep habits resulting in insufficient sleep also reported engaging in increased risk-taking behaviors compared

TABLE 4
Sleep and Risk-Taking Behavior

Risk-Taking Behaviors	School-Night TST						Weekend Delay						Weekend Oversleep						
	Low			High			Low			High			Low			High			
	M	SD	F	M	SD	F	M	SD	F	M	SD	F	M	SD	F	M	SD	F	
Safety Behaviors	.23	.19	.19	.15	0.82	.16	.16	.24	.19	16.20***	.23	.18	.20	.18	.20	.18	.20	.18	2.28
Violence Behaviors	.04	.08	.03	.06	0.82	.03	.06	.05	.08	2.72	.05	.08	.04	.07	.04	.07	.04	.07	1.75
Tobacco Use	.15	.18	.10	.12	2.96	.05	.09	.18	.17	50.55***	.13	.15	.12	.16	.12	.16	.12	.16	0.37
Alcohol Use	.26	.20	.16	.16	6.96**	.14	.15	.30	.20	58.09***	.26	.19	.23	.20	.19	.23	.20	.20	1.95
Marijuana Use	.16	.20	.11	.17	1.25	.05	.11	.20	.21	48.54***	.15	.18	.13	.20	.13	.20	.13	.20	0.47
Drug Use	.03	.06	.01	.03	3.71	.01	.02	.03	.09	8.05**	.03	.04	.02	.05	.02	.05	.02	.05	0.21
Sexual Behaviors	.22	.24	.13	.20	3.98*	.08	.17	.24	.23	39.95***	.18	.21	.16	.23	.16	.23	.16	.23	0.47

Note. TST = total sleep time.

* $p < .05$. ** $p < .01$. *** $p < .001$.

TABLE 5
Academic Grades Across the Three Sleep Pattern Variables

Grades	School-Night TST		Weekend Delay		Weekend Oversleep	
	Low (<i>n</i> = 170; ≤405 min)	High (<i>n</i> = 35; ≥495 min)	Low (<i>n</i> = 108; ≤1 hr)	High (<i>n</i> = 186; ≥2 hr)	Low (<i>n</i> = 80; <1 hr)	High (<i>n</i> = 186; >2 hr)
Mostly As–As and Bs						
<i>n</i>	90	22	84	97	49	111
%	52.9	62.9	77.8	52.2	61.3	59.7
Mostly Bs–Bs and Cs						
<i>n</i>	56	10	18	67	24	54
%	32.9	28.6	16.7	36.0	30.0	29.0
Mostly Cs–Cs and Ds						
<i>n</i>	22	3	6	20	6	21
%	12.9	8.6	5.6	10.8	7.5	11.3
Mostly Ds and Fs						
<i>n</i>	2	0	0	2	1	0
%	1.2	0	0	1.1	1.3	

Note. For school-night TST: $\chi^2(3, N = 205) = 1.56, p > .05$. For weekend delay: $\chi^2(3, N = 294) = 19.39, p < .001$. For weekend oversleep: $\chi^2(3, N = 266) = 3.16, p > .05$. TST = total sleep time.

TABLE 6
 Results of Linear Regression Analyses for the Prediction of Risk-Taking
 Behaviors Using Scores From the Daytime Sleepiness Scale and
 Sleep-Wake Behavior Problems Scale

<i>Variable</i>	<i>B</i>	<i>SE of B</i>	β
Daytime Sleepiness scale scores as predictor			
Safety Behaviors	0.024	0.019	.065
Violence Behaviors	0.018	0.008	.119*
Tobacco Use	0.044	0.016	.138**
Alcohol Use	0.041	0.020	.103*
Marijuana Use	0.043	0.020	.110*
Drug Use	-0.013	0.007	-.009
Sexual Behaviors	0.060	0.024	.130*
Sleep-Wake Behavior Problems scale scores as predictor			
Safety Behaviors	0.070	0.014	.251***
Violence Behaviors	0.020	0.006	.173**
Tobacco Use	0.068	0.012	.282***
Alcohol Use	0.079	0.015	.270***
Marijuana Use	0.078	0.015	.266***
Drug Use	0.011	0.005	.106*
Sexual Behaviors	0.085	0.017	.245***

* $p < .05$. ** $p < .01$. *** $p < .001$.

to students who reported obtaining more adequate sleep. Overall, school-night TST had a limited relationship to self-reported risk-taking behavior (i.e., alcohol use), and length of weekend delay was related to both self-reported risk-taking behavior and academic performance. Specifically, students who obtained the least amount of sleep on school nights reported greater alcohol usage than those students who obtained the most sleep on school nights, and those students with the biggest difference between their school-night and weekend-night bedtimes reported higher levels of risk-taking behavior and lower academic performance. It may be that those students who obtained less sleep during the week and/or whose weekend sleep schedules differ the most from their school-week sleep schedules are more susceptible to various risky behaviors, as well as emotional and behavioral difficulties. The third indicator of poor/irregular sleep habits, weekend oversleep, was not significantly related to any of the risk-taking behaviors or to academic performance, suggesting that "catching up" on sleep on the weekends may not be detrimental to adolescents' daytime functioning.

The results of this study are consistent with previous research. These findings provide some support for prior studies noting that daytime sleepiness has negative implications for adolescents' daytime functioning (e.g., Carskadon, 1990, 1999). In addition, the relationship between sleep and academic performance has been documented in numerous studies (e.g., Allen, 1992; Kowalski & Allen, 1995;

Wolfson & Carskadon, 1998). Previous studies have also shown that insufficient sleep is linked to decreased cognitive ability in adolescents (e.g., Carskadon, 1999; Wolfson & Carskadon, 1998). However, this is the first study documenting a relationship between poorer sleep habits and self-reported increased risk-taking among adolescents.

It was found that 85.5% of the adolescents in this study had engaged in unsafe behavior, 42.3% had experienced violent behavior, and 43.3% had experienced some level of suicide/depressive feeling. Regarding substance use, 62.1% of the sample had at least tried smoking cigarettes or used some form of tobacco, 83.4% had at least one drink of alcohol, 39.6% had tried marijuana, 35.0% had tried some drug other than marijuana, and 38.7% had had sexual intercourse. Rates were higher for participants in upper grades compared to lower grades. The national results of the Centers for Disease Control and Prevention's 1999 YRBS (Kann et al., 2000) showed similar results: 70.4% of that sample reported that they had tried smoking a cigarette, 81.0% had had at least one drink of alcohol, 47.2% had tried marijuana, 41.1% had tried some drug other than marijuana (i.e., cocaine, some type of inhaled substance, heroin, methamphetamines, steroids, or some injectable substance), and 49.9% had had sexual intercourse. Rates for most items were higher for participants in upper grades compared to lower grades. In addition, 28.3% of that sample reported feeling so sad or hopeless every day for at least 2 weeks in a row that they stopped doing some usual activities, and 19.3% of the sample reported seriously considering attempting suicide during the 12 months preceding the survey. Female participants were more likely to report this than males in all grades.

The results of this study supported most of the findings of Wolfson and Carskadon (1998), with a few exceptions. Both studies noted changes in both weekday and weekend sleep habits across grade/age, including decreased school-night TST and weekend-night TST, later school-night bedtimes and weekend-night bedtimes, and increased weekend delay. However, contrary to the findings of Wolfson and Carskadon (1998), our sample did not differ in weekend oversleep across grade. Furthermore, Wolfson and Carskadon (1998) found that students with higher grades reported differences in both their weekday and weekend sleep habits compared to students with poorer academic performance. In this study, results showed that there was only a difference in academic performance between those students exhibiting a long versus short weekend delay. As in the study by Wolfson and Carskadon (1998), our sample also exhibited differences in daytime functioning according to their sleep patterns. Specifically, in this study, those students with shorter school-night TST reported more daytime sleepiness, more sleep-wake behavior problems, and higher levels of depressive mood. Also, those students with a longer weekend delay reported more sleep-wake behavior problems than those with a shorter weekend delay. These results partially corroborate the findings of Wolfson and Carskadon (1998); however, no effect for weekend oversleep on daytime functioning was found in this sample.

The exact mechanism linking sleep habits and risk-taking is unknown. It may be that reduced cognitive functioning makes teens more susceptible to peer pressure or less likely to fully consider the consequences of risky behaviors. On the other hand, the possibility exists that some third variable, such as sensation-seeking, could be affecting both adolescents' sleep habits and their tendency to engage in risk-taking. Perhaps those students who engage in risk-taking have a decreased need for sleep or have a lower threshold for the effects of what amounts to a pattern of sleep deprivation. Alternatively, it is possible that another factor, such as parental control, could underlie both adolescents' poorer sleep habits and increased risk-taking behavior. Finally, because the rates of the self-reported risk-taking behaviors examined in this study seemed to be higher in students in upper grades compared to lower grades, and because sleep habits appeared to be poorer in upper grades as compared to lower grades in this sample, it cannot be ruled out that age may be an underlying factor mitigating this relationship between sleep and risk-taking in adolescents.

In the current research, we found that many adolescents are not obtaining an adequate amount of sleep during the week. That is, many of the participants in this study are obtaining 6 hr 45 min of sleep per night, or less, during the school week. Because previous research has shown that adolescents require at least 8.5 hr of sleep per night (Carskadon et al., 1980), and more appropriately 9.25 hr of sleep, many of the students in this study are functioning in a sleep-deprived state. Furthermore, school-night TST decreased as students moved into higher grades. Eighty-one percent of the participants obtaining less than 7 hr of sleep per night were in 12th grade. Furthermore, only 9.2% of the entire sample were obtaining at least 8 hr 15 min of sleep a night during the week. Previous research has supported such a pattern in adolescence (Levy, Gray-Donald, Leech, Zvagulis, & Pless, 1986; Wolfson, 1996; Wolfson & Carskadon, 1998).

For all grades, weekend bedtimes were later overall compared to bedtimes during the week. This finding is again consistent with previous research (Carskadon, 1990; Wolfson, 1996; Wolfson & Carskadon, 1998). The majority of this sample (62.4%) reported going to bed at 11 p.m. or later during the week, which is consistent with previous research by Wolfson and Carskadon (1998). However, on the weekends, 97.1% of the students reported going to bed at 11 p.m. or later. A decreasing pattern of weekend-night TST was also observed across grades. This result also follows previous research (Carskadon, 1990; Strauch & Meier, 1988; Wolfson, 1996; Wolfson & Carskadon, 1996). Participants in higher grades obtained less sleep than those in lower grades. However, mean amounts for participants in all grades were greater than 8.5 hr a night on weekends. Furthermore, results showed no detrimental effects for those participants who reported a longer weekend oversleep compared to those with a shorter weekend oversleep. Thus, "catching up" on sleep on the weekends may not be a bad thing for adolescents.

Daytime sleepiness was considered at least moderately problematic by 35.1% of the sample. This was based on ratings of daytime sleepiness as "more than a lit-

tle problem,” “a big problem,” or “a very big problem.” In addition, 67% of participants indicated that they thought they obtained “too little sleep.” Obviously, these students are experiencing significant sleepiness during the day. Furthermore, although they did not reach the level of significance set in this study, the results showed a trend indicating that this daytime somnolence was related to self-reported substance use and behavior difficulties. Sleep problems were also examined in this sample. Students reporting more sleep problems were also more likely to report that they were experiencing behavior problems and substance use.

Finally, there were no significant differences in self-reported sleep habits or self-reported risk-taking behavior across gender in this study. Although previous research has reached conflicting conclusions regarding whether boys engage in more risk-taking than girls do, the current study indicated no differences. Further examination of the data revealed that means for all risk-taking behaviors were higher for males than for females (even though the differences were not significant); therefore, one possible explanation for this could be the size or the specificity of the sample described in this study. In addition, despite the researchers’ efforts to assure participants of the anonymity of their responses, some students may have been reluctant to accurately report their risk-taking behaviors. The lack of differences in reported sleep habits across gender in this study could also be attributed to the sample size. Although it was felt that this sample size was sufficient to detect significant relationships among the variables under study, other studies have had a much larger number of participants (e.g., Wolfson & Carskadon, 1998), which might have enabled them to detect even more subtle differences in sleep habits between males and females.

There are several limitations to the current research. The first potential limitation was the study sample itself. The sample was limited to schools that agreed to participate in this research, and three of the four participating schools were Catholic institutions. Furthermore, all the schools were located in the same geographic area, and there was not an equal distribution of grades represented by each school. In addition, because of the correlational nature of this study, it is difficult to draw causal conclusions from the data presented. Therefore, all results should be interpreted with caution.

There are also a number of limitations to the present study related to its validity and generalizability. These would include lack of a diverse sample, in regard to both the age distribution of the participants and the type and location (urban, suburban, or rural) of the school from which the sample was drawn. Future research should attempt to obtain a geographically diverse sample to increase the external validity of these results. In addition, the use of self-report may also be a limitation to the current research. Although every effort was made to assure participants that their responses would be anonymous, some participants may not have provided accurate information about their sleep habits, risk-taking behaviors, or both. Future research could attempt to verify self-report information with some objective criteria to determine whether the self-reported information was accurate.

The current results also provide several possible directions for future research. Although a link has been established between sleep patterns and self-reported emotional problems, behavior problems, substance use, and academic difficulties, these relationships are not clear. These correlates of sleep are all complex, and the role of sleep in their existence is not completely understood. Future research should clarify these relationships.

Overall, the results of this study support the expectation that inadequate sleep and increased sleep problems have negative effects on adolescents' daytime functioning, including poorer academic performance, increased daytime sleepiness, negative moods, behavior problems, and increased risk-taking. Of interest, no detrimental effects were found for adolescents who slept longer on weekends, indicating that weekend oversleep may not be related to risk-taking behavior in adolescents. Risk-taking is a complex phenomenon, and adolescents seem to be a particularly vulnerable population. This study adds one more piece to the puzzle, in that sleep habits and sleep problems may also relate to risk-taking behaviors.

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