Relationships Among Sleepiness, Sleep Time, and Psychological Functioning in Adolescents

Melisa Moore,[1] PhD, H. Lester Kirchner,[2] PhD, Dennis Drotar,[3] PhD, Nathan Johnson,[4] MS, Carol Rosen,[5] MD, Sonia Ancoli-Israel,[6] PhD, and Susan Redline,[4] MD

[1]Center for Sleep and Respiratory Neurobiology, University of Pennsylvania School of Medicine, [2]Geisinger Center for Health Research, Geisinger Health System, [3]Center for Adherence and Self-Management, Cincinnati Children's Hospital Medical Center, [4]Center for Clinical Investigation, Case Western Reserve University School of Medicine, [5]Department of Pediatrics, Case Western Reserve School of Medicine, and [6]Department of Psychiatry, University of California

Objective This study examined associations among adolescent sleepiness, sleep duration, variability in sleep duration, and psychological functioning (symptoms of anxiety, depression, externalizing behaviors, and perceived health). **Methods** This was a cross-sectional analysis of data from a community-based cohort study of sleep and health. Participants were 247 adolescents (48.6% female, 54.3% ethnic minority, mean age of 13.7 years). Sleep duration and variability in sleep duration were measured by actigraphy and sleepiness was measured by adolescent questionnaire. Primary outcomes were measured by parent, teacher, and adolescent questionnaires. **Results** Sleepiness was associated with higher scores on measures of anxiety (Adjusted partial $r^2 = .28$, $p < .001$), depression (Adjusted partial $r^2 = .23$, $p < .001$), and perceived health (indicating more negative outcomes) (Adjusted partial $r^2 = .19$, $p < .01$). Significant associations between sleep duration or variability in sleep duration with psychological variables were not found. **Conclusions** Findings highlight the inter-relationships between sleepiness and psychological functioning and the potential importance of addressing sleepiness in health and psychological evaluations of adolescents.

Key words adolescents; sleep; psychosocial functioning.

Introduction

Normative biological, psychological, and social changes occur during adolescence that predispose adolescents to insufficient sleep and sleepiness. Although the need for sleep does not decrease during the teenage years, adolescents typically obtain less than the 9.2 h of sleep that is recommended (Carskadon, 1982; Fredriksen, Rhodes, Reddy, & Way, 2004). In non-clinical samples, 63–87% of adolescents report that they do not get enough sleep (Mercer, Merritt, & Cowell, 1998; Wolfson & Carskadon, 1998). Additionally, research has demonstrated that when adolescents and children sleep for the same number of hours per night, adolescents report higher rates of sleepiness during the day, which supports the idea that adolescents may have a greater sleep need (Carskadon, Harvey, Duke, Anders, Litt, & Dement, 1980). Lack of adequate sleep can lead to inconsistent sleep schedules, chronic patterns of sleep deprivation, and attempts at ''catch-up sleep'' wherein adolescents oversleep on non-school days (Mindell, Owens, & Carskadon, 1999).

Such lack of sleep, sleepiness, and irregular sleep patterns may lead to negative psychosocial consequences such as depressed mood and behavior problems, and it has been hypothesized that insufficient sleep may contribute to problems as suicide and motor vehicle accidents, which are two of the leading causes of death in adolescents (Carskadon & Acebo, 2002). Insufficient sleep may also contribute to increased reports of pain and reports of poor overall health (Meltzer, Logan, & Mindell, 2005; Moffitt, Kalucy, Kalucy, Baum, & Cooke, 1991) as

All correspondence concerning this article should be addressed to Melisa Moore, PhD, 3624 Market St., Suite 205 Philadelphia, PA 19104, USA. E-mail: mooremel@email.chop.edu

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well as poor functioning at school and work. There are relatively few empirical studies of the relationship between sleep and psychological functioning in adolescents. Moreover, the number of adolescents reporting insufficient sleep underscores the importance of additional research.

Sleep and Psychological Functioning in Adolescents

Though not well-studied in adolescents, there is growing evidence to support important relationships between indices of sleep quality and duration to psychological symptoms and functioning such as symptoms of depression and anxiety as well as perceived health. For example, research has demonstrated an association between sleep problems (including an inconsistent sleep schedule) and symptoms of depression and anxiety in adolescents (Roberts, Roberts, & Chen, 2001; Morrison, McGee, & Stanton, 1992; Wolfson and Carskadon 1998). Regarding externalizing behaviors, Smedje, Broamn, & Hetta (2001) found that by parent report, 36% of children with sleep problems had behavior problems and that 15% of those with behavior problems had sleep problems. Chervin, Dillon, Archbold, & Ruzicka (2003) demonstrated that parent-reported conduct problems were associated with symptoms of restless legs syndrome, periodic limb movement disorder, and sleep disordered breathing. Finally, Roberts, Roberts, and Chen (2002) found that sleep problems related to somatic complaints while Mahon (1995) found positive correlations between perceived health and both sleep duration and sleep efficiency (amount of time actually sleeping while in bed).

It should be noted that a bidirectional relationship likely exists whereby psychological outcomes may contribute to poor sleep quality as well as poor sleep contributing to psychological symptoms. Disrupted sleep and mood disorders may also occur in the same individuals if both disorders occur as consequences of common neurobehavioral dysregulatory systems.

Limitations of Previous Studies and the Contribution of the Current Study

Previous research has demonstrated that decreases in sleep duration, irregular sleep patterns, and increased sleepiness occur with the onset of adolescence. However, there have been relatively few studies of the relationship between these specific sleep variables and adolescent psychological functioning. Moreover, the conclusions that can be drawn from existing studies may have been affected by significant methodological limitations.

A primary limitation of previous research is inadequate measurement of both sleep and psychological functioning. Much of the research found in the current literature has relied on single item self-report or parent report of sleep problems and average sleep duration (i.e., ''do you have trouble sleeping''; ''how many hours do you/does your child usually sleep at night''). Single item or few item questionnaires may not be adequate assessments of sleep duration, variability in sleep duration or sleepiness. Adolescent report of sleep duration may not be accurate and parents may not know how many hours their teen sleeps once they are in bed, thus limiting internal validity. Studies have also shown that perceptions of sleep duration and quality may be distorted in certain populations, including anxious adults with higher levels of cognitive and physiological arousal (Tang & Harvey, 2004) and children with major depressive disorder (Bertocci et al., 2005). Studies that have used the same measure to determine both sleep variables and psychological variables may also have inflated correlations owing to item overlap and shared symptoms on sleep scales and scales of psychological symptoms. Finally, many studies have utilized a wide age range that encompasses both children and adolescents, which limits the conclusions that can be drawn about any particular age group.

The current study adds to the literature by including an objective estimate of sleep duration and multiple reporters of psychological functioning. Three specific sleep-related variables: sleep duration, variability in sleep duration and sleepiness were measured. Actigraphy, which is used in the present study to provide an objective estimate of sleep duration, is a methodological strength not only because of issues with adolescent and parent reporting as previously described, but actigraphy also allows for the measurement of sleep duration over multiple nights in a subject's normal sleep environment. This provides information about a subject's typical sleep schedule and is less intrusive than polysomnography (PSG). Additionally, multiple reporters of psychological functioning, including parent, teacher, and adolescent were employed. Because prior research has suggested that adolescents may be the best reporters of their own internalizing symptoms (Angold et al., 1987), in the current study, adolescent report was used for anxiety, depression, and perceived health. Parent report was used for both perceived health and externalizing symptoms and teacher report was also used for externalizing symptoms.

Specific Aims and Hypotheses

The major aim of this study was to determine the associations between sleepiness, total sleep duration, variation in

sleep duration, and psychological functioning in adolescents. Previous research has demonstrated that adolescents are predisposed to problematic changes in amount and regularity of sleep (Carskadon & Acebo, 2002). Shorter sleep duration and inconsistent sleep patterns have been linked to more negative psychological outcomes. Thus, it is hypothesized that shorter sleep duration, increased night to night variability in sleep and increased sleepiness are associated with higher parent and teacher reports of externalizing behavior, higher self-reported symptoms of anxiety, higher self reported symptoms of depression, and lower scores on parent and adolescent measures of perceived health.

Methods

Participants

The study sample was derived from the Cleveland TeenZzz Study, which included a sample of adolescents studied at ages 13–16 years, who initially participated in the Cleveland Children's Sleep and Health Study (CCSHS). The CCSHS is an ongoing longitudinal cohort study designed to evaluate the role of sleep disturbances on health outcomes. This urban community-based cohort of 907 children was assembled as a stratified random sample of full-term and preterm children born at one of three Midwestern hospitals between 1988 and 1993, designed to over-represent African-American and former preterm children, as described previously (Rosen et al., 2003). Recruitment for the TeenZzz Study sample was designed to enroll at least 250 CCSHS participants, representing all snorers and children with sleep disordered breathing at the time of the CCSHS examination, and a stratified (gender, race, term) random sample of the remaining cohort. This sampling frame identified 389 potentially eligible children. Of those 389, 75.1% (292) agreed to participate, 14.9% refused, 10.0% could not be located, and <1% were ineligible due to illness (e.g., kidney failure, oral surgery, and suicidality). There were no differences on key demographic variables between those who decided to participate and those who did not. Of the families who refused to participate, the reasons were passive refusal (e.g., agreed to participate but did not respond to calls) (17.2%), too busy (19.0%), did not like medical procedures (13.8%), or miscellaneous (50.0%). This yielded a sample of 292 adolescents. For this analysis, we excluded the 23 adolescents with sleep disordered breathing (apnea hypopnea index ≥ 5, $n = 23$) since prior work has shown that actigraphy may systematically underestimate sleep duration in those with sleep apnea (Ancoli-Israel et al., 2003; Johnson et al., 2007). Adolescents whose actigraphy did not include at least two weekdays and one weekend day were also excluded ($n = 18$), as one of the primary outcomes was night-to-night variability. Additionally, those with a severe medical illness (e.g., cerebral palsy; $n = 4$) were excluded, bringing the total sample to 247 (see Table I for characteristics of the sample).

Table I. Sample characteristics

	N	*n* (%)	Mean (*SD*)
Age	247		13.6 (0.7)
BMI percentile	243		68.2 (27.8)
Gender	247		
Male		120 (48.6%)	
Female		127 (51.4%)	
Ethnicity	247		
Minority		134 (54.3%)	
Non-minority		113 (45.7%)	
Preterm	247		
Preterm		143 (57.9%)	
Term		104 (42.1%)	
Asthma	247		
With Asthma		56 (22.7%)	
Without Asthma		191 (77.3%)	
Parent education	241		
Some High school		21 (8.7%)	
High school diploma/GED		50 (20.7%)	
Some college/vocational school		86 (35.7%)	
College		60 (24.9%)	
Graduate/professional		24 (10.0%)	
Parent income	235		
<5000		23 (9.8%)	
5000–9999		19 (8.1%)	
10 000–19 000		23 (9.8%)	
20 000–29 999		22 (9.4%)	
30 000–39 999		25 (10.6%)	
40 000–49 999		20 (8.5%)	
>50 000		76 (43.8%)	
Outcome measures			
Externalizing *t*-score (parent report)	242		49.4 (11.4)
Externalizing *t*-score (teacher report)	177		49.5 (9.1)
Depression	247		7.17 (6.3)
Anxiety	243		36.94 (14.3)
Perceived health (teen report)	240		72.9 (17.0)
Perceived health (parent report)	246		73.0 (15.4)

Procedures

The institutional review board approved this study, and written informed consent or assent was obtained from all parents/guardians as well as the adolescents. The overall study protocol collected an extensive array of data from home visits, in-home overnight cardio-respiratory studies, and questionnaires about sleep, general health, behavior,

and emotional functioning. Adolescents were instructed to use the actigraphs overnight while at home for 5–7 days prior to a scheduled examination in a General Clinical Research Center, wherein overnight PSG was performed, as well as a history and physical examination, and measurement of height and weight.

Measures

Demographics

Demographic information was collected from a parent questionnaire, which included information about the adolescent's age, birth date, ethnicity, birth weight, sex, and parent income and education. Body mass index (BMI) was calculated using the current height and weight and was defined as weight in kilograms divided by height in meters squared (kg/m^2). BMI percentages calculated based on age and gender were used in subsequent analyses.

Sleep-Related Measures

Actigraphy (Octagonal Sleep Watch, AMI; Ambulatory Monitoring, Inc., Ardsley, NY). Actigraphy uses a watch-like device that non-invasively measures sleep and wake times based on movement frequencies. In this study, 5–7-day wrist actigraphy on the non-dominant wrist was used to determine mean sleep duration and variability in sleep duration, which was calculated as the standard deviation of sleep duration divided by the mean sleep duration, expressed as a percentage. For sleep duration, studies with healthy adults have found rates of agreement with PSG, the ''gold standard'' of sleep measurement, to be 78–90% (Ancoli-Israel et al., 2003). In a subgroup of this population, we have shown intraclass correlation coefficients (ICCs) between actigraphy and PSG for sleep duration to be .64 for those without sleep disordered breathing (Johnson et al., 2007). In the subgroup of 115 adolescents in the current sample who underwent an additional one night of actigraphy concurrently with in-lab PSG, the ICCs were .68 and .56 for girls and boys, respectively.

Epworth Sleepiness Scale (ESS; Johns, 1991). The ESS, a self-report questionnaire used to measure daytime sleepiness, consists of eight situations wherein subjects are asked to rate how likely they would be to fall asleep. The response possibilities are ''would never doze, slight chance of dozing, moderate chance of dozing, and high chance of dozing.'' Though this questionnaire was initially designed for adults, it has been used in studies with children and adolescents with slight modifications (Bootzin & Stevens, 2005; Melendres, Lutz, Rubin, & Marcus, 2004). For this study, the last item ''in a car while stopped for a few minutes in traffic'' was replaced with ''doing homework or taking a test.'' In the current study, Cronbach's α was .75.

Psychological Functioning

Child Behavior Checklist, Parent and Teacher Report (CBCL;Achenbach, 1991a, TRF; Achenbach, 1991b). The CBCL and TRF are widely used screening measures designed to identify child and adolescent behavior and emotional problems, and the reliability and validity of both have been well documented (Achenbach, 1991a, b). In this study, for the CBCL and TRF, the externalizing behavior scale T-score was used, and Cronbach's α for the TRF externalizing scale was .96 and for the CBCL externalizing scale was .93.

Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997). The MASC was developed to evaluate symptoms of anxiety in children and adolescents ages 8–19. Each of the 39 items has four Likert-type response options: never, sometimes, rarely, and always true about me. The MASC yields total score and four main factors (physical symptoms, social anxiety, separation anxiety, and harm avoidance), which are further divided into six sub factors. The total anxiety score was used in this study and in this sample Cronbach's α was .87.

Children's Depression Inventory (CDI; Kovacs, Gastonia, Paulauskas, & Richards, 1990). The CDI was designed to assess depressive symptoms in children and adolescents ages 7–17 during the two week period prior to administration. The scale is comprised of 27 items, which measure cognitive, affective, and behavioral symptoms of depression. For each item, children select a statement (from three choices increasing in severity) that best describes how they have felt over the past 2 weeks. Each item is given a score of 0, 1, or 2, and the sum of the item scores yields a total score indicating total severity of depressive symptoms. Higher scores indicate higher levels of depressive symptoms. The item scores are summed to yield a total score. Items 16 and 17, which relate to trouble sleeping and tiredness respectively, were excluded from the analyses, as these questions could have led to an inflated correlation with the sleep variables. In this sample, Cronbach's alpha of the CDI without items 16 and 17 was found to be .86.

Children's Health Questionnaire-Adolescent and Parent Report (CF87, PF50; Landgraf, Abetz, & Ware, 1999). The CHQ was developed to measure physical and psychological functioning of children and adolescents ages 5 and above. The psychometrics of the CHQ have been widely documented across ages, health conditions (i.e., ADHD, asthma, epilepsy), and parent features such as education

and marital status (Landgraf et al., 1999). The general health scale, which measures perceptions of general health, was used for this study. The internal consistency in this sample Cronbach's α for the general health scale for the parent form was .60 and for the child form was .77.

Data Analytic Plan

All analyses were conducted using SPSS 13.0. Descriptive statistics are presented for all variables (Table I). Spearman bivariate correlations were conducted between the sleep variables and the psychological variables (Table II). Associations between each outcome and demographic and health related covariates were examined with bivariate statistics. Based on variables found to be related to these sleep variables in a previous study (Moore et al., 2006) at $p < .10$, a general set of covariates was created including age, gender, minority status, parent education, parent income, BMI percentile, preterm status, Tanner stage, and vacation status (e.g., whether the child was in school). Asthma was also included as a covariate, as there was a high prevalence of generally mild asthma, which is consistent with other similar urban populations. Prior to conducting linear regression modeling, exploratory analyses were conducted on continuous variables to assure that linearity assumptions were met and to assess the inter-relationships of average and variability in sleep duration and sleepiness. Log transformations were made to correct for non-normal distributions for the CBCL, TRF, and CDI. Separate multiple regression analyses were performed for the six outcome variables: self-reported anxiety, depression, and perceived health, parent report of perceived health and parent and teacher reported externalizing behaviors. The models included either sleep duration, variability in sleep duration or sleepiness as the predictor variable. Final models were trimmed to include only covariates, which could be biologically related to both sleep and psychological functioning (e.g., BMI percentile) and the presence of asthma.

Table II. Bivariate Correlations Between Sleep Variables and Psychological Variables

	Sleep duration	Variability in sleep duration	Sleepiness
Externalizing (Parent report)	$r = -.10$	$r = .12$	$r = .10$
	$N = 242$	$N = 242$	$N = 242$
Externalizing (Teacher report)	$r = -.15^*$	$r = .04$	$r = .21^{**}$
	$N = 177$	$N = 177$	$N = 176$
Depression	$r = -.06$	$r = .10$	$r = .23^{**}$
	$N = 243$	$N = 243$	$N = 242$
Anxiety	$r = .01$	$r = .04$	$r = .30^{**}$
	$N = 243$	$N = 243$	$N = 243$
Perceived health (teen report)	$r = -.04$	$r = .01$	$r = .21^{**}$
	$N = 246$	$N = 246$	$N = 246$
Perceived health (parent report)	$r = -.02$	$r = .11$	$r = .12$
	$N = 240$	$N = 240$	$N = 239$

$^*p < .05$; $^{**}p < .01$.

Results

Descriptive Statistics

The final sample had a mean age of 13.7 years (range 13–16) and nearly equal numbers of boys and girls (Table I). Adolescents of minority ethnicity (54.3%) were primarily African American (93%). In this sample, 91.3% of caregivers reported obtaining at least a high-school diploma or GED and 62.9% reported an income at or above $30,000 per year. With regard to health-related variables 22.7% reported a diagnosis of asthma and 40.3% had a BMI at or above the 85th percentile. On average, sleep duration in this group was 471.2 min (7.85 h) and the average variability in sleep duration was 16.38%. The mean ESS score was 7.9 ($SD = 4.5$) with 26.6% of the sample having a score >10. In adult populations, a score >10 is considered to be clinically significant; however, there are no clinical cutoffs for the ESS in adolescents. Means were also calculated for the psychological variables, and these scores did not enter the range of clinical significance (Table I).

Results of Hypothesis Testing

It was hypothesized that each of the six outcome variables (self-reported anxiety, depression, perceived health, parent report of teen's health, and parent and teacher reported externalizing behaviors) would demonstrate significant associations with sleep duration and variability in sleep duration. Contrary to hypotheses, in bivariate linear regression analyses (which included the aforementioned covariates), none of the hypothesized relationships were statistically significant, though the relationship between variability in sleep duration to parent reported health ($p = .06$) approached significance.

It was also hypothesized that self-reported sleepiness would be associated with parent and teacher report of externalizing behavior and self-reported symptoms of anxiety and depression as well as be negatively correlated with parent and self-report of perceived health. Three of the hypothesized relationships from sleepiness to psychological variables were significant (Tables III, IV, and V). First, statistical models assessing the association between the self reported sleepiness score and depressive symptoms were adjusted for BMI percentile and the presence

Table III. Summary of Simultaneous Linear Regression Analysis for Variables Predicting Adolescent Reported Depressive Symptoms ($N = 223$)

Variable	*B*	SE *B*	β	Partial r^2
Sleepiness (ESS)	0.05	0.01	.23**	.23
BMI (percentile)	0.00	0.00	.11	.11
Asthma	−0.20	0.14	−.07	−.08

*$p < .001$.

Table IV. Summary of Simultaneous Linear Regression Analysis for Variables Predicting Adolescent Reported Anxiety Symptoms ($N = 238$)

Variable	*B*	SE *B*	β	Partial r^2
Sleepiness (ESS)	0.62	0.14	.28**	.28
BMI (percentile)	−0.01	0.02	−.02	−.02
Asthma	2.31	1.45	.10	.10

**$p < .001$.

Table V. Summary of Simultaneous Linear Regression Analysis for Variables Predicting Adolescent Reported Perceived Health ($N = 223$)

Variable	*B*	SE *B*	β	Partial r^2
Sleepiness (ESS)	0.63	0.22	.18**	.19
BMI (percentile)	0.03	0.04	.05	.05
Asthma	7.10	2.30	.19**	.20

**$p < .01$.

of asthma. In this model, only sleepiness was significantly associated with depressive symptoms [Adjusted partial $r^2 = .23$; $F(3, 220) = 6.24$, $p < .001$] with higher sleepiness scores relating to higher self-reported depressive symptoms (Table III). Also in accord with hypotheses, self-reported sleepiness was associated with symptoms of anxiety when accounting for BMI percentile and the presence of asthma. Again in this model only sleepiness was associated with symptoms of anxiety [Adjusted partial $r^2 = .28$; $F(3, 235) = 7.45$, $p < .001$] (Table IV). Finally, as hypothesized higher self-reported sleepiness, when accounting for BMI percentile and the presence of asthma, was associated with self-report of general health (e.g., perceived health) with higher sleepiness scores relating to lower general health scores [Adjusted partial $r^2 = .19$; $F(3, 238) = 6.58$, $p < .001$]. In this model sleepiness and asthma were significant (Table V). Collectively, every one-half standard deviation increase in self-reported sleepiness (e.g., ∼4 points on the ESS) was associated with an average increase of 3 points on the MASC, 3.4 points decrease in general health score of the CHQ, and a 22% increase on the CDI.

In contrast to our hypotheses, sleepiness scores were not significantly related to parent report of their teen's health or externalizing behaviors or teacher reported externalizing behaviors. Additionally, inclusion of sleep duration and variability in sleep duration in models testing the associations between sleepiness and the psychological outcome variables did not appreciably influence the findings.

Discussion

The most important finding was that degree of sleepiness, but not objectively determined estimates of sleep duration or variability in sleep duration, was correlated with adolescents' report of symptoms of depression and anxiety as well as with their perceived health. It has been argued that the ability to self regulate (and thus modulate emotions) may depend in part on having adequate personal resources, including sufficient sleep (Baumeister, 2002). This study indicated that it may be level of sleepiness (rather than absolute sleep duration) that is associated with affect. A subjective feeling of sleepiness might cause a general negative mood as well as a decreased ability to regulate emotions, thus contributing to depressed and anxious feelings and somatic symptoms.

Conversely, it is also possible that adolescents, who are more anxious, depressed, or feel less healthy may feel sleepier. Research has found that depressed children report disturbed sleep despite normal architecture measured by electroencephalography (Bertocci et al., 2005). These findings are consistent with the current study wherein the subjective report of sleepiness related to findings on measures of depression, anxiety, and perceived health while objectively measured sleep duration and variability in sleep duration by actigraphy did not. There are several potential explanations for this finding, each of which might play a role in the relationship between sleepiness and psychological functioning. First, adolescents who are anxious, depressed, or feel less healthy may in fact, need more sleep than those with better psychological functioning. The challenges of getting through an ordinary day may require increased energy for these adolescents. It is also possible that adolescents who are anxious, depressed, or less healthy may have more negative perceptions of their sleep and sleepiness.

Additionally, it may be that relationships between sleep duration and psychological functioning are impacted by individual sleep need. At this time, there is no way to measure these individual differences; however, as technology advances, this is an important area of research. It may also be that selective deficits in certain sleep stages (e.g., slow wave or REM sleep) rather than modest deficits in

sleep duration, may mediate the relationship between sleepiness and psychological functioning. On the other hand, because there may be individual differences in sleep need, a subjective measure of sleepiness may in fact, be more sensitive than an objective measure of sleep duration. Although we chose to use an objective measure of sleep duration (actigraphy), even this measure is subject to misclassification, and may have biased the findings to the null.

Despite previous studies that have found associations between sleep duration and externalizing behavior (Chervin et al., 2003; Smedje et al., 2001), in this study sleepiness, sleep duration, and sleep duration variability were not associated with parent and teacher reports of externalizing behavior. It is possible that the inability to detect an association was due to our use of a broad externalizing score that may not have been as sensitive to the effects of sleep problems as more specific externalizing behavior subscales, such as those that measure symptoms of inattention or aggression.

Our finding showing an association between self perceived sleepiness and psychological symptoms is consistent with two studies which demonstrate the relationship between subjective reports of depression and subjective reports of sleep quality (Bertocci et al., 2005; Tang et al., 2004). Future work utilizing objective measures of sleepiness such as the Multiple Sleep Latency Test may help to further assess whether the associations between psychological functioning and self reported sleepiness reflect a greater sensitivity of subjective measures compared to objective measures, or whether sleepiness per se, as a more proximate mediator for behavior than sleep duration, is the stronger predictor.

Another important finding in this study was that despite increasing research supporting the importance of sleep for adolescents, adolescents in this sample generally did not get enough sleep and nearly one quarter had elevated sleepiness scores. The mean sleep duration of just under 8 h was less than the 9.2 h recommended for adolescents (Carskadon, 1982), but is consistent with previous literature (Carskadon & Acebo, 2002).

Limitations and Future Directions

The methodological limitations of the current study affect the interpretation of results and at the same time, suggest avenues for future research. First the cross-sectional study design limited the ability to attribute causality to the relationship between the sleep variables and the psychological variables. For example, while it was hypothesized that sleepiness would contribute to poorer perceptions of health; it is possible that poorer perceptions of health result in being sleepier. As previously mentioned, it is likely that many of the relationships between sleep and psychological functioning are bidirectional, and longitudinal studies with large samples are needed in order to investigate the causality.

Second, the use of adolescent self-reported measures of sleepiness, adolescent depression, anxiety, and perceived health may have influenced the results. For example, it is possible that correlations were inflated as a result of method variance. On the other hand, prior studies (Angold et al., 1987) have found that adolescents may be the best reporters of their own internal states. The use of objective measurements of sleepiness, such as the MSLT or the Maintenance of Wakefulness Test (MWT) might reduce measurement error and better clarify the relationships between sleepiness and psychological symptoms.

The variables investigated in this study explained only a small amount of the variance in the regression models, as may be expected in studies of a generally healthy community based cohort. While this study found an association between sleepiness and perceived health, studies exploring the effect of sleepiness on physiological or clinical measures of health and illness would also be valuable. Research could be expanded to various populations including adolescents with chronic illnesses or in the intensive care unit. Such studies are needed in order to further examine functional outcomes of sleepiness in a variety of vulnerable populations.

Clinical Implications

Empirical evidence, including findings from this study, continues to highlight the relationship between sleep and psychological functioning. One clinical implication of such findings is that adolescents and their parents should be educated concerning the natural predisposition to poor sleep in adolescents and the relationship of sleepiness to psychological functioning. Moreover, when adolescents present with psychological symptoms such as anxiety, depression, and somatic complaints, they should be offered guidance about monitoring sleepiness and developing healthy sleep habits in addition to more traditional psychological interventions.

Second, although assessments of psychological functioning often include brief questions about total sleep duration and quality, clinicians should also ask about sleepiness. As suggested by this study, sleepiness may be a more sensitive predictor of psychological symptoms than are objective estimates of sleep duration. Informed clinical assessment should include questions about sleepiness and its functional consequences.

Moreover, interventions to reduce sleepiness need to be developed and tested. Such interventions could be delivered in multiple ways including in schools (for example: via health class, the school counselor or nurse, to parents at PTA meetings, and to teachers) and through mental health services such as psychiatry, psychology, and social work. Additionally, practitioners who develop psychological treatment manuals for conditions such as anxiety and depression should consider including modules that address the potential consequences of sleepiness.

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