ARTICLE

Epidemiology of DSM-IV Insomnia in Adolescence: Lifetime Prevalence, Chronicity, and an Emergent Gender Difference

Eric O. Johnson, PhD[a], Thomas Roth, PhD[b], Lonni Schultz, PhD[c], Naomi Breslau, PhD[d]

[a]Substance Abuse Epi, Prevention and Risk Behavior, Research Triangle Institute International, Research Triangle Park, North Carolina; [b]Sleep Disorders and Research Center and [c]Department of Biostatistics and Research Epidemiology, Henry Ford Health System, Detroit, Michigan; [d]Department of Epidemiology, Michigan State University, East Lansing, Michigan

The authors have indicated they have no financial relationships relevant to this article to disclose.

ABSTRACT

OBJECTIVE. The confluence of sleep/wake cycle and circadian rhythm changes that accompany pubertal development and the social and emotional developmental tasks of adolescence may create a period of substantial risk for development of insomnia. Although poor sleep affects cognitive performance and is associated with poor emotional and physical health, epidemiologic studies among adolescents have been limited. In this first epidemiologic study of insomnia defined by *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) criteria in a US sample of adolescents, we estimated lifetime prevalence of insomnia, examined chronicity and onset, and explored the role of pubertal development.

METHODS. Data come from a random sample of 1014 adolescents who were 13 to 16 years of age, selected from households in a 400 000-member health maintenance organization encompassing metropolitan Detroit. Response rate was 71.2%. The main outcome measured was DSM-IV–defined insomnia.

RESULTS. Lifetime prevalence of insomnia was 10.7%. A total of 88% of adolescents with a history of insomnia reported current insomnia. The median age of onset of insomnia was 11. Of those with insomnia, 52.8% had a comorbid psychiatric disorder. In exploratory analyses of insomnia and pubertal development, onset of menses was associated with a 2.75-fold increased risk for insomnia. There was no difference in risk for insomnia among girls before menses onset relative to boys, but a difference emerged after menses onset. In contrast, maturational development was not associated with insomnia in boys.

CONCLUSIONS. Insomnia seems to be common and chronic among adolescents. The often found gender difference in risk for insomnia seems to emerge in association with onset of menses.

www.pediatrics.org/cgi/doi/10.1542/peds.2004-2629

doi:10.1542/peds.2004-2629

Key Words
adolescence, epidemiology, insomnia

Abbreviations
DSM-IV—*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*
HMO— health maintenance organization
CDISC-IV—Computerized Diagnostic Schedule for Children, Version Four
ICSD-R—*International Classification of Sleep Disorders–Revised*
ADHD—attention-deficit/hyperactivity disorder
IQR—interquartile range
HR— hazard ratio
CI— confidence interval
DSPS— delayed sleep-phase syndrome

Accepted for publication Jul 29, 2005

Address correspondence to Eric O. Johnson, PhD, Substance Abuse Epi, Prevention, and Risk Behavior , Division of Health, Social, and Economic Research, Research Triangle Institute International, PO Box 12194, 3040 Cornwallis Rd, Research Triangle Park, NC 27709-2194. E-mail: ejohnson@rti.org

THE BIOLOGICAL AND cultural transitions that characterize adolescence affect sleep/wake regulation and timing.[1] Compared with prepubertal youth, adolescents seem to need more sleep,[2] have reduced time in slow-wave sleep and latency to rapid-eye-movement sleep,[3] and have a propensity toward a delayed sleep phase.[4] In addition, cultural factors such as early school start times, after-school employment, and extracurricular and social activities contribute to limited sleep and disrupted sleep patterns, making adolescents vulnerable to excessive sleepiness.[5,6] Poor sleep adversely affects cognitive function and performance[7,8] and is associated with poor emotional and physical health,[9–12] conduct problems, and substance use.[13–15]

Sleep problems have been investigated in several community- and school-based samples of adolescents but have been defined idiosyncratically and measured for periods from 2 weeks to 12 months.[10–20] Consequently, prevalence estimates of sleep problems among adolescents has varied from 6% to 39%. The study by Ohayon et al[21] is the one study that included adolescents and used *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV)[22] criteria. They found that 4% of 15- to 18-year-olds from general population samples of the United Kingdom, France, Germany, and Spain had insomnia in the past 30 days. Of those with a diagnosis of current insomnia, approximately half had primary insomnia, 27% had insomnia related to another psychiatric disorder, 12% had insomnia related to substance use, and 7% had insomnia related to a medical condition: 2.2%, 1.1%, 0.5%, and 0.3% were the corresponding population prevalence estimates.

With this broad variation in definitions of sleep problems, the distribution by demographic characteristics also has varied. Most, although not all,[18,23] studies found trouble sleeping to be more prevalent in girls than in boys.[10,13,14,16,17] Ohayon et al[21] found a significantly higher prevalence of primary insomnia among female compared with male adolescents (3.4% vs 1.2%) but no gender difference for other insomnia subtypes. There has been little evidence of differences by race/ethnicity.[13,14,20] The association of current trouble sleeping with age has been inconsistent: some studies reported an increase with age,[15,23] whereas others found no association.[13,14,16] The prevalence of current DSM-IV insomnia and the subtypes of insomnia among the 15- to 18-year-old adolescents in the study by Ohayon et al[21] did not significantly differ from the prevalence among young adults who were aged 18 to 24 years and drawn from the same study, suggesting that insomnia may not increase rapidly during the transition from late adolescence to young adulthood.

In addition to the paucity of information on prevalence of insomnia among adolescents, little is known about its natural course.[24] No study has examined the age of onset of trouble sleeping or insomnia diagnosis. Few studies have examined the persistence of insomnia. Two studies of adolescents found that, similar to adults,[25,26] ≥50% or more of those with sleep problems at baseline had them 2 to 4 years later.[13,18]

The confluence of sleep/wake cycle and circadian rhythm changes that accompany pubertal development, other biological changes of that maturation process, and the social and emotional developmental tasks of adolescence may create a period of substantial risk for the development of insomnia.[1] Indeed, such a pattern of increased incidence of disorders with pubertal development has been observed for depression.[27,28] The degree to which the onset of insomnia may be associated with pubertal development and/or broader changes in sleep patterns associated with such development have not been described.

In this first epidemiologic study of insomnia defined by DSM-IV criteria in a US sample of adolescents, we address several gaps in our knowledge. We report the first lifetime prevalence estimate of DSM-IV–defined insomnia in a community-based cohort of adolescents. We examine the distribution of insomnia by demographic characteristics and its chronicity and onset. Finally, we explore the role of pubertal development in the onset of insomnia and which symptoms of insomnia may play a role in their association.

METHODS

Sample

A sample of 1676 youth-parent pairs was randomly selected from all households with at least 1 adolescent who was aged 13 to 15 from a 400 000-member health maintenance organization (HMO) in the Detroit metropolitan area. The target population was defined by Wayne, Oakland, and Macomb counties, encompassing the city of Detroit and surrounding communities. Of this sample, 251 (15%) were ineligible for the study because of incorrect date of birth in the HMO database, inability to speak English, severe cognitive impairment, incarceration, or residence outside the area. Of the remaining 1425 pairs, 1014 participated in this study (response rate: 71.2%); 233 (16.3%) youth-parent pairs refused participation, and 178 (12.5%) could not be contacted.

The demographic characteristics of this sample (Table 1) reflect the HMO membership, representing the tricounty population, excluding the extremes of socioeconomic status. The racial composition is similar to the tricounty population (ie, 67.3% white, 25.0% black, and 7.7% other),[29] but the median income ($60 000–$69 999) and proportion of parents with at least a bachelor's degree (44%) are higher than the population ($49 740 and 19.7%, respectively).[29]

Measures

Interviewers conducted computer-assisted structured interviews with each adolescent. Data were collected on

TABLE 1 **Prevalence of DSM-IV Lifetime Diagnosis of Insomnia**

	N	% of Sample	% With a Diagnosis of Insomnia	OR	95% CI
Total sample	1014		10.7		
Gender					
Male	504	49.7	8.9	1.0	
Female	510	50.3	12.4	1.44	0.96–2.15
Race					
White	632	62.3	10.9	1.0	
Black	316	32.2	10.4	0.95	0.61–1.48
Other	63	6.2	9.5	0.86	0.36–2.06
Age					
13	226	22.3	9.3	1.0	
14	250	24.6	6.0	0.62	0.31–1.24
15	415	40.9	14.9	1.71	1.02–2.89
16	123	12.1	8.1	0.86	0.34–1.90
Family income					
<$30 000	114	11.2	13.2	1.0	
$30 000–$49 999	152	15.0	10.5	0.78	0.37–1.64
$50 000–$69 999	264	26.0	9.5	0.69	0.35–1.37
$70 000–$99 999	175	17.2	9.1	0.66	0.31–1.40
$100 000	225	22.2	9.8	0.72	0.35–1.44
Parent marital status					
Married	717	70.7	10.0	1.0	
Divorced/widowed/separated	181	17.8	13.8	1.43	0.88–2.34
Single	113	11.1	8.8	0.87	0.43–1.74
Parent education					
High school or less	224	22.1	14.7	1.0	
Some college	343	33.8	11.7	0.76	0.46–1.25
College graduate	248	24.5	7.7	0.48	0.26–1.87
Graduate/professional school	198	19.5	8.1	0.51	0.27–0.96
Household location					
City	270	26.6	11.5	1.0	
Suburb	744	73.4	10.3	0.89	0.59–1.22

OR indicates odds ratio.

several domains, including sleep habits and problems, personality traits, substance use, academic and social competence, extracurricular activities, physical health, stressful life events, and sociodemographics. Mental disorders and substance use were assessed by using the Computerized Diagnostic Schedule for Children, Version Four (CDISC-IV).[30,31]

The primary criteria for a diagnosis of insomnia according to the DSM-IV are a complaint of difficulty initiating or maintaining sleep or nonrestorative sleep that lasts for a period of 1 month or longer and results in significant distress or impaired function.[22] The DSM-IV criteria do not specify a frequency of insomnia symptoms (ie, times per week) during an episode of insomnia; neither does the *International Classification of Diseases, 10th Revision* or the *International Classification of Sleep Disorders–Revised* (ICSD-R).[32,33] Making the DSM-IV criteria for insomnia operational, it was, nevertheless, important to select a minimum frequency of symptoms. We selected 4 times per week as the threshold for a symptom to count toward an episode of insomnia. Selection of this threshold was based on the suggestion in the ICSD-R that those with mild insomnia would experience symptoms almost nightly and on analyses of the frequency of symptoms and reports of impairment as a result of sleep problems in this study. These analyses found that 4 times per week was the symptom frequency at which a majority of adolescents began to report daytime impairment (data available on request). Therefore, in this study, a lifetime DSM-IV diagnosis of insomnia was defined as a complaint of difficulty initiating or maintaining sleep or nonrestorative sleep, at least 4 times per week, that lasts for a period of 1 month or longer and results in significant distress or impaired function.[22] The questions that were used to assess symptoms and impairment are given in Table 2. These symptom questions were derived from those that were used in previous epidemiologic studies of sleep problems,[34,35] with the addition of duration criteria from the DSM-IV and the frequency guideline from the ICSD-R. The questions that assessed impairment as a result of insomnia parallel those in the CDISC for lifetime diagnosis of psychiatric disorders in children. Among those with a lifetime diagnosis, those who reported that their most recent episode like this occurred within 4 weeks of the interview were defined as current cases of insomnia. Onset of insomnia was assessed retrospectively as the earliest age at which a symptom of

TABLE 2 **Assessment of DSM-IV Insomnia**

Symptom Type	Questions
Difficulty initiating sleep	In your lifetime, have you ever had difficulty falling asleep when you wanted to go to sleep?
	In your lifetime, has it ever taken you an hour or longer to fall asleep after you were in bed?
Difficulty maintaining sleep	In your lifetime, have you ever awakened >3 times during a single night?
	In your lifetime, have you ever awakened before you wanted or needed to but were unable to go back to sleep?
	In your lifetime, have you ever awakened during the night and it took you a long time to fall back to sleep?
Nonrestorative sleep	In your lifetime, have you ever awakened on your own and not felt rested or refreshed?
	In your lifetime, has your sleep ever left you feeling fatigued throughout the day?
Distress or impairment	Do you ever worry about having trouble sleeping, so much of the time?
	Does having trouble sleeping, so much of the time, make you feel frustrated?
	Does having trouble sleeping, so much of the time, ever make it more difficult for you to do things you normally do?

To meet a diagnosis of insomnia, participants had to report 1 or more symptoms, which must have occurred 4 or more times per week for a period of 1 month or longer and have endorsed 1 or more distress or impairment questions.

insomnia occurred 4 times per week for 1 month or longer, among those with a lifetime diagnosis.

The American Academy of Sleep Medicine Working Group's recently published research diagnostic criteria for insomnia suggests that it is a general disorder in itself (albeit with subtypes) that parallels the DSM-IV criteria for primary insomnia but without the exclusions for association with other medical conditions, other mental disorders, or substance use.[36] Similarly, the National Institutes of Health State-of-the-Science Conference Statement suggests conceptualizing insomnia as a disorder in itself, which may or may not be comorbid with other disorders, rather than as primary or secondary as has been the historical practice of designating insomnia.[37]

The conceptualization and the measurement of insomnia disorder in this study thus follow these views of insomnia by treating insomnia as a general disorder without exclusions for other disorders that are part of the definition of primary insomnia. Although the main focus of these analyses is on the general insomnia disorder, we have also distinguished between insomnia with and without comorbid psychiatric disorders. Insomnia with comorbid psychiatric disorder was defined by a diagnosis of insomnia plus 1 or more of the following DSM-IV–defined disorders with impairment as assessed by the CDISC-IV: social phobia, simple phobia, panic disorder, agoraphobia, obsessive compulsive disorder, attention-deficit/hyperactivity disorder (ADHD), major depression, conduct disorder, oppositional defiant disorder, and any substance use disorder.[30,31]

Pubertal development was measured by a self-administered rating scale that was developed by Carskadon and Acebo[38] and assesses 3 general indicators of development (growth in height, growth of body hair, and skin changes) and 2 gender-specific indicators (boys: deepening of voice and growth of facial hair; girls: breast development and menstruation). Girls were also asked to report the age of onset of menses. Except for onset of menstruation, all indicators are rated on a 4-point scale (1: not started yet; 2: barely started; 3: definitely started; and 4: seems complete). Authors provided scoring criteria for categories that parallel Tanner stages.[38] Major depressive disorder was assessed using the CDISC-IV, which provided a lifetime DSM-IV diagnosis as well as age at onset of the symptom cluster that qualified the adolescent for this diagnosis.[30,31]

Procedures

Both the CDISC-IV and the sleep habits and disorder structured interviews were conducted face to face at participants' homes or Henry Ford Health System offices by trained interviewing staff. One-on-one in-home interviews were conducted in as private a setting as possible without the presence of other family members or any other people. In-office interviews were conducted in a private office that was dedicated to interviewing. Before the interview, written informed consent and assent were obtained from the adolescents' parent or guardian and the adolescent participant, respectively. The study was approved by the Henry Ford Health System Institutional Review Board. Interviews took place between February 2001 and May 2003.

Analysis

Differences in the lifetime prevalence of insomnia as a function of individual and household characteristics were assessed using logistic regression. For highly skewed variables (eg, age at onset), the median and interquartile range were reported, and Mann-Whitney *U* statistic was used to test differences. The chronicity of insomnia was defined as the proportion of those who had a lifetime history and reported current insomnia.

To examine the role of pubertal development, we estimated the risk for insomnia associated with the onset of menses using Cox proportional-hazards model with age as the unit of survival time and onset of menses as a time-dependent covariate. Age of onset was reported retrospectively. This provided comparison of the risk for insomnia after the onset of menses relative to premenses risk, with girls switching from pre- to postmenses onset status, based on age at onset of menses. Girls who reported onset of both menses and insomnia at the same age were censored at the age before the onsets. The model also included a term for being a boy and thereby

tested the risk for insomnia in girls before and after menses onset relative to boys.

RESULTS

Prevalence, Onset, and Chronicity

Of the 1014 adolescents who were 13 to 16 years of age and participated in this study, 108 (10.7%) met DSM-IV criteria for insomnia during their lifetime. Examining the prevalence of insomnia by demographic characteristics, lower parental education was associated with increased prevalence of insomnia (Table 1); prevalence did not differ consistently by other demographic characteristics. However, girls seemed to be more likely to have a history of insomnia than boys, although the difference was marginally nonsignificant ($P = .08$).

Of those with a lifetime history of insomnia, 68.5% reported difficulty initiating sleep, 26.2% reported difficulty maintaining sleep, and 48.1% reported nonrestorative sleep; corresponding population prevalences were 11.6%, 4.5%, and 7.8%. A significant minority of adolescents with insomnia reported multiple symptom types: 33.3% reported 2 of the 3 types, and 4.6% reported all 3 types. One third (34.3%) of those with insomnia met criteria that were based only on difficulty initiating sleep symptoms, 22.2% met criteria that were based only on nonrestorative sleep symptoms, and 5.6% met criteria that were based only on difficulty maintaining sleep symptoms.

Prevalence of current insomnia was 9.4%. Of those with a lifetime history of insomnia, 88% also had a current episode, which suggests that either the interviews took place close to the onset of insomnia or that insomnia is chronic in this population.

Figure 1 shows the cumulative incidence of insomnia by gender. For these highly skewed data, the median age at onset of insomnia was 11 (interquartile range [IQR]: 9–13 years). Consistent with an apparent divergence in the cumulative incidence of insomnia between boys and girls at age 11, girls reported a significantly older median age at onset of insomnia (age 12) than did boys (age 10; $z = 2.49$; $P = .01$). There was no difference in median onset across levels of parental education ($\chi^2 = 4.80$, degrees of freedom [*df*] = 3; $P = .19$). The median difference between age at onset of insomnia and age at interview was 3 years (IQR: 2–5.75 years). Only 5.6% of those who had a lifetime history of insomnia had their onset at the same age as when they were interviewed for this study.

Exploration of Pubertal Development and Insomnia

To examine the role of pubertal development, we estimated the risk for insomnia associated with the onset of menses using Cox proportional-hazards model with age as the unit of survival time and onset of menses as a time-dependent covariate. This provided comparison of the risk for insomnia after the onset of menses relative to premenses risk, with girls switching from pre- to postmenses onset status on the basis of age at onset of menses. The model also included a term for being a boy and thereby tested the risk for insomnia in girls before and after menses onset relative to boys.

As girls began to switch from premenses to postmenses onset at age 10 (Fig 2) a 2.75-fold increased risk for insomnia developed, adjusting for parental education (Table 3). No significant difference in risk for insomnia was found among girls before menses onset relative to boys. However, as girls switched to postmenses onset status, they were approximately 2.5 times more likely than boys to have insomnia.

These data suggest that the difference in prevalence of insomnia between adolescent girls and boys may develop as a consequence of pubertal development gener-

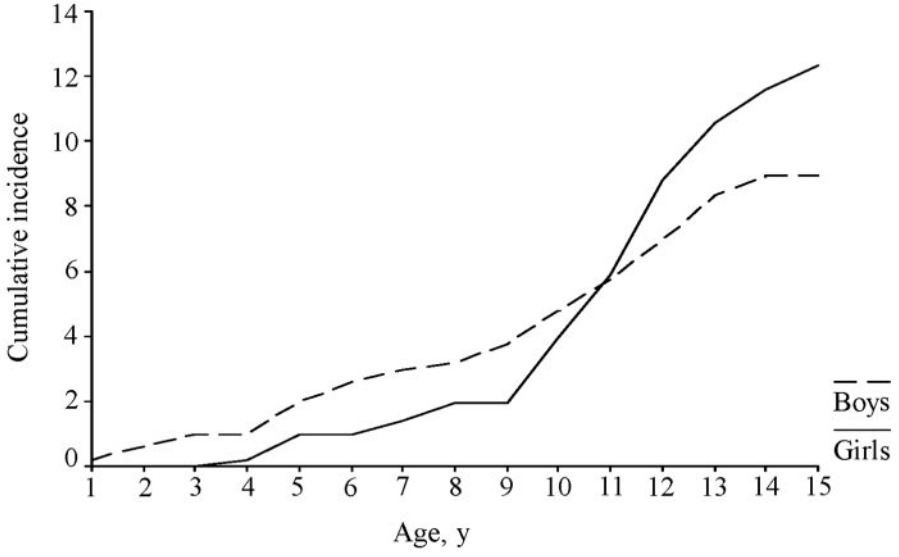

FIGURE 1
Age at onset of insomnia.

ally and the onset of menses specifically. However, these findings may reflect other processes. First, Angold et al[27] reported that risk for current depression was increased in girls, relative to boys only in the later stages of pubertal development (Tanner stage III and higher). The relationship among depression, insomnia, and menses onset is likely to be complex, requiring longitudinal data to disentangle. However, 1 important testable possibility here is that the emergent gender difference in risk for insomnia may reflect gender differences in depression. As 1 test of this, onset of DSM-IV major depression before insomnia was added as a time-dependent covariate to the primary analysis model. Although onset of depression increased the risk for insomnia (hazard ratio [HR]: 3.65; 95% confidence interval [CI]: 1.62–8.23), its inclusion did not alter the association of menses onset with insomnia (HR: 2.61; 95% CI: 1.36–5.02), the lack of a difference between premenses girls and boys (HR: 1.11; 95% CI: 0.67–1.85), or the difference between postmenses onset girls relative to boys (HR: 2.35; 95% CI: 1.39–3.95), suggesting that these relationships were not attributable to emerging gender differences in depression. Second, boys' pubertal development lags behind that of girls, so it may be that the apparent difference between girls and boys would be resolved as boys "catch up" to girls' development. However, there was no association between Tanner stage and insomnia among boys (stage II: 12.5%; stage III: 8.8%; stage IV: 9.1; stage V: 5.9%; $\chi^2 = 0.58$, $df = 3$; $P = .91$).

Analyses of Insomnia Symptom Types

Difficulty initiating sleep was by far the most common symptom among those with insomnia. Thus, the question arises: "To what degree is the effect of menses on risk for insomnia associated with sleep initiation only or also with sleep maintenance and nonrestorative sleep symptoms of insomnia?" We conducted separate exploratory analyses, using the same Cox proportional-hazards model approach as the main analysis, to assess the association of menses with insomnia among those with only difficulty initiating sleep symptoms ($n = 36$) and among those with only difficulty maintaining sleep or nonrestorative sleep symptoms ($n = 33$). No association was found between menses and insomnia with only difficulty initiating sleep symptoms (see Table 3). However, onset of menses was significantly associated with difficulty maintaining sleep/nonrestorative sleep only, and postmenses girls were at significantly greater risk for this type of insomnia than boys.

Insomnia With and Without Comorbid Psychiatric Disorders

The population prevalence of insomnia with and without comorbid psychiatric disorders, including mood, anxiety, behavioral, and/or substance use disorders, were 5.8% and 5.6%, respectively. Thus, just more than half (52.8%) of adolescents with a lifetime diagnosis of insomnia had 1 or more comorbid psychiatric disorders. There were no significant differences between those with insomnia only and those with insomnia and a comorbid psychiatric disorder across gender, race/ethnicity, family income, parental marital status, parent education, or household location (all $P \geq .20$). A nonsignificant trend toward an older age among those with insomnia and a comorbid disorder compared with those with insomnia only was observed ($\chi^2 = 5.83$, $df = 3$; $P = 0.12$). There was no significant difference in chronicity of insomnia between those with and without comorbid disorders ($\chi^2 = 1.22$, $df = 1$; $P = 0.27$) or in the relative proportions of those who had insomnia and reported difficulty initiating sleep, difficulty maintaining sleep, or nonrestorative sleep (all $P \geq .86$). Adjusting for any comorbid psychiatric disorder did not significantly alter the association between insomnia and onset of menses or differences between boys and postmenses girls in

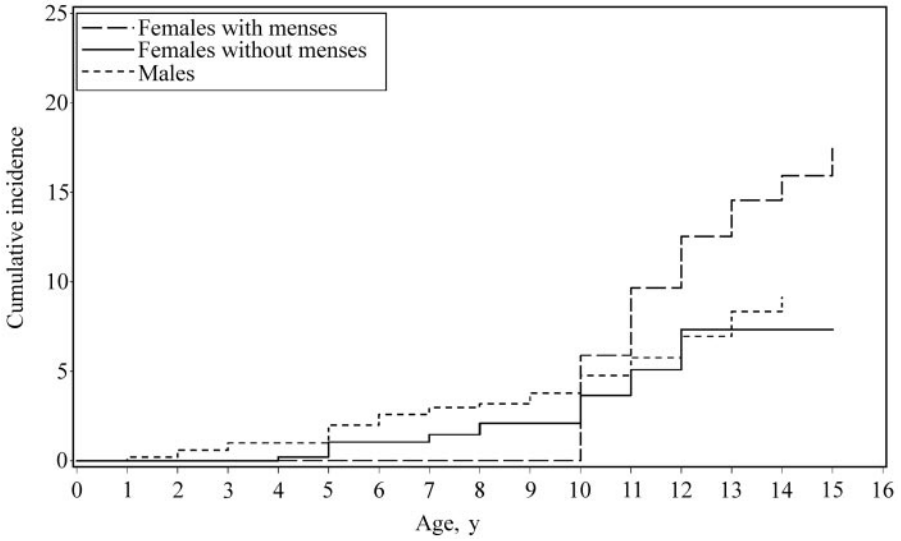

FIGURE 2
Risk for lifetime insomnia associated with menses onset.

TABLE 3 **Association of DSM-IV Insomnia and Symptom Types With Menses Onset: Cox Proportional-Hazards Analysis With Time-Dependent Covariates**

	Insomnia		Difficulty Initiating Sleep Only		Difficulty Maintaining Sleep and/or Nonrestorative Sleep	
	HR	95% CI	HR	95% CI	HR	95% CI
Premenses girls	1.0		1.0		1.0	
Postmenses girls	2.76	1.45–5.29	1.89	0.60–5.90	6.97	2.08–23.41
Boys[a]	1.0		1.0		1.0	
Premenses girls	1.11	0.67–1.85	1.17	0.49–2.82	1.26	0.46–3.49
Postmenses girls	2.48	1.48–4.17	1.61	0.67–3.85	5.53	2.12–14.37

All analyses were adjusted for the highest level of parental education.

[a] HR comparing postmenses girls with boys was calculated by re-estimating the model with boys as a reference group.

proportional-hazards analyses (results available on request).

The 1 significant difference observed between those who had insomnia with and without a comorbid psychiatric disorder was age of onset. The median age of onset for those with insomnia and a comorbid psychiatric disorder was 2 years younger than those with insomnia alone (10 vs 12 years of age; $z = 2.10$; $P = .04$).

Insomnia and Delayed Sleep Phase

It has been reported that adolescents develop an increased preference for a delayed sleep phase (going to bed and waking later than during earlier childhood).[4] Combining a shift toward a delayed sleep phase with the restrictions on sleep times imposed by typical school schedules could give rise to symptoms of insomnia (eg, difficulty falling asleep at the bedtime needed to get sufficient number of hours of sleep, given the required wake time, and perceiving sleep as nonrestorative as a result of a reduced amount of sleep). What distinguishes delayed sleep-phase syndrome (DSPS) from insomnia is that there is little difficulty maintaining sleep once initiated and that sleep is normal but delayed, in the absence of required sleep-onset and wake times (ICSD-R). To investigate the degree to which DSPS might generate a diagnosis of insomnia, we approximated the ICSD-R criteria for DSPS in the past 2 weeks. To be considered a case of DSPS, we required (1) a minimum 1-hour shift in sleep-onset and wake times from the weekday to the weekend, (2) complaint of frequent difficulty falling asleep, (3) report of little or no difficulty maintaining sleep, (4) frequent difficulty awakening, and (5) at least 7 hours of sleep per night on the weekends. On the basis of this approximation, 19 adolescents (1.9% of the sample) had DSPS in the last 2 weeks. Four (4.2%) of the 95 adolescents with insomnia in the past 30 days and 15 (1.6%) of the 919 adolescents without insomnia had current DSPS. Although there may be an association between current DSPS and insomnia diagnosis, it was not statistically significant in these data (odds ratio: 2.65; 95% CI: 0.86–8.15), and DSPS does not account for a significant proportion of insomnia cases.

DISCUSSION

In this first community-based study of adolescents to assess lifetime insomnia by DSM-IV criteria, insomnia was found to be common (10.7%) and seemed to be chronic; 88% of those who had a lifetime history of insomnia reported current insomnia. Among adolescents with insomnia, the most common symptom was difficulty initiating sleep (68.5%), then nonrestorative sleep (48.1%) and difficulty maintaining sleep (26.2%). Approximately 38% of those with insomnia reported 2 or more insomnia types. The lifetime prevalence of insomnia was higher among adolescents whose parents were less well educated and marginally among girls relative to boys. Exploring pubertal development and insomnia, onset of menses was associated with a 2.75-fold increased risk for insomnia. Girls before the onset of menses were not at increased risk for insomnia compared with boys but were after the onset of menses. In contrast, there was no association between pubertal development and insomnia in boys. Analyses of insomnia symptom types suggested that the association of insomnia with menses onset and the emergent gender difference may be attributable to difficulty maintaining sleep and nonrestorative sleep symptoms of insomnia. Additional analyses found that ~53% of those with insomnia also had a comorbid psychiatric disorder but that there were few differences between these groups, except that those with insomnia alone had a significantly later age at onset of insomnia.

This study extends previous knowledge of insomnia in adolescents in a number of ways. First, this study provides the first estimate of lifetime prevalence of insomnia among adolescents. This study also added to our understanding of the natural course of insomnia by examining age at onset and chronicity. Second, this is the first community-based study of adolescents to use DSM-IV criteria to define insomnia in the United States. Third, this is the first epidemiologic study of adolescents to examine the association of insomnia with pubertal development, a central feature of the biological and social changes during this period of life.

Prevalence of Insomnia

Much of the previous adolescent research focused on the broader concept of sleep problems. These studies varied widely in their definition of these problems and did not assess lifetime prevalence. Among these studies, the prevalence of current sleep problems ranged from 6% to 39%.[10–20] The estimate of DSM-IV insomnia in the past 30 days in this study falls at the lower end of this range (9.4%). The 1 other epidemiologic study of adolescents to assess insomnia by diagnostic criteria found a much lower prevalence of DSM-IV insomnia (with or without comorbid disorders) in the past 30 days (4%) than was found here.[22] There are at least 2 potential explanations for this difference. First, there may be differences in the base rates of insomnia in the populations sampled. The sample for this study was drawn from HMO member households in a metropolitan area of the United States, whereas Ohayon et al[22] sampled the populations of the United Kingdom, Germany, France, and Spain. Second, there may be differences in how the computer-assisted interview assessments were conducted. Two pieces of indirect evidence suggest that the difference in prevalence is not attributable to inaccurate assessment methods in this study. First, when asked about the frequency of insomnia symptoms occurring in the past 2 weeks as part of the Sleep-Wake Activity Inventory,[39] before the diagnostic part of the interview, those who met DSM-IV criteria for insomnia during the past 30 days had a median scale score that was substantially higher than those who did not meet criteria (16 vs 8, respectively; $z = -13.05$; $P < .001$); the difference was of the same magnitude as the IQR of the scale (6–13). Second, the lifetime prevalence estimate of insomnia in adolescents (10.7%) is reasonable relative to the 1 lifetime prevalence estimate of insomnia among young adults (26%), which was also from the same geographic region as this study.[34]

Assessing both the lifetime and past-month prevalence of insomnia allowed for estimation of the chronicity of DSM-IV insomnia. We found that 88% of those with a lifetime history of DSM-IV insomnia had their most recent episode of insomnia within the past month. Given that the median difference between age at onset of insomnia and age at interview was 3 years and only 5.6% of those who had a lifetime history of insomnia had their onset at the same age as when they were interviewed for this study, the substantial overlap between lifetime and current insomnia seems to express the chronicity of the disorder. There are few studies of adolescents with which to compare this level of chronicity. Morrison et al[18] reported that nearly 50% of 13-year-olds from a general population sample who had any sleep problem in the past year had a sleep problem 2 years later. Patten et al[13] reported that of those with current sleep problems at baseline (aged 12–18), ~72% had any or frequent sleep problems at follow-up (3–4 years later). In a general population sample that included older adolescents and adults, Ohayon and Roth[25] found that 57% of those with current DSM-IV insomnia reported that the duration of their insomnia was 5 or more years, and an additional 26% reported that their insomnia had persisted for 1 to 5 years. Thus, the results of this and other studies suggest that insomnia may be a highly chronic disorder.

Insomnia and Pubertal Development

The association of menses onset with increased risk for insomnia found here parallels findings of Angold et al[27] regarding depression. They found that increased rates of current depression were present among girls relative to boys only at a Tanner stage III and higher. The relationship among insomnia, depression, and pubertal development may be complex. A number of biological and social changes occur around the onset of menses, which may increase risk for both depression and insomnia. Angold et al[28] showed that changes in the level of testosterone and estrogen but not follicle-stimulating hormone or luteinizing hormone are associated with the increased risk for depression among adolescent girls relative to boys. They argued that it is these hormonal changes that seem to explain the increasing risk, rather than the morphologic changes that have been hypothesized to generate increased social pressures on girls, more so than boys.[40] The exploratory finding that difficulty maintaining sleep and nonrestorative sleep symptoms, which seem to be more strongly associated with physiologic causes of insomnia compared with difficulty initiating sleep,[41–44] may be responsible for the menses-insomnia association, bolsters such a hormonal interpretation for the association between menses onset and insomnia. However, the degree to which similar hormonal changes lead to both the association of pubertal development with insomnia and with depression in girls but not in boys remains a question, particularly because adjusting for DSM-IV major depression did not reduce the association between menses onset and insomnia.

Insomnia With and Without a Comorbid Psychiatric Disorder

The recent National Institutes of Health State-of-the-Science Conference Statement suggested that insomnia be conceptualized as a disorder in and of itself, which is or is not comorbid with other disorders, rather than drawing conclusions about insomnia's primary or secondary status.[37] Thus, although the main focus of this study was on insomnia, regardless of psychiatric comorbidity, subanalyses were conducted to estimate the prevalence of insomnia with and without comorbid disorders as well as assess which differences in results this distinction might make. Approximately half of the adolescents in this study with a lifetime history of insomnia had a comorbid lifetime DSM-IV psychiatric disorder. There were no demographic and few insomnia characteristic

differences between those with and without comorbid psychiatric disorders. The single exception was that those adolescents with a comorbid psychiatric disorder had an earlier age at onset than those without such a comorbid condition. Adjusting for any comorbid psychiatric disorder did not alter the association between insomnia and onset of menses or differences between boys and postmenses girls in proportional-hazards analyses.

Limitations

First, the sample was obtained from an HMO membership directory, which will not include those without health insurance and those with traditional insurance. This sampling strategy does not include the very low and high ends of the socioeconomic spectrum. However, the results of this study and those that examined trouble sleeping among adolescents suggest little, if any, association with socioeconomic status.[13,14] Second, onset of menses and insomnia were assessed retrospectively rather than captured prospectively, which has the potential to introduce recall biases. Third, girls in this study were too physically mature to examine variation in risk for insomnia by Tanner stages, as was done with boys. Fourth, because age of onset of depression symptoms was assessed only as clusters in the CDISC-IV, the analyses of insomnia and menses onset could be adjusted only for DSM-IV diagnosis of major depression. We could not adjust for the more prevalent subthreshold depressive symptoms.

Directions for Future Research

The findings and limitations of this study suggest a number of directions for future research. First, a longitudinal study that begins before the onset of puberty and follows children through this transition will be essential to understand the mechanisms, be they biological or social, behind the association between pubertal development and insomnia for girls and not for boys found in this study. Such a focused study could also provide physical assessment of Tanner staging for increased validity. Second, the exploratory finding that the emergent gender difference in insomnia may be specifically linked to nonrestorative sleep and sleep maintenance types of insomnia deserves additional study. If these findings were replicated, then they may point to more specific mechanisms for this gender difference. Third, the relationship between insomnia and depression is likely to be complex, as difficulty sleeping is a symptom of depression. However, understanding their relationship is also likely to be important to understanding the development of both disorders and their parallel emergent gender difference associated with puberty. As a first step to disentangling these relationships in adolescence, future longitudinal research is needed to examine the risk for depression associated with insomnia among those without other concurrent early symptoms of depression and to assess the association of previous depression with the development of insomnia as a disorder.

Significance of Insomnia in Adolescence

The high prevalence of insomnia found in this study suggests that it may be of significant clinical and public health concern among adolescents because of its association with adverse outcomes. Disrupted, poor, and insufficient sleep, all of which are associated with insomnia, have been shown to reduce cognitive function and performance[7,8] and increase ADHD-like symptoms of inattention.[1] Trouble sleeping has been associated with concurrent problems at school, with peers, and with parents.[20] Finally, a number of studies have found trouble sleeping to be associated with psychiatric disorders and substance use.[9–15] Although available data on the degree to which treatment for insomnia may reduce the risk for daytime consequences are limited in both adolescents and adults, there is some evidence that ADHD-like symptoms improve subsequent to treatment for sleep problems.[45,46] Thus, treatment and prevention of insomnia may be important priorities in adolescent health.

CONCLUSIONS

DSM-IV insomnia was found to be common among adolescents 13 to 16 years of age and seems to be a chronic condition. Risk for insomnia was higher in girls than in boys but only after the onset of menses. Studies of the cause of insomnia should examine not only this emergent gender difference and the interconnections of insomnia, depression, and pubertal development but also factors that contribute to insomnia's significant prevalence in boys. Insomnia and sleep problems have been associated with poor daytime consequences and risk for psychiatric disorders. Given the substantial prevalence of insomnia found in this study and its impact on daytime functioning and association with increased risk for onset of other psychiatric disorders, significantly greater scientific and policy attention to the problem of insomnia seems warranted.

ACKNOWLEDGMENT

This work was supported by National Institutes of Health research grant MH61358 (to E.O.J.).

REFERENCES

1. Dahl RE, Lewin DS. Pathways to adolescent health: sleep regulation and behavior. *J Adolesc Health.* 2002;31:175–184
2. Carskadon MA. The second decade. In: C. Guilleminault, ed. *Sleeping and Waking Disorders: Indications and Techniques*. Menlo Park, CA: Addison-Wesley; 1982:99–125
3. Carskadon MA. Patterns of sleep and sleepiness in adolescents. *Pediatrician.* 1990;17:5–12
4. Carskadon MA, Vieria C, Acebo C. Association between puberty and delayed phase preference. *Sleep.* 1993;16:258–262
5. Wolfson AR. Sleeping patterns of children and adolescents:

developmental trends, disruptions, and adaptions. *Child Adolesc Psychiatr Clin N Am.* 1985;5:549–568
6. Wolfson AR, Carskadon MA. Sleep schedules and daytime functioning in adolescents. *Child Dev.* 1998;69:875–887
7. Dahl RE. The impact of inadequate sleep on children's daytime cognitive function. *Semin Pediatr Neurol.* 1996;3:44–50
8. Pilcher JJ, Huffcutt AJ. Effects of sleep deprivation on performance: a meta-analysis. *Sleep.* 1996;19:318–326
9. Blader JC, Koplewicz HS, Abikoff H, Foley C. Sleep problems of elementary school children: a community survey. *Arch Pediatr Adolesc Med.* 1997;151:473–480
10. Kirmil-Gray K, Eagleston JR, Gibson E, Thoresen CE. Sleep disturbance in adolescents: sleep quality, sleep habits, beliefs about sleep, and daytime functioning. *J Youth Adolesc.* 1984;13:375–384
11. Johnson EO, Chilcoat HD, Breslau N. Sleep problems and anxiety/depression in childhood. *Psychiatry Res.* 2000;94:93–102
12. Roberts RE, Roberts CR, Chen IG. Ethnocultural differences in sleep complaints among adolescents. *J Nerv Ment Dis.* 2000;188:222–229
13. Patten CA, Choi WS, Gillin C, Pierce JP. Depressive symptoms and cigarette smoking predict development and persistence of sleep problems in US adolescents. *Pediatrics.* 2000;106(2). Available at: www.pediatrics.org/cgi/content/full/106/2/e23
14. Johnson EO, Breslau N. Sleep problems and substance use in adolescence. *Alcohol Drug Depend.* 2001;64:1–7
15. Liu X, Zhou H. Sleep duration, insomnia and behavioral problems among Chinese adolescents. *Psychiatry Res.* 2002;111:75–85
16. Price VA, Coates TJ, Thoresen CE, Grinstead OA. Prevalence and correlates of poor sleep among adolescents. *Am J Dis Child.* 1978;132:583–586
17. Yang L, Zuo C, Eaton LF. Research note: sleep problems of normal Chinese adolescents. *J Child Psychol Psychiatry.* 1987;28:167–172
18. Morrison DN, McGee R, Stanton WR. Sleep problems in adolescence. *J Am Acad Child Adolesc Psychiatry.* 1992;31:94–99
19. Gau S-F, Soong W-T. Pediatric sleep disorders: sleep problems of junior high school students in Taipei. *Sleep.* 1995;18:667–673
20. Roberts RE, Roberts CR, Chen IG. Impact of insomnia on future functioning of adolescents. *J Psychosom Res.* 2002;53:561–569
21. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association; 1997
22. Liu X, Uchiyama M, Okawa M, Kurita H. Prevalence and correlates of self-reported sleep problems among Chinese adolescents. *Sleep.* 2000;23:27–33
23. Ohayon MM, Roberts RE, Zulley J, Smirne S, Priest RG. Prevalence and patterns of problematic sleep among older adolescents. *J Am Acad Child Adolesc Psychiatry.* 2000;39:1549–1556
24. Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Med Rev.* 2002;6:97–111
25. Breslau N, Roth T, Rosenthal L, Andreski P. Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. *Biol Psychiatry.* 1996;39:411–418
26. Ohayon MM, Roth T. Place of chronic insomnia in the course of depressive and anxiety disorders. *J Psychiatr Res.* 2003;37:9–15
27. Dodge R, Cline MG, Quan SF. The natural history of insomnia and its relationship to respiratory symptoms. *Arch Intern Med.* 1995;155:1797–1800
28. Angold A, Costello EJ, Worthman CM. Puberty and depression: the role of age, pubertal status and pubertal timing. *Psychol Med.* 1998;28:51–61
29. Angold A, Costello EJ, Erkanli A, Worthman CM. Pubertal changes in hormone levels and depression in girls. *Psychol Med.* 1999;29:1043–1053
30. US Census Bureau. Online summary tables of 2000 US Census data; 2003. Available at: factfinder.census.gov/servlet/SAFFPeople?_sse=on. Accessed December 14, 2005
31. Shaffer D, Fisher P, Dulcan MK, et al. The NIMH Diagnostic Interview Schedule for Children Version 2.3 (DISC-2.3): description, acceptability, prevalence rates, and performance in the MECA study. *J Am Acad Child Adolesc Psychiatry.* 1996;35:865–877
32. Shaffer D, Fisher P, Lucas C, Comer J. *Computerized Diagnostic Interview Schedule for Children (CDISC-IV)*. New York, NY: New York State Psychiatric Institute, Columbia University; 2000
33. World Health Organization. *The ICD-10 Classification of Mental and Behavioural Disorders*. Geneva, Switzerland: World Health Organization; 1992
34. American Academy of Sleep Medicine. *International Classification of Sleep Disorders, Revised: Diagnostic and Coding Manual*. Rochester, MN: American Academy of Sleep Medicine; 2001
35. Roehrs T, Hollebeek E, Drake C, Roth T. Substance use for insomnia in Metropolitan Detroit. *J Psychosom Res.* 2002;53:571–576
36. Edinger JD, Bonnet MH, Bootzin RR, et al. Derivation of research diagnostic criteria for insomnia: report of an American Academy of Sleep Medicine Work Group. *Sleep.* 2004;27:1567–1696
37. Leshner AI, Baghdoyan HA, Bennett SJ, et al. National Institutes of Health State-of-the-Science Conference Statement on Manifestations and Management of Chronic Insomnia in Adults (final statement). Available at: http://consensus.nih.gov/2005/2005InsomniaSOS026.html.htm. Accessed December 14, 2005
38. Carskadon MA, Acebo C. A self-administered rating scale for pubertal development. *J Adolesc Health.* 1993;14:190–195
39. Rosenthal L, Roehrs T, Roth T. The sleep-wake activity inventory: a self-report measure of daytime sleepiness. *Biol Psychiatry.* 1993;34:810–820
40. Stattin H, Magnusson D. *Pubertal Maturation in Female Development*. Mahwah, NJ: Lawrence Erlbaum; 1990
41. Waters WF, Adams SG Jr, Binks P, Varnado P. Attention, stress and negative emotion in persistent sleep-onset and sleep-maintenance insomnia. *Sleep.* 1993;16:128–136
42. Kim K, Uchiyama M, Okawa M, Liu X, Ogihara R. An epidemiological study of insomnia among the Japanese general population. *Sleep.* 2000;23:41–47
43. Rotem AY, Sperber AD, Krugliak P, Freidman B, Tal A, Tarasiuk A. Polysomnographic and actigraphic evidence of sleep fragmentation in patients with irritable bowel syndrome. *Sleep.* 2003;26:747–752
44. Mahowald MW, Mahowald ML, Bundlie SR, Ytterberg SR. Sleep fragmentation in rheumatoid arthritis. *Arthritis Rheum.* 1989;32:974–983
45. Dahl RE, Pelham WE, Wierson M. The role of sleep disturbances in attention deficit disorder symptoms: a case study. *J Pediatr Psychol.* 1991;16:229–239
46. Walters A, Mandelbaum D, Lewin DS, et al. Dopaminergic therapy in children with restless legs/periodic limb movement in sleep and ADHD. *Pediatr Neurol.* 2000;22:182–186

Epidemiology of DSM-IV Insomnia in Adolescence: Lifetime Prevalence, Chronicity, and an Emergent Gender Difference

Eric O. Johnson, Thomas Roth, Lonni Schultz and Naomi Breslau

Pediatrics 2006;117;e247
DOI: 10.1542/peds.2004-2629

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Epidemiology of DSM-IV Insomnia in Adolescence: Lifetime Prevalence, Chronicity, and an Emergent Gender Difference

Eric O. Johnson, Thomas Roth, Lonni Schultz and Naomi Breslau

Pediatrics 2006;117;e247
DOI: 10.1542/peds.2004-2629