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Original Research Article

Development and Validation of the Adolescent Insomnia Questionnaire

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Abstract

Objective Insomnia is a highly prevalent sleep disorder that is particularly common among adolescents with health conditions. We aimed to develop and validate a brief screening measure of insomnia in adolescents that can be used across clinical and community samples. We hypothesized that we would identify evidence supporting reliability, convergent/discriminant validity, and that we would determine preliminary clinical cutoff scores. **Methods** A team of experts in behavioral sleep medicine developed a 13-item brief screening measure of insomnia in adolescents (Adolescent Insomnia Questionnaire [AIQ]). We evaluated the psychometric properties of the AIQ in a sample of 315 youth (11–18 years old, Mean = 14.90, *SD* = 2.02; 64% female) who had chronic pain ($n = 37$), headache ($n = 170$), insomnia diagnosed by a sleep specialist ($n = 22$), or were otherwise healthy ($n = 86$). **Results** Using Exploratory and Confirmatory Factor Analysis, we identified three subscales consistent with major diagnostic criteria of insomnia. As expected, the measure showed strong reliability through high internal consistency ($\alpha = .91$). We also found strong convergent validity through expected positive relationships between the AIQ and self-report measures of sleep disturbance, and divergent validity via weak relationships with parent-report of snoring. Results of receiver operating characteristic (ROC) identified a clinical cutoff score that may assist in clinical decision making. **Conclusions** We found that the AIQ has sound psychometric properties in a large heterogeneous sample of treatment-seeking youth and youth from the community. The AIQ can quickly screen adolescent insomnia and could address an important clinical need in identifying youth in need of insomnia treatment in pediatric practice settings.

Key words: developmental perspectives; pain; sleep.

Introduction

Insomnia is common during adolescence impacting 10–25% of youth (de Zambotti, Goldstone, Colrain, & Baker, 2018). Insomnia disorder is characterized by frequent sleep-wake disturbances accompanied by significant morbidity including distress, poor quality of life, and impairments in emotional, social, cognitive, and academic functioning (American Academy of Sleep Medicine, 2005; American Psychiatric Association, 2013). Left untreated, insomnia and dysfunction may persist into adulthood, with substantial costs to the individual and society (Morin et al., 2009). Prospective studies show that the presence of insomnia symptoms in adolescence increases the risk of depression and substance abuse in adulthood (Roane & Taylor, 2008). Accurate early identification and treatment of insomnia are imperative for optimizing current and future physical and mental health and

quality of life, and preventing escalating healthcare costs in adolescents.

Although measures of adolescent sleep quality are available, there is currently no brief, developmentally informed measure of insomnia disorder that could inform treatment in adolescents. Because of the lack of adolescent insomnia screening instruments, prior studies have relied on assessment tools developed and validated for adults, most commonly the Pittsburgh Sleep Quality Index (e.g., Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; de la Vega et al., 2015; Werner-Seidler et al., 2019) and the Insomnia Severity Index (ISI) (e.g., Bastien, Vallières, & Morin, 2001; Palermo, Beals-Erickson, Bromberg, Law, & Chen, 2017; Werner-Seidler et al., 2019). However, there are limitations in the scoring and interpretation of these measures in adolescents. Moreover, given the substantial differences in adolescent sleep relative to adult sleep (e.g., differing sleep needs and habits, school schedules, developing independence from parents; Jenni & Carskadon, 2007), there is a critical need for insomnia symptom screening tools that are developmentally tailored and validated for use with adolescents.

Adolescents experience many physiological, psychological, and social changes that affect sleep. Although adolescents continue to require 9–9.5 hrs of sleep per night (Carskadon et al., 1980) they routinely experience irregular sleep schedules. Furthermore, pubertal hormonal changes affect sleep regulation (Carskadon, Vieira, & Acebo, 1993) causing sleep patterns to vary significantly following puberty. Key amongst these is a phase shift, a change in preferred sleep timing that leads older adolescents to routinely prefer bedtimes and wake times that are approximately 2 hrs later than middle childhood (Mindell & Owens, 2010). In combination with poor sleep hygiene (e.g., consuming caffeine, using electronic devices in bed), late evening activities, and early school start times, these developmental processes often result in youth having insufficient opportunity for sleep (Carskadon, 2011). Many youth experience insufficient sleep and display signs of sleep deprivation (Mindell & Owens, 2010). The complex landscape of typical and atypical sleep during adolescence necessitates a strong developmental perspective when attempting to distinguish insomnia from other common sleep complaints or disorders.

Insomnia frequently co-occurs with a broad range of psychiatric and medical conditions and there is growing research specifically on insomnia comorbid with chronic pain. While the lack of insomnia diagnostic screening instruments has limited the ability to easily assess comorbid insomnia in clinical populations, it is estimated that a sizeable number of adolescents with chronic pain experience symptoms of insomnia. Palermo, Wilson, Lewandowski, Toliver-Sokol, and Murray (2011) found that over 50% of youth with chronic pain report frequent difficulties initiating or maintaining sleep, highlighting the need for insomnia-focused assessment and treatment for this population.

To address the gap in insomnia measurement, we aimed to develop and validate a brief, developmentally appropriate screening measure (the Adolescent Insomnia Questionnaire [AIQ]) to assess insomnia in adolescents. We included clinical and community samples of adolescents. We hypothesized that factor analysis would reveal subscales consistent with diagnostic criteria for insomnia, and that we would demonstrate reliability via internal consistency, convergent validity via strong relationships between the AIQ and other measures of sleep disturbances (assessing different domains such as sleep initiation and maintenance problems, sleep hygiene, dysfunctional beliefs about sleep, presleep arousal, and daytime sleepiness), and discriminant validity via weak relationships with parent-reported snoring and externalizing symptoms. We also aimed to define a preliminary clinical cutoff score to identify the presence of insomnia. Base rates for insomnia were expected to be 10–20% among otherwise healthy adolescents (de Zambotti et al., 2018) and over 50% in the chronic pain and headache samples (Valrie, Bromberg, Palermo, & Schanberg, 2013). Due to our sampling procedures, 90–100% of youth recruited from the sleep clinic were expected to have insomnia.

Methods: Measure Development

Item development was conducted by a research team comprised of clinical psychologists, sleep physicians, and nurse practitioners with expertise in pediatric behavioral sleep medicine. Per DeVellis, (2016) the research team first reviewed diagnostic criteria for insomnia based on the adult Research Diagnostic Criteria, DSM-5 (American Psychiatric Association, 2013) and ICSD-3 (American Academy of Sleep Medicine, 2005). In general, the similarities in classification are that insomnia is a self-reported complaint of poor sleep quality including one of the following: difficulties initiating sleep, difficulties maintaining sleep, or waking up earlier than desired; that sleep difficulties occur despite adequate sleep opportunity; and that impaired sleep produces distress or deficits in daytime function. Considering these criteria, the team generated items regarding sleep onset difficulties, night wakings, early morning wakings, sleep quality, and daytime impairment. Next, we reviewed validated and widely used adult and Pediatric sleep questionnaires ($n = 14$; see Supplementary File 1) to identify relevant items and to select the response scaling. At

this point, items were also generated de novo. A 5-point Likert type frequency scale was selected. We refined the item bank by removing redundancies, editing content for response scaling, adjusting items to an elementary-school reading level, and incorporating developmentally relevant examples (e.g., school). This resulted in an initial bank of 72 items (47 items related to sleep onset difficulties, night wakings, early morning wakings, and sleep quality, and 25 items related to daytime impairment). Then, the 72 items were sent to a panel of 13 experts in pediatric sleep medicine and behavioral sleep medicine including physicians ($n = 3$), psychologists ($n = 7$), and masters and doctorate level nurses ($n = 3$) who rated the content validity (i.e., "How appropriate/applicable to screening for insomnia symptoms is this item?") and developmental appropriateness (i.e., "How developmentally appropriate/applicable is this item for use with 11–18 year olds?") of each item on a 0–4 scale (0 = "Not appropriate," 4 = "Extremely appropriate"). Means were calculated for each item and those with a mean of ≥ 3 on both scales (content validity and developmental appropriateness) were retained for review by the research team (MB and TP); similar items were eliminated and a combination of positively and negatively valanced items were retained. This process resulted in a 13-item bank. The measure was then completed by two young adolescents (an 11-year-old girl and an 11-year-old boy) to test understanding at the youngest end of the intended age range. Both indicated that the questionnaire was easy to understand and complete, of an acceptable length, and required no alterations. Additionally, we assessed readability using the Microsoft Word readability feature, which showed to be good. Specifically, the Flesch Kincaid Grade level was 3.15 (i.e., a third U.S. grade level is needed to comprehend the text) and the Flesch Reading Ease was 85.13% (it is considered appropriate if is higher than 60%). Thus, no additional changes to the questionnaire were made prior to recruiting the validation sample.

Methods: Initial Psychometric Validation of the AIQ

Study participants were enrolled in one of two research studies conducted at an academic medical center in the Pacific Northwest. Study 1 was the primary study for this article and the main aim was to validate the AIQ among youth with chronic pain, youth with insomnia, and otherwise healthy youth. Study 2 had a primary aim to evaluate psychosocial risk in youth with recurrent migraine and tension-type headache using survey methodology (Law, Powers, Blume, & Palermo, 2019); a subset of youth from Study 2 invited to complete a sleep assessment are included in this report. We have not previously published data on psychometric properties of the AIQ.

Our Institutional Review Board approved all procedures for both studies. All parents completed written informed consent and adolescents completed written assent prior to initiating study procedures.

Participants

Participants were 315 youth 11–18 years of age (Mean = 14.90, *SD* = 2.02; 64% female; 81% White; 90% non-Hispanic). Inclusion criteria were: (a) age 11–18 years old, (b) no serious comorbid medical condition (other than chronic pain), (c) parent was the legal guardian and lived with the adolescent, (d) parent and adolescent did not have cognitive impairment, and (e) parent and adolescent able to read/speak English.

For Study 1, three groups of participants were recruited: (a) youth diagnosed with insomnia by a provider in a pediatric sleep clinic, (b) youth diagnosed with chronic pain (pain for at least 3 months) by a provider in a pediatric pain clinic, and (c) otherwise healthy adolescents (no history of chronic pain) recruited from the community. For Study 2, two groups of participants were recruited: (a) youth from a neurology clinic with recurrent migraine or tension-type headache (at least 10 headache days per month for the past 3 months) diagnosed by a headache specialist, and (b) youth from the community experiencing at least 10 headache days per month for the past 3 months. For both studies, youth from clinical settings were recruited via postal mailings and telephone calls and youth from community settings were recruited via social media advertisements and flyers posted in local businesses.

Procedures

Recruitment/Enrollment

All potential participants completed telephone screening with study staff to determine eligibility. For Study 1,312 potential participants completed telephone screening (54 from sleep clinic, 83 from pain clinic, and 175 otherwise healthy from the community), 17 potential participants were excluded due to not meeting eligibility criteria (sleep clinic $n = 3$, pain clinic $n = 7$, otherwise healthy = 7), and 94 potential participants declined due to lack of interest (sleep clinic $n = 28$, pain clinic $n = 39$, otherwise healthy = 27). From Study 1, we enrolled 153 participants (sleep clinic $n = 22$, pain clinic $n = 37$, otherwise healthy = 94). Our recruitment/enrollment rate was 49.0% ($n = 153/312$). Participant flow for Study 2 is described in detail elsewhere (Law et al., 2019). Of the 240 participants in the larger study, 170 were invited to complete the sleep assessment.

Study Design

All adolescents (Studies 1 and 2) completed the AIQ. Adolescents from Study 1 completed additional validation measures including the ISI, and measures of sleep hygiene, sleep-related cognitions, presleep arousal, and daytime sleepiness, and a semistructured insomnia screening interview. All parents (Studies 1 and 2) reported on demographic and clinical characteristics including their adolescent's medication use and emotional/behavioral functioning. Parents in Study 1 also completed a questionnaire about adolescent symptoms of sleep-disordered breathing. All questionnaires were completed online via REDCap (Harris et al., 2009). The semistructured insomnia screening interview was completed via telephone. Participants received modest gift cards for completion of assessments (Study 1: $20 for teens, $10 for parents; Study 2: $20 for teens, $30 for parents).

Measures

Participant Characteristics

All parents provided demographic information including adolescent age, sex (i.e., male or female), race (i.e., White, Black or African American, Asian, Hawaiian or other Pacific Islander, American Indian or Alaska Native, and Other), ethnicity (i.e., Hispanic/Latino, Not Hispanic/Latino, or Unknown), and parental education. All parents reported on their adolescent's current use of prescription and over-the-counter medications, which we classified as pain medications (e.g., nonsteroidal anti-inflammatory drugs, acetaminophen, and opioids), anticonvulsants (e.g., topiramate and gabapentin), antidepressants (e.g., amitriptyline and fluoxetine), sleep medications (e.g., trazadone, melatonin, and antihistamines), or other (e.g., stool softeners, antacids, and vitamins).

To characterize adolescent emotional/behavioral functioning, all parents completed the 120-item Child Behavior Checklist-Parent Report (CBCL) (Achenbach & Ruffle, 2000). We examined T-scores for the internalizing symptoms, externalizing symptoms, and total problems scales. Higher scores indicate greater symptoms; T-scores greater than 63 are clinically significant. The CBCL has well-established reliability and validity (Achenbach & Ruffle, 2000). In our sample, reliability was $\alpha = .95$ for the total scale, $\alpha = .88$ for the internalizing subscale, and $\alpha = .89$ for the externalizing subscale.

Adolescent Insomnia Questionnaire

All adolescents completed the 13-item AIQ, described above. Total scores range from 0 to 52 with higher scores indicating more insomnia symptoms. The questionnaire is provided in Supplementary File 2.

Validation Measures

The Adolescent Sleep-Wake Scale-Short Version (ASWS)

All adolescents completed the Adolescent Sleep-Wake Scale-Short (ASWS), a 10-item self-report measure of sleep quality during the past month with items rated on a 6-point scale (1 = "Always" to 6 = "Never"; Essner, Noel, Myrvik, & Palermo, 2015). Total scores range from 1 to 6 with higher scores indicating better sleep quality. Reliability of the ASWS total score was good ($\alpha = .84$).

Insomnia Severity Index

Adolescents from Study 1 completed the ISI, a 7-item self-report measure validated for screening adult insomnia symptoms (Morin, Belleville, Bélanger, & Ivers, 2011). Symptoms are rated on a 4-point scale (0 = "None," 4 = "Very severe") and scores are summed to create a total score ranging from 0 to 28. The ISI has cutoff scores for insomnia severity that have been validated in adult populations: 0–7 absence of insomnia, 8–14 subthreshold insomnia, 15–21 moderate insomnia, 22–28 severe insomnia (Bastien et al., 2001). In our sample, internal consistency was good ($\alpha = .85$).

The Adolescent Sleep Hygiene Scale

Adolescents from Study 1 completed the Adolescent Sleep Hygiene Scale (ASHS) (LeBourgeois et al., 2004), an adolescent self-report measure of sleep hygiene behaviors during the past month, rated on a 6-point scale (1 = "Always," 6 = "Never"). We used the total score in analyses, higher scores indicate better sleep hygiene. Reliability of the ASHS total score was good ($\alpha = .84$).

Dysfunctional Beliefs and Attitudes about Sleep

Adolescents from Study 1 completed the Dysfunctional Beliefs and Attitudes about Sleep (DBAS), a 10-item self-report measure of sleep-related beliefs and attitudes, adapted for use with adolescents (Gregory, Cox, Crawford, Holland, & Haravey, 2009). Items are rated on a 5-point Likert type scale (1 = "Strongly disagree" to 5 = "Strongly agree.") and averaged to create a total score. Scores range from 1 to 5 with higher scores indicating more dysfunctional beliefs about sleep. Reliability of the DBAS was adequate ($\alpha = .77$).

Presleep Arousal Scale

Adolescents from Study 1 completed the Presleep Arousal Scale (PSAS; Nicassio, Mendlowitz, Fussell, & Petras, 1985), a 16-item self-report measure of somatic and cognitive arousal at bedtime, which has been used with adolescents (Gregory, Willis, Wiggs, Harvey, & STEPS Team, 2008). Items are rated on a

5-point Likert type scale (1 = "Not at all," 5 = "Extremely"). We used the total score in analyses (range = 16–80). Higher scores indicate greater pre-sleep arousal. Reliability of the PSAS was excellent ($\alpha = .91$).

Cleveland Adolescent Sleepiness Scale

Adolescents from Study 1 completed the Cleveland Adolescent Sleepiness Scale (CASQ; Spilsbury, Drotar, Rosen, & Redline, 2007), a 16-item adolescent self-report measure of sleepiness during daytime activities. Items are rated on a 5-point scale (0 = "Never" to 4 = "Almost every day") and are summed to create a total score (range 0–64). Higher scores indicate greater daytime sleepiness. Reliability of the CASQ was good ($\alpha = .89$).

Pediatric Sleep Questionnaire

Parents from Study 1 completed the PSQ (Chervin, Hedger, Dillon, & Pituch, 2000), a 22-item parent-report measure of sleep disordered breathing in youth. Response options are "Yes," "No," or "Don't know." The snoring subscale was scored based on 4 items (range = 0–4). Internal consistency was good for the snoring subscale ($\alpha = .87$).

Insomnia Screening Interview

Adolescents in Study 1 completed a semistructured insomnia screening interview via telephone, which was adapted from an adult version based on the research diagnostic criteria for insomnia (Edinger et al., 2004). This screening interview has been used in prior studies to identify adolescents with insomnia symptoms (Palermo et al., 2017, 2011). Per scoring procedures for adults (Edinger et al., 2004), adolescents were classified as experiencing clinically significant insomnia if they endorsed either: (a) persistent difficulties with initiating or maintaining sleep (DIMS) + associated impairment, or (b) nonrestorative sleep + associated impairment (i.e., DIMS/NRS cutoff). Since NRS is not specific to insomnia, we also used a secondary, more conservative approach, which limited classification of those with insomnia only to youth who reported difficulties with initiating or maintaining sleep + associated impairment (i.e., DIMS cutoff), that is, Option 1 described above. The mean time between administration of the screening interview and survey completion was 10.4 (15.27) days.

Data Analysis Plan

Analyses were conducted in SPSS v.21 (IBM Corp, 2011). We calculated descriptive statistics and used Pearson χ^2 tests and one-way analyses of variance (ANOVAs) to test for subsample group differences on demographic and clinical characteristics.

Exploratory and Confirmatory Factor Analysis

We conducted EFA and CFA using data from Studies 1 and 2. First, intercorrelations among the 13 AIQ items were examined to identify individual items with a pattern of very small ($r < .30$) or very large ($r > .80$) intercorrelations. Then, we divided the dataset into separate estimation and validation samples, by randomly allocating half of the sample into the estimation sample and half to the validation sample. Participants were also stratified by age, sex, and clinical group resulting in a $N = 153$ sample for the EFA and $N = 158$ for the CFA. Then, we conducted EFA to identify possible subscales. Per Field (2013) we report results of EFA using principal factor extraction, oblique (direct oblimin) rotation, with listwise deletion. Per Jolliffe's criteria, (Jolliffe, 2012) we retained factors based on visual inspection of the scree plot and Eigen values >.70. There were four participants with incomplete data who were excluded from the factor analysis, leaving a sample of $n = 311$ used in the factor analysis. Sample size required for factor analysis varies based on the construct and population under study, with samples as small as 100 adequate in some cases (Kline, 2005). The heuristic subject to item ratio of 10:1 (Nunnally, 1979) is also often cited and the current sample size meets these criteria. We then conducted a CFA fitting the model with a structural equation model (SEM), with latent constructs corresponding to the factors. The goodness of fit (GOF) was examined with the likelihood ratio test statistic, root mean squared error of approximation (RMSEA), Akaike information criterion/Bayesian information criterion, comparative fit index (CFI), Tucker-Lewis index (TLI), standardized root mean squared residual (SRMR), and coefficient of determination (CD). In order to test if the factor structure was stable, we also conducted invariance analyses splitting the sample by sex (boys and girls) and age (11–13 and 14–18 years old).

Reliability

Using data from Studies 1 and 2, we assessed internal consistency for the full scale and each subscale of the AIQ by computing Cronbach's alpha.

Convergent and Discriminant Validity

Using data from Study 1, we assessed convergent validity by calculating Pearson correlations between the AIQ and self-report measures of sleep disturbance. We assessed discriminant validity via Pearson correlations between the AIQ and parent-report measures of adolescent snoring (PSQ) and emotional/behavioral functioning (CBCL Externalizing Scale). We interpreted the magnitude of correlations per Cohen's guidelines (Cohen, 1992) as follows: small = .20, medium = .50, large = .80.

Clinical Cutoff Scores

Using data from Study 1, we conducted a receiver operating characteristic (ROC) analysis to identify preliminary clinical cutoff scores for the AIQ. ROC analysis is based on signal detection and Bayesian theories and statistically appraises an instrument's sensitivity and specificity in distinguishing clinical cases as compared to measures with established criterion scores (Youngstrom, 2014). ROC analysis provides an area under the curve (AUC). AUC > .90 are considered to have excellent diagnostic accuracy in comparison to the reference score (Zhu, Zeng, & Wang, 2010).

Due to the lack of previously validated measures of insomnia for youth, we conducted a ROC analysis using the insomnia screening interview DIMS/NRS criterion (persistent difficulties with initiating or maintaining sleep + associated impairment, or NRS + associated impairment).

Results

Participant Characteristics

Participant characteristics are presented in Tables I and II. Demographic characteristics reflected the population in our area of the Pacific Northwest. Sleep disturbances were similar across clinical cohorts (*p*s > .05) and, as expected, all clinical cohorts (insomnia, chronic pain, headache) reported greater sleep disturbances than the otherwise healthy sample (*p*s < .05). Mean CBCL scores were in the normal range across cohorts, but over one third of adolescents reported clinically elevated internalizing symptoms. More than three quarters of participants used at least one medication (76.1%), most frequently pain medications (50.0%). Average scores on the PSQ snoring subscale were below the clinical threshold, which suggests low rates of sleep apnea.

Exploratory Factor Analysis

Intercorrelations among the 13 items were examined and none were very small (*r* < .30) or very large (*r* > .80). EFA resulted in a three-factor solution that accounted for 69.21% of the variance among items. This solution had 7 (8%) nonredundant residuals with absolute values >.05, indicating no concerns for model fit. The values of the rotated individual item factor loadings ranged from .50 to .90, as shown in Table III. There were large intercorrelations (*r*'s >.50) among the three factors, supporting oblique rotation. Content of the three factors were consistent with the major diagnostic characteristics of insomnia and thus we labeled the three subscales "Sleep Dissatisfaction and Impairments," "Sleep Onset," and "Sleep Maintenance." Specifically, Factor 1 (sleep dissatisfaction and impairments) is related to sleep quality and daytime impairment, Factor 2 (sleep onset) is associated with sleep onset difficulties, and Factor 3 (sleep maintenance) is linked with night wakings and early morning wakenings. Factors cross-loadings are shown on Supplementary File 3.

Confirmatory Factor Analysis

Using SEMs, we fitted the three-factor model to the data in the validation sample, which demonstrated mediocre (RMSEA = .097, 90% CI .078–.117) to acceptable (SRMR = .07, CD = .99, CFI = .92, TLI = .90) indices (Field, 2013). See Figure 1 for details of the factor structure.

Invariance Analyses

The factor structure was invariant for sex (i.e., all the items load on the same factors for both boys and girls and for the full sample). Regarding age, the results are similar for older adolescents (14 and above) and for the full sample, however, for younger adolescents a two-factor solution is suggested: one factor for initiating and maintaining sleep (i.e., Factors 2 and 3 in the three-factor model) and another for sleep disturbances and impairments (i.e., Factor 1 in the three-factor model).

Reliability

Internal consistency for the AIQ total score was excellent (α = .91), and good or excellent for each subscale: sleep onset (α = .87), sleep maintenance (α = .79), and sleep dissatisfaction and impairments (α = .89).

Convergent and Discriminant Validity

Correlations between the AIQ and sleep measures are shown in Table IV. As expected, we found a large, positive correlation between the AIQ total and subscale scores with measures of insomnia symptoms (ISI) and sleep quality (ASWS) (range .47–.88, *p*'s <.01) which supports convergent validity. Also as expected, we found small and nonsignificant correlations between the AIQ total and subscale scores with the PSQ snoring subscale snoring subscale and the CBCL Externalizing scale (*r* = .06, *p* = .334), which supports discriminant validity.

Preliminary Clinical Cutoff Scores

The ROC model was significant (*p* < .0001) and in the excellent range (AUC = .93, *SE* = .27, 95% CI .86–.96) (Zhu et al., 2010). We identified a potential cut-off score of 15 using the DIMS/NRS classification on the insomnia screening interview (sensitivity = .907; specificity = .771). The AUC for the AIQ from ROC analyses is presented in Supplementary Figure 1.

Table I. *Demographic Characteristics of the Sample*

	Sleep clinic $n = 22$	Chronic pain $n = 37$	Headache $n = 170$	Community $n = 86$	EFA sample $n = 311$	Group differences
	M (*SD*)/%(*n*)	*M* (*SD*)/%(*n*)	*M* (*SD*)/%(*n*)	*M* (*SD*)/%(*n*)	*M* (*SD*)/%(*n*)	χ^2/ANOVA *F*(df)
Age	15.12 (1.62)	16.20 (1.60)	14.49 (1.88)	15.10 (2.82)	14.90 (2.02)	9.70 (3)[a,b,c]
Sex (female %)	54.5% (12)	81.1% (30)	64.3% (108)	59.0% (49)	64.2% (199)	6.46 (3)
Ethnicity						7.50 (6)
Hispanic/Latino	0% (0)	13.5% (5)	5.9% (10)	4.7% (4)	6.1% (19)	
Not Hispanic/Latino	95.4% (21)	81.1% (30)	88.8% (151)	91.9% (79)	90.4% (281)	
Unknown	4.6% (1)	5.4% (2)	5.3% (9)	3.5% (3)	3.5% (11)	
Race						16.22 (15)
White	81.8% (18)	86.5% (32)	81.6% (133)	77.6% (66)	81.1% (249)	
Black	0% (0)	2.7% (1)	2.5% (4)	3.5% (3)	2.6% (8)	
Asian	9.1% (2)	0% (0)	2.5% (4)	5.9% (5)	3.6% (11)	
Multiracial/Other	9.1% (2)	10.8% (4)	8.0% (13)	10.6% (9)	9.1% (28)	
Annual income						42.88 (15)*
< $10,000	18.1% (4)	43.2% (16)	36.7% (62)	10.6% (9)	29.0% (91)	
$10,000–69,999	27.3% (6)	13.5% (5)	21.9% (37)	23.3% (20)	21.7% (68)	
$70,000–100,000	40.9% (9)	37.8% (14)	39.1% (66)	64.0% (55)	45.9% (144)	
>$100,000	13.6% (3)	5.4% (2)	2.4% (4)	2.3% (2)	3.5% (11)	
CBCL total	55.65 (9.75)	53.51 (7.60)	53.18 (9.23)	52.25 (9.65)	53.14 (9.20)	57.28 (6)*
Clinical range %	54.5% (12)	43.2% (16)	11.9% (19)	7.0% (6)	17.4% (53)	
CBCL internal.	61.35 (8.90)	60.71 (7.73)	59.61 (9.15)	58.13 (9.78)	59.46 (9.16)	46.83 (6)*
Clinical range %	54.5% (12)	75.7% (28)	35.0% (56)	15.1% (13)	35.7% (109)	
CBCL external.	50.95 (9.34)	48.63 (7.54)	47.45 (8.95)	46.70 (8.97)	47.62 (8.85)	23.91 (6)*
Clinical range %	27.3% (6)	8.1% (3)	5.0% (8)	3.5% (3)	6.6% (20)	

Note. EFA = Exploratory Factor Analysis, CBCL = Child Behavior Checklist. *χ^2 p <.05. One-way ANOVA p <.05.
[a]Chronic pain versus headache.
[b]Chronic pain versus otherwise healthy.
[c]Headache versus otherwise healthy.

Table II. *Subjective Sleep Characteristics*

	Sleep clinic $n = 22$	Chronic pain $n = 37$	Community $n = 86$	Total $n = 145$
Subjective sleep measures	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Adolescent Sleep-Wake Scale (ASWS)	3.45 (.85)	3.72 (.80)	4.46 (.69)a,b	4.11 (.85)
Insomnia Severity Index (ISI)	13.55 (5.92)	14.39 (5.00)	6.36 (4.11)a,b	9.50 (5.99)
Adolescent Sleep Hygiene Scale (ASHS)	4.69 (.71)	4.51 (.48)	4.77 (.50)[a]	4.69 (.53)
Dysfunctional Beliefs & Attitudes about Sleep (DBAS)	26.73 (7.01)	28.35 (7.26)	25.62 (6.80)	26.49 (7.00)
Pre-Sleep Arousal Scale (PSAS)	39.36 (13.28)	39.43 (13.68)	30.78 (9.67)a,b	34.29 (12.07)
Cleveland Adolescent Sleepiness Scale (CASQ)	29.41 (10.41)	31.50 (10.81)	21.57 (8.92)a,b	25.28 (10.61)
Pediatric Sleep Questionnaire (PSQ), snoring	12 (.25)	.23 (.34)	.08 (.18)[a]	.12 (.25)
ISI Classification	% (*n*)	% (*n*)	% (*n*)	% (*n*)
Absence of insomnia (0–7)	18% (4)	5% (2)	63% (54)	41% (60)
Subthreshold insomnia (8–14)	36% (8)	43% (16)	33% (28)	36% (52)
Moderate insomnia (15–21)	32% (7)	41% (15)	5% (4)	18% (26)
Severe insomnia (22–28)	14% (3)	11% (4)	0% (0)	5% (7)
Insomnia interview classification	% (*n*)	% (*n*)	% (*n*)	% (*n*)
DIMS	86% (19)	89% (33)	37% (32)	58% (84)
DIMS/NRS	86% (19)	95% (35)	50% (43)	67% (97)

Note. Percentages have been rounded up. DIMS = difficulties initiating or maintain sleep; NRS = non restorative sleep. One-way ANOVA using Tukey's post hoc tests
[a]Community significantly different than chronic pain.
[b]Community significantly different than sleep clinic.
[c]Chronic pain significantly different than sleep clinic.

Discussion

We developed a 13-item adolescent self-report screening measure of insomnia symptoms called the AIQ. The AIQ has the potential to address an important gap in the field of pediatric sleep medicine, where a lack of validated screening measures for insomnia symptoms has been identified as a weakness (de la Vega & Miró, 2013; Lewandowski, Toliver-sokol, & Palermo, 2011; Spruyt & Gozal, 2011). It has been shown that youth with chronic pain are at particularly

Table III. *Factor Loadings in the Three-Factor Model (13 Items)*

	Rotated factor loadings
Factor 1: Sleep dissatisfaction and impairments	
11. I have trouble paying attention in class or concentrating because of poor sleep.	.84
10. I have trouble going to school because of sleep problems.	.81
12. I feel grumpy or sad because of poor sleep.	.71
13. I have trouble doing things with friends because of poor sleep.	.68
5. I feel sleepy or tired during the day.	.57
*3. I am satisfied with my sleep.	.41
Factor 2: Sleep onset	
1. I have difficulty falling asleep.	.84
*4. I fall asleep quickly.	.86
7. It takes me more than a half hour to fall asleep.	.80
*9. It is easy for me to settle down when it is time to go to sleep.	.57
Factor 3: Sleep maintenance	
2. I wake up too early and cannot fall back asleep.	.76
6. It is hard for me to fall back to sleep when I wake up during the night.	.63
*8. I sleep through the night.	.55

$N = 153$.
*= Item is reverse scored.

high risk for insomnia symptoms (Palermo, Law, Churchill, & Walker, 2012). In this preliminary study presenting the development and the psychometric properties of the AIQ, we focused on a large, heterogeneous sample of youth with and without chronic pain conditions recruited from the community and clinical settings.

Using EFA in the estimation sample, we identified three subscales consistent with the symptoms of adolescent insomnia: "sleep dissatisfaction and impairments," "sleep onset," and "sleep maintenance." The CFA conducted in the validation sample showed that the GOF was overall acceptable for the proposed three-factor solution, supporting the internal consistency of the measure and its alignment with the insomnia diagnostic criteria. That structure was maintained in the invariance analyses, with the exception of younger adolescents. Studies with larger samples, adolescents with other clinical conditions, and different age groups would help to better understand the AIQ stability across different populations.

As expected, the measure showed strong reliability for the total score and the three subscale scores. We also found evidence supporting convergent validity and discriminant validity. It is important to note that we used parent-report measures to assess discriminant

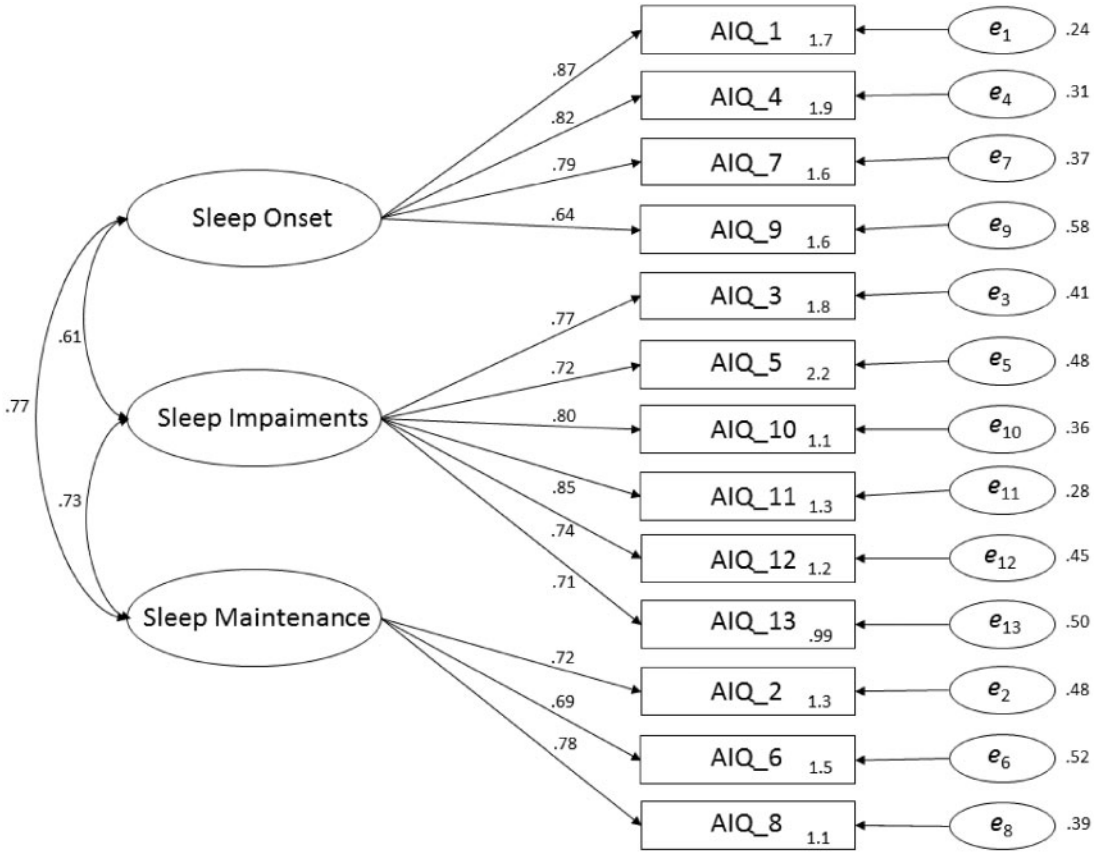

Figure 1. CFA with three factor latent structure model of the AIQ. Numbers on the curved arrows represent correlations between factors. Numbers on the straight arrows represent the loading of each item on the factor. Numbers in the squares represent the intercept of each item on the factor. Numbers at the right end represent the residual (error) variance of each item.

Table IV. *Correlations of AIQ with Other Subjective Sleep Disturbances*

	M (*SD*)	ASWS	ISI	ASHS	DBAS	PSAS	CASQ	PSQ- Snoring
AIQ total	22.29 (11.77)	−.66**	.88**	−.52**	.45**	.69**	.72**	.14
AIQ sleep dissatisfaction and impairments	10.21 (6.09)	−.47**	.78**	−.50**	.54**	.59**	.82**	.08
AIQ sleep onset	8.16 (4.66)	−.71**	.73**	−.45**	.26**	.64**	.47**	.17*
AIQ sleep maintenance	3.92 (3.00)	−.55**	.75**	−.32**	.25**	.52**	.46**	.12

Note. AIQ = Adolescent Insomnia Questionnaire; ASWS = Adolescent Sleep-Wake Scale-Short version; ISI = Insomnia Severity Index; ASHS = Adolescent Sleep Hygiene Scale; DBAS = Dysfunctional Beliefs and Attitudes about Sleep; PSAS = Pre-Sleep Arousal Scale; CASQ = Cleveland Adolescent Sleepiness Scale; PSQ = Pediatric Sleep Questionnaire. Only participants from Study 1 are included in this table (participants of Study 2 responded to the AIQ only).

*$p < .05$; **$p < .01$.

validity, and child-report measures to assess convergent validity. As such, findings regarding convergent and discriminant validity should be interpreted with some caution due to potential reporter bias which may have inflated correlations between measures completed by the same reporter.

We were also interested in defining a preliminary cutoff score for the AIQ. Our criterion measure was the insomnia screening interview. Using this approach, we identified a cutoff of 15. Clinicians and researchers could consider the cutoff score when the goal of the screening is to identify adolescents who have insomnia symptoms (i.e., to conduct a more in-depth assessment).

Our findings regarding potential preliminary cutoff scores should be interpreted with caution since our study is the first to evaluate psychometric properties of the AIQ. Despite that limitation, identification of potential clinical cutoff scores is a strength of our study because other PSQs cannot be used to screen for clinically significant symptoms (Lewandowski et al., 2011).

Regarding the applicability of the AIQ, due to its brevity and ease of scoring, it is a tool that could be included in routine assessments of healthy adolescents or included in multidimensional assessment of clinical populations with chronic health conditions, such as chronic pain, without significantly increasing the burden. Future studies could explore the feasibility of including it as part of routine health check-ins or as part of research protocols studying adolescents with chronic health problems.

There are several additional limitations to consider when interpreting results from this study. First, although the items in the AIQ were deemed age-appropriate by a panel of pediatric sleep experts and tested by two young adolescents, no formal cognitive testing was conducted which would have been an additional step to ensure the items were fully evaluated for their understandability and content validity. Additionally, our sampling strategy should be considered when interpreting our findings. In order to ensure an adequate signal for detection of insomnia, we oversampled clinical populations expected to have high rates of insomnia. Moreover, our results may not generalize to youth with medical conditions other than chronic pain or headache and research is needed to evaluate the AIQ in other pediatric populations. Similarly, although youth with psychiatric comorbidities were not excluded from our sample, research is needed to evaluate the AIQ in youth seeking treatment for psychiatric conditions that commonly co-occur with insomnia (e.g., depression). Finally, the same is true regarding racial and ethnical minorities: although they were included, the number of participants was low.

In conclusion, the AIQ is a brief adolescent self-report screening measure of insomnia symptoms. Our findings suggest that the AIQ is a promising tool for screening insomnia symptoms in adolescents seeking treatment for insomnia symptoms, chronic pain, and headache as well as otherwise healthy youth from the community.

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Supplementary Data

Supplementary data can be found at: https://academic.oup.com/jpepsy.

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