A National Validation Study of the Sleep Disorders Inventory for Students (SDIS)

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** The Sleep Disorder Inventory for Students (SDIS) is distributed by Pearson, Inc, to school and clinical psychologists, psychiatrists, and physicians nationwide since 2005.

ABSTRACT

Objectives: To validate the Sleep Disorders Inventory for Students (SDIS), a parent-report sleep screening inventory for children, ages 2 through 10 years (SDIS-C), and adolescents, ages 11 through 18 years (SDIS-A).

Design: A purposive critical case nonprobability sample was used at the hospitals and by psychologists. A stratified random sample was used with a "quasi-control" group of students.

Settings / Participants: The Pilot study contained 226 children and the Main Study had 595 children from 45 public schools, two private practices, and seven sleep centers.

Measurement and Results: The Expert Panel obtained 94% content validity. Pilot Study Exploratory Factor Analysis (EFA) suggested five factors. SDIS-C Main Study EFA (n = 188) suggested four factors (OSAS, EDS, PLMD, and DSPS) and was substantiated using Confirmatory Factor Analysis (CFA) (n=202). Five factors (OSAS, EDS, Narcolepsy, PLMD/RLS, and DSPS) were confirmed for the SDIS-A using CFA on 182 adolescents. Concurrent validity produced moderate correlations for the SDIS-C and SDIS-A when comparing the SDIS: OSAS scale with the PSG/RDI Index. The SDIS-C and SDIS-A had high predictive validity of 86% and 96% when determining which children needed referrals to sleep specialists. Predictive validity for the exact sleep disorder ranged from 72-100%. High internal consistency was obtained for the SDIS – C and SDIS-A (.91 and .92). Subscale internal consistency ranged from .71 to .95. Test-retest reliability was .97 for the SDIS-C and .86 for the SDIS-A.

Conclusions: The SDIS-C and SDIS-A have strong psychometric properties and are designed for use by many professionals. The SDIS-C measures four sleep domains, and the SDIS-A measures five sleep domains, both providing a Sleep Disturbance Index, graphed T-Scores, percentiles, an interpretive report, and forms available in English and Spanish. The report also provides information and interventions for children who have sleep-talking, sleep-walking, bruxism, sleep terrors, or nocturnal enuresis.

Key Words: children's sleep disorders; sleep survey; screening instrument; sleep problems

INTRODUCTION

Research on the epidemiology of pediatric sleep disorders is limited. However, a conservative estimate made by the National Institute of Health in 2001 suggested that up to 15% of all students may have a sleep disorder negatively impacting their health, learning, and daytime functioning. A recent study indicated that only 0.1% of people with sleep disorders were diagnosed in community-based outpatient health clinics and only 3.1% were diagnosed at university-based clinics, most of which were adults.[1] For the small percentage of people being diagnosed with a sleep disorder, the average amount of time that may elapse from onset of the disorder until the time of diagnosis could be 10-15 years.[2] Consequently, these untreated sleep disorders are negatively affecting students' achievement, behaviors, and interpersonal functioning. Results of numerous sleep studies have indicated the urgent need to identify and correct these sleep disorders in early childhood before they negatively affect cognition, achievement, grades, behaviors, health, and safety.[3-18] Furthermore, treatment and correction of students' sleep disorders have resulted in improved cognition, achievement, grades, and overall behaviors.[3, 6, 12-13] It appears that the lack of a nationally available pediatric screening process could be significantly improved if the professionals who have the most contact with children would assist in the screening and referral process; namely teachers, pediatricians, school and clinical psychologists.

Presently, there are no nationally validated screening instruments normed on samples of children reflective of the 2000 U.S. Census population demographics, nor are the existing inventories designed and available for general use by any professional working with parents and children. Such a screening inventory also needs to identify the major sleep disorders negatively affecting achievement, behaviors, and quality of life for children between 2-and-18 years of age; uphold stringent psychometric standards if it is to be used in epidemiology studies or with confidence by school and clinical psychologists, or other professionals experienced in behavioral screening and assessment; be validated at numerous sleep centers from different regions of the USA who use nationally accepted pediatric diagnostic criteria for sleep disorders; contain a sample of children from many schools with educational representation from general education, special education, gifted education, and the most commonly occurring DSM-IV diagnoses; be written on a clear, simple 3-to-5th grade reading level with the assistance of professionals representing the major ethnic backgrounds in this country to prevent items with cultural bias or insensitive questions; use many forms of validation and reliability and obtain high validity and reliability coefficients across measures to increase its accuracy and functional utility; have a well-defined and broad item response (scoring) scale of 4-to-7 points to ensure rating accuracy and specificity; measure the most commonly or frequently occurring sleep disorders in children while even red flagging some less frequently occurring sleep disorders (even if it cannot exactly define them in a brief screening); be easy and quick to complete by parents; provide accurate computer scoring (to prevent avoidable errors and ensure quick scoring and interpretation for large screenings of school children or in epidemiology studies); and finally, produce a clear and simple interpretative graph and report that facilitates understanding for the general practitioner and parent who have limited knowledge about sleep disorders.[19-24]

The development of the Sleep Disorders Inventory for Students (SDIS) has made a valid assessment tool available to professionals who screen students with medical, academic, and/or behavior problems, while meeting stringent assessment criteria. An increase in the number of professionals screening students could result in a significantly greater number of students being referred to medical personnels for early diagnosis and treatment of sleep disorders. This is a presentation of the preliminary reliability and validity data on the Sleep Disorders Inventory for Students (SDIS), a parent-report sleep screening inventory specifically designed for children and youth from 2-through-18 years of age. The SDIS has been developed with data collected from parents of children in 45 schools, two psychology private practices in Florida, and seven sleep clinics nationwide, all but one which were American Academy of Sleep Medicine (AASM) certified.

METHODS

Pilot Study Participants

An initial pilot study was conducted on 226 children ranging in ages from 2-through-18 years using exploratory factor analysis (EFA). The Pilot Study consisted of three sample groups: (1) a retrospective sample of 31 children and adolescents who were referred by local pediatricians to sleep specialists for an initial examination and then an overnight polysomnography (PSG) completed at Tampa General Hospital or All Children's Hospital

Sleep laboratories in Tampa Bay, FL between 2000-2002; (2) a sample of 171 children and adolescents who had never been referred for a sleep study and consisted of three groups: (a) students in the Tampa Bay, FL area, mostly enrolled in general education, who were selected by stratified random sampling, (b) students referred to Pasco County, FL school psychologists for learning or behavior problems or gifted assessment during the 2002 school year, and (c) a sample of 19 children who were evaluated for learning, behavior, or gifted programs by school or clinical psychologists at two private practices in Tampa Bay, FL. IRB approval was obtained at all Pilot Study data collection sites and all participants signed consent forms.

Main Study Participants

The Main Study was a national study of 595 children ranging in ages from 2-through-18 years that targeted data collection in four different regions of the USA: (1) The Southern Region included children from Miami Children's Hospital in Miami, FL, University Community Hospital in Tampa, FL, and students from 45 schools in the Pasco County, Pinellas County, and Hillsborough County, FL Schools Districts; (2) the Eastern Region was represented by children from Johns Hopkins Pediatric Sleep Center in Baltimore, MD; (3) the Midwest was represented by children from Carle Regional Sleep Disorders Center in Urbana, IL, and (4) the Western Region was represented by participants from Stanford Sleep Disorders Clinic in Stanford, CA. All five sleep centers were certified by AASM and had extensive training and experience in diagnosing children's sleep disorders. IRB approval was obtained at these sleep centers and school districts, and consent forms were signed by all parents of students in the hospital, school, and private practice samples.

This study consisted of five sampling groups: (1) a retrospective sample of 37 (-out-of-167) parents who responded to the mailing of the SDIS and demographic surveys. Their children had undergone an overnight PSG at Johns Hopkins Pediatric Sleep Centers, MD, Stanford Sleep Disorders Clinic, CA, or University Community Hospital, Tampa, FL between 2001-2003. The majority of these children had been diagnosed with a sleep disorder or nocturnal seizures or epilepsy; (2) a prospective sleep clinic sample of 146 parents whose children's clinical evaluation resulted in a referral for an overnight PSG at Carle Regional, Johns Hopkins, Miami Children's Hospital, or Stanford; (3) a sample of 255 students from 29 schools who were referred by teachers or parents to school psychologists in the Pasco County, FL School District for a wide variety of learning concerns, behavior problems, or gifted assessment; (4) a sample of 131 parents working in the Pasco County, FL school system were asked to participate and complete the SDIS on their children (these children came from 24 schools in the Pasco, Hillsborough, or Pinellas County, FL school districts and became a "quasi-control group" because this group closely represented the national percentages of educational classifications with 76% enrolled in general education, 13% in special education, and 11% in gifted programs); and (5) a sample of 26 parents of students referred to two psychology private practices in the Tampa Bay, FL region for gifted, learning, emotional, or behavioral assessment (these practices were in Pinellas and Hernando Counties, FL and were selected due to interest expressed by the psychologists that they would like to participate in the study and learn more about sleep disorder screening methods for students). It was important to include sample groups 3, 4, and 5 who had not been referred for a sleep evaluation since one of the main goals was to develop an instrument that is designed for use in educational settings by school psychologists, teachers, counselors, social workers, and school nurses. IRB approval was obtained at all Main Study data collection sites and all participants signed consent forms.

DESIGN

A purposive critical case nonprobability sample was used at the sleep centers and for the students referred to school and private practice psychologists. A stratified random sampling was used for the quasi-control group in the Tampa Bay, FL school districts.

VALIDATION

Content Validation of the SDIS

Content validation refers to the extent to which an assessment instrument appears to measure what it purports to measure.[24] Content validation is the first step in the development of a screening instrument. Based on an extensive review of the pediatric sleep research literature[3] and recommendations from many sleep specialists involved in both pediatric research and clinical practice, 54 potential sleep items were developed in Phase One to

describe the characteristics of five sleep disorders that were reported to negatively affect students' functioning.[3-18] These disorders are Obstructive Sleep Apnea Syndrome (OSAS), Narcolepsy (NARC), Periodic Limb Movement Disorder (PLMD), Restless Legs Syndrome (RLS), and Delayed Sleep Phase Syndrome (DSPS), or in younger children, Behavioral Insomnia of Childhood might be the best term, even though it will be referred to in this study as DSPS because that is the term that was used by the sleep specialists at the time of this study.

In Phase Two, an Expert Test Review Panel (ETRP) was selected in 2001 to validate the item content (see names of panel listed in beginning of article). To participate on an ETRP, professionals had to have extensive clinical experience in the fields of sleep medicine, measurement and inventory development, or assessment. All nine ETRP members met these criteria, and all have published scientific articles in professional journals or Dissertation Abstracts. The panel included six national experts representing the fields of sleep medicine or clinical sleep practice, one professor who is an expert in the design of educational inventories and has recently written a textbook on this topic, and two school psychologists with extensive assessment experience. The ethnic composition of the ETRP included professionals of Caucasian, Asian-American, African-American, and Hispanic-American backgrounds. The three professionals of diverse cultural backgrounds and ethnicity had measurement and assessment experiences, but little knowledge about sleep disorders. These three experts rated the SDIS in Phase Three for cultural sensitivity and linguistic clarity, reading level, and quality of the rating scales.

In Phase Four, the six sleep specialists judged the degree to which inventory items described a sleep disorder and determined if items should be rewritten, retained or discarded. They also rated items according to which sleep disorder they best represented. Eleven items were deleted after the third and fourth phases of rating the SDIS because the items were not specifically describing one of the five sleep disorders, were culturally insensitive, or the items did not discriminate well between children with and without sleep disorders. The panel re-worded 32% of the questions for clarity or to prevent cultural bias. They also requested that 5 items pertaining to the child's health be split into two separate items (they were asking two questions in one item) and then be rewritten in a "Yes" or "No" format. These health items were not included in the SDIS sleep disorder scales or statistical analyses because they did not fit into the 7-point response scale. However, these items were retained at the end of the inventory to provide medical professionals more health information pertaining to possible OSAS. These questions inquire about the child's weight and height as a toddler and at the present time, if the child has numerous respiratory or ear infections, if the child still has his/her tonsils and adenoids, and if so, has a physician ever reported that they are enlarged. After the questions were rewritten, the SDIS was evaluated and found to be written on a 4^{th} to 5^{th} grade reading level based on the Fry analysis of estimating sentence length and syllables per 100 words.[25]

Finally the inventory entered Phase Five of content validation where the panel of sleep specialists rated each of the remaining 38 items on two criteria: (1) Did each item accurately described one or more of the five sleep disorders and should remain in the inventory (SDIS Content Validity), and (2) if so, which sleep disorder/s did the items best describe (Item Validity)? An item was deleted if $\geq$ 60% of the panel voted "No" for it. Two items were deleted by the panel. The SDIS Content Validity was 94%, which is considered high content validity, especially for a screening instrument.[21] There was a range of agreement on the remaining 36 items from 65%-to-100% with 92% agreement among the six sleep specialists as to which sleep constructs were described by each item (Item Content Validity). Table 1 provides an abbreviated description of the remaining items, the Panel Members' sleep scale classifications for each item, and the percentage of agreement among panel members (Item Content Validity):

Table 1 - Content Validity of ETRP Members When Coding SDIS Item's for Sleep Constructs

Abbreviated Items	ETRP Item Coding of Sleep Constructs	Total %
1. Stops breathing 5+ sec.	OSAS=100%	100%
2. Sleep-Walking	OSAS=40% / NARC=40%	(Delete)
3. Mouth Breather / Daytime	OSAS=100%	100%
4. Mouth Breather / Nighttime	OSAS=100%	100%
5. More sleepy in Daytime	OSAS=100% / NARC=100% / PLMD=83% / RLS=83% / DSPS=100%	93%
6. Difficulty Arising in A.M.	OSAS=67% / NARC=83% / PLMD=83% / RLS=83% / DSPS=67%	77%
7. Unable to Talk upon Awakening	OSAS=0% / NARC=100%	100%
8. Repeated Leg Jerks	OSAS=60% / PLMD=100% / RLS=80% / NARC=20 (Delete NARC)	80%
9. Raspy Breathing / Light Snoring	OSAS=100%	100%
10. Loud Snoring	OSAS= 83% / None=17%	83%
11. Confusion upon Awakening	OSAS=100% / NONE=83% / DSPS=40% (Delete DSPS)	92%
12. Rolls Around the Bed	OSAS=83% / PLMD=100% / RLS=100% / NARC=17% (Delete NARC)	94%
13. Up Past 1:00 a.m. Playing	DSPS=100%	100%
14. Gasps, Chokes, Snorts in Sleep	OSAS=100%	100%
15. Bed-Wetting	OSAS=100%	100%
16. Sweats a lot in Sleep	OSAS=100%	100%
17. Iritable	OSAS=100% / NARC=83% / PLMD=83% / RLS=83% / DSPS=100%	90%
18. Diff. Falling Asleep	DSPS=100%	100%
19. Restless Leg Pain in Child	RLS=100% / PLMD=17% (Delete PLMD)	100%
20. Restless Leg Pain in Parent	PLMD=100% / RLS=100%	100%
21. Tired in A.M./ Alert in P.M.	DSPS=100% / OSAS= 20% (Delete OSAS) / NARC=20% (Delete NARC)	100%
22. Sleeps in Strange Positions	OSAS=100%	100%
23. Attacks of Muscle Weakness	NARC=100%	100%
24. Heavy Breathing while Sitting	OSAS=67% / None=33%	67%
25. Accident Prone	OSAS=67% / NARC=67% / PLMD=67% / RLS=67% / DSPS=67%	67%
26. Night Awakenings	OSAS=83% / NARC=67% / PLMD=83% / RLS=67%	75%
27. Tired After Enough Sleep	OSAS=83% / NARC=83% / PLMD=67% / RLS=67% / DSPS=67%	73%
28. Vivid Dreams or Hallucinations	NARC=100%	100%
29. Skips/Late for Early Classes	OSAS=83% / NARC=83 / PLMD =83 / RLS=17 (Delete RLS) / DSPS=100%	87%
30. 30+ Min. to Go to Sleep	OSAS=67% / PLMD=67% / RLS=100 / DSPS=100%	84%
31. Falls Asleep When Talking	OSAS=100% / NARC=100% / DSPS=60%	87%
32. Diff. Shifting Sleep Onset Earlier	DSPS=100%	100%
33. Frequent Headaches	OSAS=100%	100%
34. Strange Automatic Behaviors	OSAS=17% (Delete OSAS) / NARC=100% / DSPS=17% (Delete DSPS)	100%
35. Dry Mouth upon Awakening	OSAS=100%	100%
36. Difficulty Breathing at Night	OSAS=83% / None=17%	83%
37. Falls Asleep More in Daytime	OSAS=100% / NARC=100% / PLMD=83% / DSPS=100%	96%
38. Complained of blurred or double vision.	NARC=50% / None=50%	(Delete)
Scale Validity after Deleted Items were Omitted:		**92%**
Total SDIS Content Validity		**94%**

Note[1]. OSAS = Obstructive Sleep Apnea Syndrome; NARC = Narcolepsy; PLMD = Periodic Limb Movement Disorder; RLS = Restless Legs Syndrome; DSPS = Delayed Sleep Phase Syndrome; None = No sleep disorder was endorsed.
Note[2]. Permission was granted to abbreviate and reproduce this table by M. Luginbuehl (pp. 113-115).[3]

Several months after the Content Validation process was completed, two sleep specialists participating in the Main Study requested that additional items be added to the SDIS. Since this is acceptable in the development of a new inventory, [20-21] these questions were permitted and were validated in the Pilot and Main Study validation processes. Dr. Daniel Picchietti, sleep specialist at Carle Regional Sleep Disorders Clinic, IL, recommended that two additional items be added to the SDIS to measure PLMD ("....touchy or tantrums..." and "...noncompliant..."). Dr. Marcel Deray, sleep specialist from Miami Children's Hospital, recommended that four items be added to measure DSPS and EDS ("...sleep onset on week nights...", "...sleep onset on weekends...", "...amount of sleep on week nights...", and "...amount of daytime naps...").

SDIS Item Rating Format

A seven-point likert scale was used so that each item could be rated across a broad range of time and behavioral frequencies to increase the reliability and specificity of the scales.[20-21] One of the major weaknesses of most inventories is that the range of responses for each item is too narrow, which decreases item specificity. Each item on the SDIS could be rated from "Never" occurring, to "Always" occurring, according to how frequently the behavior was observed. A brief, but exact definition of each rating was provided to assist participants in the rating process and to increase response accuracy. Since both Prospective and Retrospective inventories had to be used in this study, there was also a "0 = Don't Remember" response for the Retrospective sample. See Table 2 for the likert rating scale.

Table 2 - SDIS Definitions of the 7-Point Likert Scale

0 = CAN'T REMEMBER: Too long ago to remember.
1 = NEVER: The child **never** exhibits this behavior.
2 = RARELY: Child exhibits the behavior maybe **once every month or two.**
3 = OCCASIONALLY: Child exhibits the behavior **3-to-4 times per month**.
4 = SOMETIMES: Child exhibits the behavior **several times per week**.
5 = OFTEN: Child exhibits this behavior on a **daily basis.**
6 = ALMOST ALWAYS: Child displays behavior **multiple times per day or night.**
7 = ALWAYS: Child exhibits behavior **multiple times per hour daily or nightly.**

Note.[1] Parents in Retrospective Hospital Sample used this scale written in past tense with the "0" rating included and were instructed to rate their child before a sleep evaluation was done.
Note.[2] M. Luginbuehl (p. 119)[3] granted permission to use Table 2.

STATISTICAL ANALYSES

Preliminary Pilot Study Analysis

Since limited research existed on the characteristics of sleep disorders in children of different ages, construct validity using Exploratory Factor Analysis (EFA) was conducted to assess the factor structure of the SDIS and gain more knowledge about which items best measure these sleep factors for different age groups.[26-27] EFA was conducted on the data from the 42-item SDIS after parents of 226 children completed the inventory to determine the relationship between the items and the five sleep factors (OSAS, NARC, PLMD, RLS, and DSPS). Pilot Study demographic information on these participants can be obtained on pp. 120-130.[3]

Main Study Analyses - Construct Validation

After using EFA in the Pilot Study to analyze the relationship between the items and the five factors, further construct validity measurements were conducted in the Main Study after separating the 2-through-5 year and 6-through-10 year age groups (SDIS-Children's Form) from the 11-through-14 year and 15-through-18 year age groups (SDIS-Adolescent Form). A second, EFA was conducted on 188 children in the younger sample (SDIS-C) to determine if the factor structure was different for younger children than the five factor model demonstrated in the Pilot Study when all ages were combined because qualitative differences were noted between the younger and older age groups in the Pilot Study. Then confirmatory factor analysis was conducted on a different sample of 201 children in the younger group (SDIS-C) to verify a good model fit (CFA uses computer maximum likelihood estimations to measure the SDIS factor structure previously identified in EFA and determine if that model fits the data provided by parents in the Main Study). There were not enough students in the adolescent (SDIS-A) sample to conduct both EFA and CFA on the Main Study, so only CFA was conducted on 182 adolescents to verify a good model fit.

Main Study Analyses Criterion-Related Validation

Two types of criterion-related validation were used to analyze the SDIS: concurrent and predictive validity. C*oncurrent validity* correlated the criterion measurement scores derived from the Hospital samples' Polysomnography (PSG) Respiratory Distress Index (RDI) obtained from the sleep study with the Total OSAS scaled scores on the SDIS for both age groups (children and adolescents). A second correlation was made for both age groups between the Snore Index on PSG and one item about snoring severity on the SDIS ("Child/adolescent snores loudly..."). The PLMD, RLS, Narcolepsy, and DSPS sample sizes were too small to obtain accurate validity coefficients for the SDIS PLMD scale with PSG PLM Index, the SDIS Narcolepsy scale with MSLT SOREM's or Sleep Latency scores, or the DSPS scale with PSG sleep latency scores or sleep logs. Therefore, predictive validity was of utmost importance in measuring criterion-related validity with these sleep disorders of small sample size.

The second type of criterion-related validity was *predictive validity*. This refers to the degree to which the sleep factor scores on the SDIS predicted the sleep specialists' diagnoses of sleep disorders. Discriminate Function Analysis (DFA) with a Jackknife procedure was used to measure predictive validity for 411 children and 182 adolescents.[24] DFA used the SDIS sleep factor (subscale) scores from the diagnosed group of hospital participants to generate means and standard deviations for the SDIS sleep disorder subscales, as well as the means and standard deviations for the students who had not undergone a sleep study. Seven categories were derived based on sleep center diagnoses and the school and private practice groups: (1) No Sleep Study Group – Students who had never undergone a sleep study; (2) Uncertain – Children who had OSAS ruled out in a sleep study (although one-fourth of these children had barely missed the OSAS criteria by 0.1-to-0.3 on the RDI index), but who continued to have significant sleep problems, some of which were being monitored for OSAS or other concerns; (3) OSAS diagnosed group; (4) PLMD or RLS or PLMD/RLS diagnosed group; (5) Narcolepsy diagnosed group; (6) DSPS diagnosed group; and (7) Other Sleep Problems diagnosed group (e.g., nocturnal seizure disorder, epilepsy, night terrors, fragmented sleep, sleep onset disorder, etc.). Then each participant's individual scores were removed from the group mean (n-1), and that student was classified by a DFA Jackknife analysis into one of these seven groups depending on which group their means and standard deviations most closely resembled. Hit rates (predictive validity) were analyzed. After classification criteria (T-score cut-offs) were adjusted mildly on the OSAS and PLMD scales to increase predictive validity, a second sub-analysis was conducted on a smaller sample of 50 sleep

center diagnosed students from Johns Hopkins, Carle Regional, and Miami Children's Hospitals to determine predictive validity on these OSAS and PLMD.

Main Study Reliability Analyses

Finally, the SDIS-C and SDIS-A subscales were assessed for internal consistency reliability using Cronbach's Alpha coefficients on 412 children and 182 adolescents.[22] Test-retest reliability was conducted on 10% (54) of the inventories randomly selected across a two-to-five month time interval instead of the typical two-to-four weeks that normally elapses due to the extended amount of time psychologists and sleep specialists needed to return the packets. The retrospective hospital group was not included because these children had undergone treatment.

PROCEDURES

Main Study School and Private Practice Samples

A packet was completed by the parent/guardian of each student that contained (a) the Sleep Disorders Inventory for Students (SDIS), (b) a consent form, and (c) a family survey requesting demographic information about the parents' address, education level, yearly income of family, ethnicity, primary language, the student's educational classification, any medical or psychiatric (DSM-IV) diagnoses of student, grade point average (GPA) (rated on a three-point scale: 1=Above Average; 2=Average; 3=Below Average) in reading, math, and writing if school age, and 12 questions about behaviors (rated on a 7-point scale from 1=Never to 7=Almost Always). Parents were asked to complete this information when they came into the school or private practice for a parent conference to receive the results of their child's psychoeducational assessment or participate in counseling. The psychologists did not record the parent non-responder rate, but they reported that the responder rate was almost 100% because these parents wanted as much information about their child's problems as possible.

For the sample whose parents worked in the school system, these parents were selected by a stratified random sampling at six schools in Pasco County. All school employees with one or more children were gathered together to explain the study and asked if they would complete the packet and then return it to the school psychologist's parents' school mailboxes if they were willing to participate in the study. Ninety-two percent of the school employees with children agreed to participate. A random stratified sample was taken of every third case (33%), and a broad range of employees ratings were obtained including administrators, teachers, paraprofessionals, cafeteria workers, maintenance, etc.

Main Study Hospital Samples

Prospective Sample. The prospective hospital sample completed the same packet as the school samples when parents brought their children in for the initial sleep examination or before the children had the overnight sleep study. These parents did not know the sleep diagnosis at the time of packet completion. After the overnight sleep study was completed, sleep technicians or secretaries returned information by mail on the children in the hospital samples indicating the student's sleep diagnosis, recommended treatment by MD, PSG and MSLT scores if conducted, and signed consent forms. Sleep centers did not record the percentage of non-responders, but they reported that a high percentage of parents were willing to participate in the perspective sample.

Retrospective Sample. The same packets were mailed to the retrospective hospital sample except these parents also reported (a) the sleep disorder diagnosis, if known, (b) treatment recommendations, and if this treatment had been conducted, (c) the outcome of treatment (corrected, partially corrected, or not corrected), and (4) ratings of the student's GPA and 12 behaviors pre- and post-treatment. Parents returned the information in a self-addressed, stamped envelope provided in the packets. The return rate was 15% for the Pilot Study retrospective sample and 22% for the Main Study retrospective sample. Data of eight Pilot Study participants and 18 Main Study participants were discarded because they did not complete 10% or more of the questions.

RESULT OF THE PRELIMINARY PILOT STUDY

Exploratory Factor Analysis (EFA) was conducted on the Pilot Study SDIS data to determine the number of factors included in a model by first examining the eigenvalue criterion.[26-27] An eigenvalue of 1.0 or greater is the most common criterion used for solving the "number-of-factor problem" based on the Kaiser criterion.[27] Eigenvalues smaller than 1.0 do not usually account for enough of the variance to be worth considering. Therefore, only 6 of the 42 eigenvalues calculated by the computer were greater than 1.0 and were considered to be meaningful factors on the SDIS. These six significant eigenvalues ranged from 10.3191 to 1.0593. A six factor model appeared possible; however, a five factor model was chosen because the sixth factor did not have enough strong items (with factor loadings above .40) to become an independent factor.[26-27] The discarded sixth factor described some of the problem behaviors that result from some sleep disorders (i.e., hyperactivity, distractibility, and ADHD-like characteristics). These items loaded strongly onto the PLMD sleep factor, but they only exhibited weak loadings on OSAS. Although ADHD-like factors are reported in many children with OSAS, it was noted that students with mild OSAS often exhibited ADHD characteristics, but those with moderate or severe OSAS were often very lethargic, so these two extremes canceled each other out in the EFA factor loadings. A five factor model was a better fit for the theoretical model on which the SDIS was based and accounted for 80% of the variance for five sleep factors of OSAS, Excessive Daytime Sleepiness (EDS), PLMD, NARC/RLS, and DSPS.

A second criterion for determining the EFA model was the scree test.[28] Using a scree test, the eigenvalues were plotted for each factor, and a five factor model still appeared to be the best choice.

A third criterion to consider was the item Communality Estimates.[26-27] These communality coefficients are analogous to the "r^2" value in correlation statistics. There was a range of communality among items from 0.3819 to 0.7860, suggesting that some items were better predictors of specific sleep disorders than others. The average of all communality estimates was .5811 (moderate range).

The Inter-Factor Correlations from the Promax Rotation demonstrated mild correlations between the five sleep factors, which were anticipated because it appears that many of these sleep disorders result in the manifestation of some similar characteristics such as daytime sleepiness, distractibility, irritability, etc. Results of these regression weights and correlation analyses indicated mild-to-high factor loadings for the items. Wording of items is abbreviated and presented with their regression coefficients in Table 3:

Table 3 - Oblique Rotation Matrix for Sleep Factors on the EFA – Pilot Study with All Ages Combined

ABBREVIATED ITEMS	FACTOR 1 (OSAS) REGRESSION COEFFICIENT	FACTOR 2 (EDS) REGRESS. COEFF.	FACTOR 3 (RLS/NARC) REGRESS. COEFF.	FACTOR 4 (DSPS) REGRESS. COEFF.	FACTOR 5 (PLMD) REGRESS. COEFF.
1. Stops Breathing 5 sec.	**.61****	.16	-.01	-.01	-.16
2. Mouth Breather / Daytime	**.76*****	.02	-.15	.02	.04
3. Mouth Breather / Nighttime	**.81*****	.12	-.27	-.01	.19
4. More Sleepy in Daytime	.10	**.79*****	-.01	-.06	.00
5. Difficulty Arising in A.M.	.10	**.54****	-.21	.12	.12
6. Unable to Talk upon Awakening	.11	**.45***	-.02	-.06	.06
7. Leg Jerks & Movements	.22	-.05	.28	-.02	**.31***
8. Raspy Breathing/Light Snoring	**.80*****	-.06	.01	-.02	.09
9. Loud Snoring	**.80*****	-.01	.06	.03	-.03
10. Confusion on Awakening	.18	**.31***	**34**	.00	.16
11. Rolls around Bed	**.41***	-.08	.09	.00	**.40***
12. Awake Past 1:00 A.M.	-.12	.30	-.08	**.59****	-.05
13. Gasps/Chokes/Snorts in Sleep	**.70*****	.10	.10	.04	-.15
14. Bed Wetting	.28	.14	-.05	-.20	**.34***
15. Sweats A Lot in Sleep	**.32***	-.03	.28	-.03	.05
16. Irritable	.04	**.53****	.06	.10	.29
17. Restless Leg Pain in Child	.04	.00	**.60****	.09	.04
18. Restless Leg Pain in Parent	.03	-.22	**.47***	.14	.07
19. Tired in A.M./Alert in P.M.	-.01	**.33***	.20	**.32***	-.12
20. Sleeps in Strange Positions	**.35***	.00	**.31***	-.02	.10
21. Attacks of Muscle Weakness	.08	.24	**.38***	-.07	.00
22. Heavy Breathing While Sitting	**.59****	.08	.18	.02	-.10
23. Accident Prone	-.03	.10	**.63****	-.06	.11
24. Awakens in the Night	.15	.03	.28	.14	**.30***
25. Tired After Enough Sleep	.13	**.63****	.20	-.08	.00
26. Vivid, Frightening Dreams	.06	-.05	**.64****	.01	.21
27. Skips/Late for Early Classes	-.08	**.56****	-.05	.28	-.03
28. 30+ Min. to Go to Sleep	.09	-.05	.01	**.57****	.28
29. Falls Asleep Talking/Standing	-.10	.17	**.52****	.12	.01
30. Diff. Shifting Sleep Onset Earlier	-.07	.18	.16	**.66****	-.02
31. Headaches	.03	**.32***	.21	.26	-.17
32. Strange Automatic Behaviors	-.12	.06	**.68****	-.04	.02
33. Dry Mouth upon Awakening	.29	-.03	**.33***	.17	-.06
34. Diff. Breathing at Night	**.36***	.07	.28	.08	-.21
35. Sleeps More in Daytime	.02	**.79*****	.09	-.07	-.11
36. High Activity Level	-.02	-.21	.18	-.04	**.69****
37. Touchy & Temper Tantrums	-.16	.18	.10	.05	**.73*****
38. Non-Compliant	-.09	.16	-.03	.08	**.80*****
39. Late Sleep Onset-Week Nights	-.11	.17	-.16	**.76*****	.17
40. Late Sleep Onset-Weekends	-.07	.11	.01	**-.80*****	.09
41. Amount of Sleep-Week Nights	-.18	.28	-.05	**-.67****	.00
42. Daytime Naps	.00	**.38***	.05	-.07	.10

Note.[1] Factor loadings of .30-to-.49 are typed in bold and have one asterix*, indicating a mild or fair predictor of the sleep disorder; loadings from .50-to-.69 have two asterix**, indicating a moderate or good predictor of the sleep disorder; loadings of .70+ have three asterix***, indicating a high or excellent measure of the sleep disorder.
Note.[2] Permission granted by M. Luginbuehl to reproduce this table (p. 137).[3]

PILOT STUDY DISCUSSION

All items were retained after EFA because there were not enough cases of RLS, Narcolepsy, DSPS, and PLMD to give strong item factor loadings for some of these sleep factors. However, it was hypothesized that a larger sample size in the Main Study would correct and strengthen the item loadings on these sleep factors. The five factors remaining after EFA were OSAS, PLMD, Narcolepsy/RLS, DSPS, and EDS. The computer EFA combined the items for RLS and Narcolepsy into one category, probably due to the fact that there were not enough cases of RLS and Narcolepsy to become separate sleep domains. Based on sleep theory and the ratings of the Expert Test Review Panel, this was not an acceptable combination. However, it was hypothesized that there would be a realignment of RLS with PLMD in the Main Study because these two sleep disorders are highly correlated. The fifth unexpected factor was EDS. Most of the sleep disorders measured in the SDIS caused EDS, especially when the sleep disorder was more severe. Therefore, this EDS factor appeared to be measuring the impairment of daytime functioning caused by the sleep disorders. It actually accounted for the second highest variance of the five factors.

A qualitative analysis of the pilot study EFA revealed that parents rated their preschool and elementary-aged children (Age groups 2-5 and 6-10 years) milder on some of the SDIS items (i.e., OSAS, Narcolepsy, and DSPS) than parents of middle- and high school-aged children (11-14 and 15-18 years). It was also noted that parents of younger children diagnosed in the sleep centers with Narcolepsy did not rate their children significantly on most of the Narcolepsy items, except EDS items. Narcolepsy characteristics like cataplexy, sleep paralysis, and hypnogogic hallucinations had not yet emerged or were not being noticed in the younger group according to parent ratings. In contrast, parents of older students with Narcolepsy rated many of these items significantly. Therefore, a decision was made to run two separate analyses on the Main Study samples to determine if two separate sleep inventories were needed: (1) one for children 2-through-10 years of age and (2) another inventory for adolescents' from 11-through-18 years. One more item was added to the inventory ("....amount of sleep on weekends...") based on a request by some parents and sleep specialists. This was the last point in the study that new items could be added.

RESULTS OF MAIN STUDY ANALYSES

Participant Demographic Data

The demographic characteristics of the Main Study sample, although not randomly selected, closely resembled the 2000 U.S. Census with only slight under-representation of African-Americans, Hispanic-Americans, and Asian-Americans, and slight over-representation of Caucasians and Multi-cultural (see Table 4). Most of the multi-cultural group was a mixture of African-American, Hispanic-American, or Asian-American combined with another ethnicity. As multi-ethnic marriages become more acceptable in the USA, it is believed that multi-cultural percentages in this study will be very representative of the 2010 US Census while Caucasian percentages decrease.

When considering the parents' primary language, 91% spoke English, 7% spoke Spanish (they completed the Spanish version of the SDIS and demographic survey), and 2% spoke other languages and had the survey translated by an interpreter if needed.

Table 4 - Ethnicity of Students in Main Study Compared to Ethnicity in the 2000 US Census

Ethnicity	Frequency Main Study	Percent Main Study/US Census
Caucasian	443	74.58% / 69.13%
African-American	59	9.93% / 12.06%
Hispanic-American	47	7.91% / 12.55%
Multi-Cultural	30	5.05% / 1.64%
Asian-American	11	1.85% / 3.60%
Native-American	2	0.34% / 0.74%
Hawaiian/Pacific Islander	0	0.00% / 0.13%
Other	2	0.34% / 0.17%

Note. Permission given by M. Luginbuehl to use Table 4 (p. 162).[3]

The demographic representation of family income was similar to the 2000 U.S. Census with only a slight over representation of middle income and a slight under-represented of the lowest and highest income. However, 15 parents did not respond who may have been from these two under-represented categories, especially the lowest income level (see Table 5).

Table 5 – Annual Family Income for Main Study Participants Compared to the 2000 U.S. Census

Income	Frequency Main Study	Percent Main Study / US Census
< $25,000	148	24.87% / 28.68%
$25,000 – 50,000	187	31.42% / 29.34%
$50,001 – 80,000	141	23.69% / ~22.69%
$80,001 +	104	17.50% / ~19.29%
No Parent Response	15	2.52% / 0.00%

Note. Permission given by M. Luginbuehl to adapt and use Table 5 (p. 162).[3]

The parents' educational levels were representative of the 2000 U.S. Census for the middle educational levels with a slight over-representation of parents completing graduate school and a slight under-representation of the lowest educational attainment (less than 9th grade education). If the "no response" parents were from the lowest educational level, then the sample would be highly representative of the U.S. Census (see Table 6).

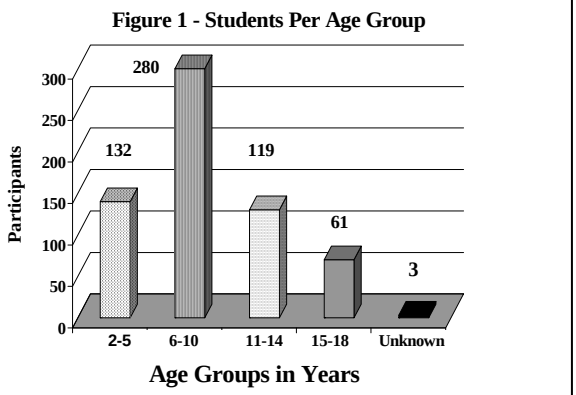
Table 6 - Educational Attainment of Parents in Main Study Compared to Representation in the 2000 U.S. Census

Educational Attainment	Freq.	Percent Main Study / U.S.
Less than 9th grade	16	1.4% / 7.5%
9th to 12th grade, no diploma	74	6.5% / 12.1%
High School graduate & GED	386	34.1% / 28.6%
Some College or Tech. Train.	96	8.5% / 21.0%
Associate degree	96	17.3% / 6.3%
Bachelor's degree	214	18.9% / 15.5%
Graduate / Professional Degree	137	12.1% / 8.9%
No Response	17	1.5% / -----

Note.[1] U.S. = 2000 U.S. Census; Tech. Train.= Technical Training.
Note.[2] Permission given by M. Luginbuehl to adapt and use Table (p. 165).[3]

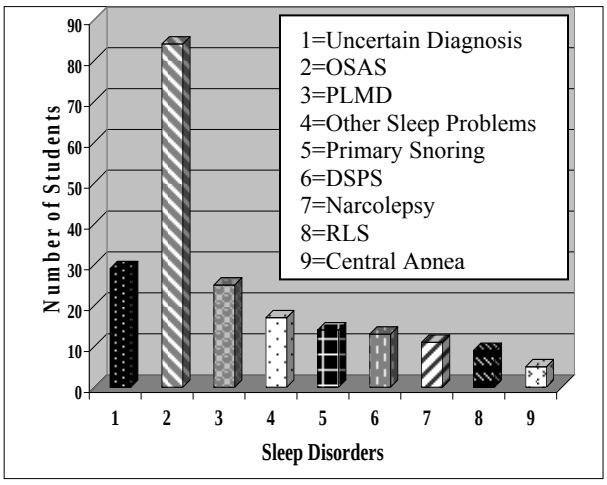
There were more elementary-aged children than other age groups in this study because more children of this age group were referred to school psychologists and sleep centers. The Main Study Age Groups are described in Figure 1 and the Main Study sleep disorder diagnoses of the five sleep center specialists are depicted in Figure 2:

Figure 1 – Number of Students Per Age Group



Note. Permission given by to use graph (p. 160).[3]

Figure 2 - Sleep Disorder Diagnoses



Note.[1] Group #1 had OSAS ruled out, but they were still undergoing tests to rule out other disorders.
Note.[2] Permission given by M. Luginbuehl to reproduce this graph (p. 171).[3]

Parents and psychologist indicated the educational classifications of 592 children. Some students had more than one classification, which results in frequencies higher than 592 and percentages adding up to more than 100%. The hospital samples had a higher than normal rate of special education possibly due to the numerous learning and behavioral problems created by sleep disorders (see Table 7).

Table 7 – Representation of Educational Classifications

Educational Classification	Schools & Private Practice Frequency	Percent	Hospitals Frequency	Percent	Total Study Frequency	Percent
Total Number of Students	412	69.6 %	180	30.4 %	592	100.0 %
Students not in Special Ed. (This includes Gifted)	273	66.0 %	99	55.0 %	372	62.8 %
Students in Special Ed.	139	34.0 %	81	45.0 %	220	37.2 %
Regular Education	204	49.5 %	97	53.8 %	301	50.8 %
Specific Learning Disability	75	18.2 %	26	14.4 %	101	17.1 %
Speech/Language Impaired	67	16.3 %	38	21.1 %	105	17.7 %
Gifted	69	16.7 %	2	1.1 %	71	12.0 %
Developmentally Delayed	26	6.3 %	12	6.6 %	38	6.4 %
Emotionally Handicapped or Behaviorally Disturbed	24	5.8 %	14	7.8 %	38	6.4 %
Other Programs (PI, VI, DHH) . .	12	2.9 %	2	1.1 %	14	2.4 %

Note.[1] Ed. = Education; PI = Physically Impaired; VI = Visually Impaired; DHH = Deaf and Hard of Hearing.
Note.[2] Permission given by M. Luginbuehl to use Table 7 (p.167).[3]

Table 8 – Summary of DSM-IV and Mental Health Diagnoses of the Main Study Samples

Mental Health/Medical Diagnoses	Schools & Private Practice Frequency	Percent	Hospitals Frequency	Percent	Total Study Frequency	Percent
Total Number of Students	412	69.6%	180	30.4%	592	100.0%
Total # Students w/o a Diagnosis	264	64.1%	65	36.1%	329	55.6%
Total # Students with a Diagnosis	148	35.9%	115	63.9%	263	44.4%
ADHD / ADD	88	21.4%	39	21.7%	127	21.5%
Asthma	34	8.3%	28	15.6%	62	10.5%
Depression	11	2.7%	16	8.9%	27	4.6%
Bipolar Disorder	8	1.9%	0	0.0%	8	1.4%
Obsessive Compulsive Disorder	7	1.7%	0	0.0%	7	1.2%
Allergies	7	1.7%	0	0.0%	7	1.2%
Cleft Palate	6	1.5%	2	1.1%	8	1.4%
Oppositional Defiant Disorder	4	1.0%	5	2.8%	9	1.5%
Downs	4	1.0%	6	3.3%	10	1.7%
Autism	4	1.0%	4	2.2%	8	1.4%
Failure To Thrive	3	0.7%	4	2.2%	7	1.2%
Tourettes Syndrome	3	0.7%	0	0.0%	3	0.5%
Seizures	2	0.5%	2	1.1%	4	0.7%
Recessive Chin	1	0.2%	2	1.1%	3	0.5%
Other Diagnoses	12	2.9%	20	11.1%	32	5.4%

Note.[1] "Other Diagnoses" included a variety of problems such as anxiety disorder, epilepsy, cancer, cerebral palsy, reflux problems, etc. If it was not reported at least three times, it was placed into this miscellaneous group.
Note.[2] Permission given by M. Luginbuehl to reproduce this Table (p. 169).[2]

Results of Construct Validity in the Main Study using EFA

The computer randomly selected half of the 2-through-10 year age group for Exploratory Factor Analysis (EFA) on the Main Study samples. The other half was saved for the Confirmatory Factor Analysis (CFA). There were 188 children in this EFA analysis with a 60-to-40% male/female ratio. There were 50 participants (27%) from the youngest age group (2-through-5 years) and 138 participants (73%) from the 6-through-10 year group.

The EFA resulted in seven eigenvalues that were greater than 1.0. These significant eigenvalues ranged from 10.7246 to 1.0671. A seven factor model appeared possible based solely on the eigenvalues. However, a four factor model was chosen for this young group due to problems with too few items in factors five, six, and seven, and they did not correspond to the theoretical model of sleep nor to the ratings made by the Expert Test Review Panel during content validation. Furthermore, the scree plot demonstrated a noticeable break after four factors, indicating only four strong factors. The communality coefficients and factor loadings clearly indicated a four factor model for this younger age group. Using this four factor model, 70% of the variance was accounted for using the sleep domains of OSAS, EDS, PLMD, and DSPS. Parents of young children with Narcolepsy were only rating them significantly on the EDS items, which resulted in no confirmation of the Narcolepsy scale for younger children. Parents did not endorse the questions for RLS for this young age group.

An Oblique Rotation Matrix was used for the analysis due to mild correlations among factors. Results of the regression weights and correlation analyses are represented in Table 9. Eight items with factor loadings less than .35 were deleted for the SDIS-Children's Form (SDIS-C) because they did not discriminate these sleep disorders well in the younger age group.

Table 9 – Exploratory Factor Analysis Oblique Rotation Matrix for SDIS-Children's Form

ABBREVIATED QUESTIONS	**FACTOR 1 (OSAS)** REGRESSION COEFFICIENT	**FACTOR 2 (EDS)** REGRESS. COEFF.	**FACTOR 3 (PLMD)** REGRESS. COEFF.	**FACTOR 4 (DSPS)** REGRESS. COEFF.	
1. Stops Breathing 5 sec.	**.76 *****	.20	-.18	-.02	
2. Mouth Breather / Daytime	**.66 ****	-.10	-.02	.12	
3. Mouth Breather / Nighttime	**.71 *****	.13	-.08	-.11	
4. More Sleepy in Daytime	.00	**.79 *****	.09	.01	
5. Difficulty Arising in A.M.	-.06	**-.30**	-.08	-.05	Delete
6. Unable to Talk upon Awakening	.14	**.34**	.28	-.08	Delete
7. Leg Jerks & Movements	.28	.14	**.43 ***	-.12	
8. Raspy Breathing or Light Snoring	**.71 *****	-.22	.19	.01	
9. Loud Snoring	**.82 *****	-.01	.04	-.04	
10. Confusion on Awakening	.32	**.46 ***	.25	-.03	
11. Rolls around Bed	**.37 ***	-.05	**.42 ***	-.03	
12. Awake Past 11:00 p.m..	-.11	.27	-.15	**.50 ****	
13. Gasps/Chokes/Snorts in Sleep	**.79 *****	.13	-.07	.01	
14. Bed Wetting	.07	.14	-.27	-.08	Delete
15. Sweats A Lot in Sleep	**.51 ****	-.03	.31	-.20	
16. Irritable	.08	.27	**.51 ****	.07	
17. Restless Leg Pain in Child	.10	**.46 ***	.28	.10	
18. Restless Leg Pain in Parent	.06	.11	.32	.07	Delete
19. Tired in A.M./Alert in P.M.	.03	**.36 ***	.14	.20	
20. Sleeps in Strange Positions	**.56 ****	.08	.06	-.06	
21. Attacks of Muscle Weakness	.10	**.42 ***	-.13	.27	
22. Heavy Breathing While Sitting	**.72 *****	.11	.15	.09	
23. Accident Prone	.28	.07	**.45 ***	.09	
24. Awakens in the Night	.05	.26	**.39 ***	.11	
25. Tired After Enough Sleep	-.06	**.70 *****	.31	-.06	
26. Vivid, Frightening Dreams	.19	.24	**.48 ***	.18	
27. Skips or Late for Early Classes	-.03	**.39 ***	.12	.13	
28. 30+ Min. to Go to Sleep	-.09	.01	**.51 ****	**.37 ***	
29. Falls Asleep Talking/Standing	.04	**.64 ****	-.09	.00	
30. Diff. Shifting Sleep Onset Earlier	-.07	.27	-.09	**.66 ****	
31. Headaches	.15	.14	.11	.08	Delete
32. Strange Automatic Behaviors	-.04	.19	.25	.25	Delete
33. Dry Mouth upon Awakening	.30	.07	.25	.06	Delete
34. Diff. Breathing at Night	**.42 ***	.25	-.16	.06	
35. Sleeps More in Daytime	-.07	**.86 *****	-.03	-.06	
36. High Activity Level	-.07	-.14	**.71 *****	.04	
37. Touchy & Temper Tantrums	-.08	.09	**.76 *****	-.03	
38. Non-Compliant	-.09	-.03	**.80*****	-.01	
39. Late Sleep Onset-Week Nights	-.11	.09	.09	**.78 *****	
40. Late Sleep Onset-Weekend	-.08	.04	.06	**.77 *****	
41. Amount of Sleep-Week Nights	-.03	.05	-.03	**-.76 *****	
42. Amount of Sleep-Weekends	-.18	.34	-.10	**-.63 ****	
43. Daytime Naps	.30	.19	.03	-.15	Delete

Note.[1] Factor loadings between .35 - .49 are marked with one asterik* indicating that an item is a mild or fair measure of the sleep factor; loadings of .50 - .69 (**) indicate a moderate or good indicator; loadings of .70+ (***) indicate a high or very good measure.

Note.[2] Permission given by M. Luginbuehl to reproduce this table (p. 181).[3]

Construct Validity using Confirmatory Factor Analysis on the SDIS-Children's Form (SDIS-C)

There were 201 participants in the Confirmatory Factor Analysis (CFA) for the SDIS-C (ages 2-through-10 years); 117 (58%) were male and 84 (42%) were female. There were 62 participants (31%) from the youngest age group (2-through-5 years) and 139 participants (69%) from the 6-through-10 year group.

CFA was completed using the 36 items remaining after the Pilot Study elimination process. A good CFA model fit was based on the recommended Fit Indices as follows: (1) The Non-Normed-Fit Index (NNFI) is a good estimate model fit for smaller, non-random sample sizes,[29] which occurred in this study. Values range from 0 to 1 with a value of .90 or greater being considered a good fit; (2) Bentler's Comparative Fit Index[30] (CFI) is similar to the NNFI because it provides an accurate measure of fit regardless of sample size, but it tends to be more precise than the NNFI or other fit indices.[30] CFI values range from 0-to-1, with values over .90 indicating a good fit. A final fit index to be considered was the Root Means Square Error of Approximation (RMSEA). A desirable value to be obtained here would be a score of $\leq .06$.[31]

The first run of the CFA Model resulted in CFI and NNFI Fit Indices that were in the high .70's and not satisfactory. Therefore, specified modifications were made, resulting in ten items being deleted, and allowance for nine items to measure two or even three factors. It was necessary to delete these items because some of them had R^2 values lower than .30, and some items were better discriminators of sleep disorders in older students, but not good discriminators for younger students. Eight residuals (error measures) were also correlated. After discarding the items with high error coefficients, 25 items remained.

After making these modifications, CFA was again conducted and a good model fit was attained. The chi-square (X^2) of 366.82, and df = 250 was significant ($p < .0001$). The X^2 / df ratio was 1.467, which was under the required 2.0, indicating an acceptable model fit. The value of the RMSEA was .05, which also indicated a good fit. The Non-Normed Fit Index (NNFI) was .95, and the most reliable of all indices for this study, the Comparative Fit Index (CFI) was .96, which indicated a very good model fit. Based on these CFA fit indices, the revised SDIS-C with a four factor structure model was confirmed based on the theoretical model proposed with some modifications. Some items were not unique to one factor and are listed under more than one sleep domain. Table 10 displays the CFA confirmed sleep factors on the SDIS-C, their corresponding items, and regression weights:

Table 10 – SDIS-C Confirmatory Factor Analysis Factors

Abbreviated Item	OSAS / PLMD	/DSPS	/EDS
1. Stops Breathing 5+ sec.	**.74**		
2. Mouth Breather/Daytime	**.67**		
3. Mouth Breather/Nighttime	**.71**		
4. More Sleepy in Daytime			**.88**
5. Leg Jerks & Movements	**.34**	**.37**	
6. Raspy Breathing/Night	**.72**		
7. Loud Snoring	**.86**		
8. Confusion on Awakening	**.28**	**.35**	**.36**
9. Rolls around Bed	**.33**	**.44**	
10. Gasps or Snorts in Sleep	**.88**		
11. Sweats A Lot in Sleep	**.42**	**.27**	
12. Irritable			**.49**
13. Tired in a.m./alert p.m.			**.69**
14. Sleeps in Strange Positions	**.56**		
15. Heavy Breathing/Sitting	**.69**		
16. Awakens in the Night		**.41**	**.38**
17. Tired After Enough Sleep		**.28**	**.56**
18. 30+ Min. to Go to Sleep		**.30**	**.44**
19. Diff. Shifting Sleep Onset Earlier			**.66**
20. Falls asleep More in Daytime			**.76**
21. High Activity Level		**.69**	
22. Touchy & Temper Tantrums		**.72**	
23. Non-Compliant		**.70**	
24. Late Sleep Onset-Week Nights			**.96**
25. Late Sleep Onset-Weekend			**.91**

Note. OSAS=Obstructive Sleep Apnea Syndrome; PLMD=Periodic Limb Movement Disorder; DSPS=Delayed Sleep Phase Syndrome; and EDS=Excessive Daytime Sleepiness.

Construct Validity using Confirmatory Factor Analysis on the SDIS-Adolescent Form (SDIS-A)

There were 182 participants in this CFA analysis; 111 (61%) were male and 71 (39%) were female. There were 119 (65%) participants in the 11-through-14 year age group and 63 participants (35%) from the 15-through-18 year age group. The initial Pilot Study EFA results, which indicated five factors and regression weights for their items, were used to guide Confirmatory Factor Analysis (CFA). Three items with low factor loadings of <.35 and weak communality scores in the Pilot Study EFA were discarded because they did not discriminate well between older students with and without sleep disorders.

The first run of the CFA Model resulted in CFI and NNFI Fit Indices that were in the high .60's and .70's and not satisfactory. Specified modifications were made, resulting in ten items being deleted and 19 items were allowed to measure two or more factors. These deletions were necessary because some of the items were more discriminating of sleep disorders in younger students, but not in older students. Seventeen residuals (error measures) were also correlated. Also items with R^2 values below .30 were discarded leaving 30 items.

After making these modifications, CFA was again conducted and a good model fit was attained. The chi-square (X^2) was 517.98 and the df = 352, which was significant ($p < .0001$). The X^2 / df ratio was 1.47, which met the requirement of < 2.0, indicating an acceptable model fit. The value of the RMSEA was .05, which indicated a good fit. The Non-Normed Fit Index (NNFI) was .94, and the most reliable of all indices for this study, the Comparative Fit Index (CFI), was .95, which was regarded as a good fit. Based on these fit indices, the revised

SDIS – Adolescent Form supported the theoretical model proposed in EFA using a five factor structure model with modifications. See Table 11 for a summary of the Five Sleep Factors, their items, and regression weights.

Table 11 – SDIS-A CFA Confirmed Sleep Factors with Corresponding Item & Regression Weights

Abbreviated Items	PLMD	OSAS/RLS/	DSPS/	NARC/	EDS
1. Stops breathing 5"	**.78**				
2. Mouth breather/night	**.62**				
3. Daytime sleepiness				**.46**	**.47**
4. Can't arise within 5-10 min. & start routine			**.29**		**.43**
5. Unable to talk/move when awakened					**.53**
6. Leg Jerks & Movements		**.52**		**.22**	
7. Raspy Breathing/Night	**.67**				
8. Loud Snoring	**.88**				
9. Confusion Awakening	**.38**				**.32**
10. Stays up past 1:00 a.m. on school nights			**.74**	**.28**	
11. Gasps / Snorts in Sleep	**.85**				
12. Irritable					**.89**
13. Student has urge to move legs/uncomfortable tingling sensation…		**.80**			
14. Tired in a.m./alert p.m.			**.24**	**.33**	**.41**
15. Sleeps in Strange Positions…	**.47**	**.35**			
16. Attacks of muscular weakness….		**.37**		**.49**	
17. Awakens in the Night…		**.58**		**.31**	
18. Tired After Enough Sleep				**.41**	**.57**
19. Vivid, frightening dreams		**.50**		**.29**	
20. Skips/Tardy to early class…			**.43**	**.35**	**.28**
21. 30+ Min. to Go to Sleep …		**.27**	**.43**		
22. Falls asleep while talking…				**.72**	
23. Difficulty Shifting Sleep Onset Earlier…			**.77**		
24. Strange automatic behavior		**.61**		**.10**	
25. Falls asleep during day…				**.89**	**.21**
26. Touchy & loses temper …		**.18**			**.55**
27. Non-Compliant with …		**.60**			
28. Late Sleep Onset-School Nights…			**.76**		
29. Late Sleep Onset-Weekend			**.72**		
30. Takes daytime naps				**.75**	

Note. CFA=Confirmatory Factor Analysis; OSAS=Obstructive Sleep Apnea Syndrome; NARC=Narcolepsy; PLMD=Periodic Limb Movement Disorder; DSPS=Delayed Sleep Phase Syndrome; and EDS=Excessive Daytime Sleepiness.

Criterion-Related Validation - Concurrent Validity

The criterion-related validity correlation of the OSAS scale with PSG RDI was based on a sample of 106 children for the SDIS-C. The correlation coefficient was .33 and was statistically significant ($p<.0005$). The OSAS correlation with the RDI Index for the SDIS – A was based on a sample size of 48 students. The correlation coefficient was .57 and was statistically significant ($p<.0001$).

A second correlation was made between the PSG Snore Index to Item #9 on the SDIS ("...snores loudly at night."). This correlation was based on a sample of 98 children in the Young Group. The correlation coefficient was .43 and was statistically significant ($p<.0001$). The Snoring Item for the SDIS – A was based on a sample size of 43 students and the correlation coefficient was .64 ($p<.0001$).

There were not enough PLMD, DSPS, or Narcolepsy cases to conduct concurrent validity correlations with the corresponding PSG measures of PLMs, Sleep Latency, or MLST Sleep Onset REMs (SOREMs) and average Sleep Latency. Therefore, predictive validity became an important measure of the validity for these sleep domains.

Criterion-Related Validation - Predictive Validity of the SDIS-Children's Form

DFA with a Jackknife process was conducted on the SDIS-C for 411 participants, 112 of which were medically diagnosed with either a sleep disorder or some type of sleep concern. The first measure of predictive validity was to determine if the SDIS-C could identify the children who were referred for a sleep study regardless of the nature of the sleep disorder. The SDIS-C had a predictive validity (hit rate) of 95-out-of-111 hospital referred students (85.6%) that it would have referred to sleep specialists for a comprehensive sleep evaluation. There were some miscellaneous diagnoses such as nocturnal seizure disorder, fragmented sleep disorder, etc. for which the SDIS-C was not designed to screen. These disorders were included in the 86% overall hit rate. When considering only the sleep disorders for which the SDIS was designed to screen (OSAS, PLMD, DSPS, and Narcolepsy-using the EDS scale), it would have referred 70-out-of-75 of these cases to a sleep specialist for a 93% hit rate.

The second measure of predictive validity was the accuracy of the SDIS-C in predicting which sleep diagnoses the children in the hospital sample had been given (OSAS, PLMD, Narcolepsy, DSPS, Uncertain, or Other Sleep Problem). The SDIS-C predicted 3-out-of-3 cases of DSPS for a 100% hit rate, 4-out-of-5 cases of Narcolepsy using the EDS scale for 80% accuracy, 35-out-of-59 cases of OSAS for 59%, 3-out-of-10 cases of PLMD for 30%, 5-out-of-26 cases of Uncertain for 19%, and 4-out-of-9 cases of Other Sleep Problems for 44%. For the "Uncertain" and "Other Sleep Problems" groups, the SDIS-C sometimes classified them into one of the four sleep disorder groups it had been designed to screen (i.e., OSAS, Narcolepsy, PLMD, or DSPS). However, the SDIS-C would have referred 20-out-of-26 Uncertain cases to a sleep specialist for a 77% hit rate of identifying a need for a sleep referral. When screening the Other Sleep Problem cases, it would have referred 1-of-the-9 cases for OSAS and 3-of-the-9 cases as "Uncertain, but it seems there is a sleep problem".

Because the OSAS hit rate was only moderately accurate and the PLMD hit rate was poor, modifications were made by lowering the cut-off levels of T-scores (from 70 to 65) for these two sleep subscales to improve accuracy. Then analyses were conducted on a randomly selected sample of 50 OSAS and 35 PLMD cases diagnosed at Johns Hopkins, Carle Regional, and Miami Children's Hospital using the newly adjusted cut-off levels for OSAS and PLMD. The SDIS-C had to predict "no OSAS" or "yes OSAS" and "no PLMD" or "yes PLMD". This would show whether the SDIS-C could accurately predict both children with the sleep disorder and those without. The SDIS-C accurately predicted 36-out-of-50 cases of OSAS for a 72% hit rate, and 27-out-of-35 children tested for PLMD for a 77% hit rate. This was a significant improvement for both SDIS subscales, especially the PLMD scale. The error scores on the OSAS subscale was due to 20% false positives occurring to 8% false negatives. On the PLMD subscale, there were 15% false positives to 5% false negatives. Although the OSAS and PLMD cut-off levels could be raised to decrease the amount of false positives, this would not be a medically wise change because it would increase the false negatives to 15-20%. OSAS and PLMD are medical disorders that can have serious consequences to a child's health and functioning, so it is better to error on the false positive side and refer 10-20% too many children to sleep specialists, but identify and correct most sleep disorders. Furthermore, the children with the false positives for OSAS and PLMD had other sleep disorder diagnosed in 69% of these cases and needed to be referred for a sleep evaluation. The false positives decreased the predictive validity of the OSAS and

PLMD subscales, but it raised the overall screening hit rate of identifying the children who needed a referral for a sleep evaluation, which is the goal of a sleep screening inventory.

Additionally, the SDIS-C was fairly accurate in discriminating the children with primary snoring from those with OSAS. Six of the 50 hospital cases had only Primary Snoring, but were referred to sleep clinics due to suspicions of OSAS. The SDIC-C would have referred only 2-of-the-6 for a 33% error rate compared to a 100% error rate by the referring physicians.

Finally, all SDIS-C subscale raw scores were combined to provide standard T-Scores and Percentile Ranks for a total Sleep Disturbance Index (SDI). This index was designed to provide parents and professionals an estimate of the overall disturbance to the day and nighttime functioning of the student when all sleep problems were combined.

The SDIS-C predicted that 99-out-of-299 (33%) students in the school or private practice samples who had not undergone a sleep study needed one because their SDIS-C scores were equally severe as the Hospital groups with sleep diagnoses. It is hypothesized that a high percentage of these students may have qualified for special education services due to significant learning or behavior problems caused by a sleep disorder.

Criterion-Related Validation - Predictive Validity of the SDIS-Adolescent Form

DFA was conducted on 182 participants in the two older 11-through-14 and 15-through-18 year age groups (SDIS-A); 132 students came from the school and private practice groups and 50 students came from the Hospital groups and were medically diagnosed with either a sleep disorder or some type of sleep concern. The SDIS-A accurately predicted 48-out-of-50 students who needed to be referred for a sleep study for a 96% hit rate regardless of their diagnoses. When considering only the Hospital diagnosed groups of OSAS, Narcolepsy, PLMD/RLS, or DSPS for which the SDIS-A was designed to screen, the overall hit rate was also 48-out-of-50 of these disorders for a 96% hit rate. The SDIS-A predicted 24-out-of-24 OSAS cases for a 100% hit rate, 4-out-of-4 possible Narcolepsy cases for a 100% hit rate, 4-out-of-4 DSPS cases for a 100% hit rate, and 7-out-of-9 PLMD cases for a 78% hit rate. Even in sleep categories for which it was not designed to screen, it accurately predicted 7-out-of-7 Uncertain for a 100% hit rate, and 2-out-of-2 Other Sleep Problems for a 100% hit rate.

All SDIS-A subscale raw scores were combined to provide Standard T-Scores and Percentile Ranks for a total Sleep Disturbance Index (SDI). This index was designed to provide an estimate to professionals and parents of the overall disturbance to the day and nighttime functioning of the student when all sleep problems were combined.

Finally, the SDIS-A predicted that 36-out-of-132 (27%) students in the school or private practice samples who had not undergone a sleep study needed one because their SDIS-A scores were equally severe as the Hospital groups with actual sleep diagnoses. A high percentage of these students qualified for Special Education classes due to speech, learning, or behavior problems. Table 12 displays the Predictive validity (Hit Rates) for the SDIS-C and SDIS-A.

Table 12 – Predictive Validity for the SDIS-C and SDIS-A

M.D.'s Diagn.	Child Needs Sleep Study	Hit Rate	Specific Diagnosis	Hit Rate
SDIS-C	**96-out-of-112**	**86%**		
For: DSPS, NARC, OSAS, & PLMD			**70-out-of-75**	**93%**
DSPS:	3-out-of-3	100%	3-out-of-3	100%
NARC:	5-out-of-5	100%	4-out-of-5	80%
OSAS:	57-out-of-59	97%	35-out-of-59	59%
PLMD:	7-out-of-10	70%	3-out-of-10	30%
UNCER:	20-out-of-26	77%	5-out-of-26	19%
OTHER:	4-out-of-9	44%	0-out-of-9	0%
Adjust OSAS:	(n = 50)		35-out-of-50	72%
Adjust PLMD:	(n = 35)		27-out-of-35	77%
SDIS-A	**48-out-of-50**	**96%**	**48-out-of-50**	**96%**
DSPS:	4-out-of-4	100%	4-out-of-4	100%
NARC:	4-out-of-4	100%	4-out-of-4	100%
OSAS:	24-out-of-24	100%	24-out-of-24	100%
PLMD:	7-out-of-9	78%	7-out-of-9	78%
UNCER:	7-out-of-7	100%	7-out-of-7	100%
OTHER:	2-out-of-2	100%	2-out-of-2	100%

Note. UNCER = Uncertain Sleep Diagnosed Group; OTHER = Other Sleep Problems diagnosed; Adjust OSAS or Adjust PLMD = Adjustments made to Cut-off T-scores for OSAS and PLMD.

Reliability Analyses: Internal Consistency

A desirable overall internal consistency for a screening instrument like the SDIS is considered to be ≥ .70, and for a more critical diagnostic instrument, it should be in the .90's.[21] Using Cronbach's Alpha, 412 SDIS-C were analyzed and a total reliability coefficient of .91 was obtained. Cronbach's Alpha for the SDIS-C item subscales was .90 for OSAS, .84 for the EDS subscale, .85 for PLMD, and .76 for DSPS.

A total reliability coefficient of .92 was obtained for the analysis of 182 SDIS-Adolescent Forms. The OSAS subscale had a Cronbach's alpha reliability coefficient of .88; the Narcolepsy subscale was .92; PLMD/RLS was .83; DSPS was .71, and EDS was .83.

Reliability Analyses: Test-Retest Reliability

Test-retest reliability was conducted on 54 SDIS Inventories (30 SDIS-C and 24 SDIS-A forms). The SDIS-C had a stability coefficient of .97 ($p<.0001$), and the SDIS-A obtained a stability coefficient of .86 ($p<.0001$).

DISCUSSION

Validation Discussion

CFA indicated that some characteristics that were purported in the sleep literature to measure only one factor, such as Narcolepsy (i.e., Confusional arousals-> SDIS #8. "...confusion upon awakening"), really occurred among many sleep disorders or factors (OSAS, PLMD, Narcolepsy, and EDS), suggesting that confusional arousals may truly be a measure of extreme sleepiness caused by any one of these sleep disorder disrupting the child's nighttime sleep. Furthermore, none of the tetrad of Narcolepsy symptoms (i.e., cataplexy→ SDIS: "...attacks of muscle weakness"; hypnogogic hallucinations → SDIS: "...vivid, frightening dreams..."; sleep paralysis → SDIS: "...unable to talk/move when awakening...") were confirmed with EFA or CFA for the younger group except EDS, but they were confirmed for the older group even though cataplexy was the only characteristic unique to the SDIS Narcolepsy subscale. This suggests that EDS is the only characteristic of Narcolepsy that children under 11 years of age are clearly and consistently exhibiting across cases.

Although RLS items were not endorsed by parents for the young participants, they were endorsed by parents of adolescent participants. This should not be interpreted that RLS never exists in younger children because a few of the younger children in this study had a diagnosis of RLS. However, it suggests that many young children have difficulty conveying this condition of restless legs to their parents, or parents do not notice the symptoms. As a result, parents rarely rated younger children significantly on the RLS items so they had to be deleted on the SDIS-C.

When conducting criterion-related validity between the OSAS subscale and the PSG RDI Index, it appeared that the RDI scale limited the attainment of higher correlations because the RDI range was large in this study (ranging from 0-to-86 RDI per hour), but a low score of 2 was already an indicator of OSAS at the hospitals. Even though the RDI scale went up much higher, most children with an RDI of 2 were already exhibiting many daytime and nighttime problems and their parents were rating them very high on the SDIS OSAS items/subscale. Students with a very high RDI could not be rated by parents much higher than the ratings made by parents whose children had RDI's between 2-and-10. Given these limitations of the RDI Index, the OSAS subscale correlated significantly with the RDI measurements and showed good specificity in accurately identifying most children with mild OSAS. It easily predicted children with moderate and severe OSAS.

Predictive validity was high for this brief screening instrument in determining which students should be referred to a sleep specialist for a more comprehensive examination. It was also high in predicting the sleep disorders for which it had been designed to screen (OSAS, PLMD/RLS, Narcolepsy, and DSPS). Although it could not predict other sleep problems (i.e., nocturnal seizures, epilepsy, fragmented sleep disorder, etc.), it was fairly accurate in predicting that these students needed to be referred to a sleep specialist for further evaluation.

Reliability Discussion

Overall internal consistency was high for both the SDIS-C and SDIS-A with subscale stability coefficients ranging from the .70's (acceptable) to the .90's (high). Although the DSPS subscales had the lowest stability coefficients due to the small number of items (4-or-5 items), it had a 100% hit rate with the sleep specialists' diagnosis of DSPS, which is the most accurate measure of validity.

General Discussion

While developing these instruments, many interesting qualitative observations were noted about children's sleep disorders and their measurement:

1) There were measurable differences in sleep disorder ratings between the younger group of children (2-10 years of age) and adolescents (11-through-18 years of age). Parents of adolescents with OSAS, Narcolepsy, or DSPS

rated them more severe on the 7-point likert scale than parents of children less than 11 years. As children became older, their sleep disorders often increased in severity of symptoms. Furthermore, some items that were discriminate of a sleep disorder and appropriate for the adolescent group (i.e., Narcolepsy and RLS) were not endorsed by parents of younger children and had to be deleted. Therefore, the same items, scoring criteria, and subscales could not be used for both age groups on the SDIS. If the same criteria is used for both, younger children will be under-identified, and older children will be over-identified. The SDIS-A had higher predictive validity than the SDIS-C (96% vs. 86%) because older children's sleep disorders become more severe and are easier to identify. Therefore, sleep specialists may need more studies focused on possible differences in children vs. adolescents when using PSG measures (RDI, PLM's, etc).

2) When children in this study obtained a PSG RDI > 1.5, the parents often indicated on the SDIS that these children were having very significant nighttime sleep problems as well as daytime behavior problems. Therefore, it appears that an RDI above 1.5 already suggests that there may be significant impairment in daytime functioning of a child below 11 years of age. This deterioration in functioning may be an important criterion to consider along with the PSG scores when deciding whether a child needs treatment.

3) It was noted that a PSG RDI score > 8-to-10/hr. often caused so many sleep problems that it automatically elevated the PLMD, Narcolepsy, or DSPS scales of the SDIS. This occurred because even moderate OSAS caused many limb movements, restless sleep, fighting sleep, daytime EDS, confusional arousals, and sometimes sleep paralysis and hypnogogic hallucinations in older students (based on parent ratings). Therefore, when several scales are high on the SDIS, the sleep specialist must always begin by ruling out OSAS unless the OSAS scale score is low. If the SDIS OSAS scale is low, but PLMD, Narcolepsy, and/or DSPS are high, then the sleep specialist should start by ruling out PLMD first, which also created escalated scores on the other scales. Some of the students diagnosed with Narcolepsy had high ratings on both the Narcolepsy and PLMD scales. This raises the question of co-morbidity between these two sleep disorders, or whether undiagnosed PLMD is causing extreme EDS resembling Narcolepsy. This study was not designed to answer these diagnostic questions.

4) This study's two exploratory and two confirmatory factor analyses indicated that many sleep characteristics, which were often attributed to one sleep disorder in earlier assumptions (i.e., confusional arousals, sleep paralysis, sweating at night, limb movements, etc…) are characteristics of two or more sleep disorders or EDS. Therefore, the sleep disorders being screened with the SDIS have several common characteristics, and only a few unique characteristics.

5) Even though the sample size was small (n=6), the SDIS-C had higher specificity than referring physicians in distinguishing primary snoring from OSAS. Based on a qualitative analysis of the SDIS-C data, if children exhibited snoring, but few other OSAS items were endorsed, then it was usually primary snoring. OSAS resulted in parents rating many OSAS items high and not just snoring.

6) Even though the SDIS-C does not have a Narcolepsy scale, the EDS items were the only consistent and effective measures when identifying the younger children with a diagnosis of Narcolepsy. In the older adolescent group (SDIS-A), parents of Narcolepsy-diagnosed students were frequently endorsing the SDIS items that indicated mild signs of cataplexy, confusional arousals, hypnogogic hallucinations, and/or sleep paralysis along with high ratings of EDS. This tetrad of characteristics was confirmed and retained on the SDIS-A Narcolepsy scale.

7) Although the SDIS-C has a DSPS scale, it is believed that a more accurate label for this scale would be Behavioral Insomnia of Childhood (BIC). When talking to parents who rated their children high on this scale, the parents often described the characteristics of BIC, such as problems with inconsistent discipline and permitting poor sleep hygiene in their young children, which appeared to foster the late sleep onset more than a change in circadian rhythms that is common in adolescence. However, since most sleep specialists in this study used the diagnosis of DSPS, this term was retained on the SDIS-C, but BIC is also discussed in the SDIS-C Interpretive Report.

8) The SDIS should be more accurate if parents observe their child sleeping for one or two nights before completing the SDIS. In the directions of the published SDIS, parents are asked to observe their child after s/he is asleep for approximately 1-2 hours and again in the early morning hours between 4-5 a.m. It is believed that these additional observations, if conducted by the parents, will increase the OSAS and PLMD scales' predictive validity for certain

nighttime sleep questions (i.e., Does the child stop breathing 5+ seconds during sleep,"; "Does child have leg or arm jerking movements in sleep…"; etc.).

9) It appears that parents have some concerns about the accuracy of the PSG ratings on the RDI and PLM indices in an artificial sleep lab setting compared to their child's typical sleep problems at home. For children who had a diagnosis of a "normal sleep study" based on PSG measures in the retrospective samples, approximately half of the parents made comments on their surveys that they did not think the sleep study in the lab was typical of their child's sleep. They reported that their children had more difficulty falling asleep or slept unusually well at the lab and did not have the same amount of breathing, kicking, or movement problems during the sleep study as at home. Some sleep problems like PLMD may occur irregularly or more often when the child is over-fatigued or stressed out, but not consistently every night. The discontented parents reported that their children continued to have significant sleep problems at home, and they wished the sleep specialist could see their child's home problems. This concern might justify more evaluations of children in the natural home environment over several nights.

10) In approximately 20% of the retrospective cases, parents were unhappy with the communication of sleep study results by the referring physicians. They reported that they had not been informed of the results, or they had been informed that their child had a sleep disorder (usually OSAS), but the referring physician had made no recommendations for treatment, and the child was still struggling. The sleep specialist had sent the overnight sleep study diagnosis and recommendations back to the referring physician in report format, but some of these physicians had not given the parents these recommendations or followed through with treatment six-to-18 months post-sleep study. This lack of continuity of services might be improved by sleep specialists routinely scheduling a follow-up meeting with the parents to inform them of the results and treatment possibilities. Another option might be to mail out a follow-up questionnaire or the SDIS inventory 2-3 months post-sleep study to determine if treatment has been pursued and whether treatment was successful.

SUMMARY

The SDIS-Children's Form and SDIS-Adolescent Form were developed with interdisciplinary collaboration from respected sleep specialists and sleep centers, school and clinical psychologists, and measurement experts. Both forms were validated with samples of children from four regions of the USA, two psychology private practices, and 45 schools. These norming samples represented all educational classifications and the most frequently occurring DSM-IV diagnoses and closely reflected the population demographics of the 2000 U.S. Census. Both SDIS forms adhere to stringent test construction standards and resulted in high content, construct, and predictive validity, as well as high internal consistency and test-retest reliability. Considering the brevity of these screening instruments (to ensure convenience to parents and the professionals using them), their psychometric accuracy is noteworthy.

The SDIS-C and SDIS-A were validated using samples of both English- and Spanish-speaking parent and are available in both languages. However, the computer-generated Graph and Interpretive Report for parents and professionals are only available in English at the present time. Although no statistical analyses were conducted on the Spanish data independently due to small numbers of Spanish participants (n=42), the inventories were analyzed qualitatively and no differences were noted between the parents completing the English and Spanish forms.

The SDIS takes 6-10 minutes for parents to complete. The computer scoring requires about 3-5 minutes for a secretary to load and produce a sleep graph with standard scores (T-scores) for each sleep subscale and a T-score with Percentile Rank for the Total Sleep Disturbance Index (SDI) to be given to the professional and parent. It also indicates whether the child's subscale scores and SDI are within the "Normal Sleep" range, the "Caution" range, or the "High Risk of a Sleep Disorder" range based on this norming sample. An Interpretive Report can be printed, which explains the meaning of the subscale scores in simple terminology for parents and professionals who have minimal knowledge or training in sleep disorders. If a child scores within the "High Risk" range on one or more of the subscales, the parent is encouraged to consult with a pediatrician or sleep specialist. If the child scores within the "Caution" range, the child's sleep behaviors need to be monitored carefully by the parent, and if the child's sleep or daytime problems increase, the parents are encouraged to consult with a pediatrician or sleep specialist.

A nationally validated and standardized sleep disorders screening inventory like the SDIS is needed many professionals are going to feel confident referring children to sleep specialists. This study suggests that there are a

high percentage of students, especially in special education, who may have a sleep disorder, but psychologists and pediatricians will be hesitant or unable to convince insurance companies to permit many of these referrals if professionals do not have a nationally validated screening instrument of high predictive validity to substantiate their suspicions. Finally, use of a nationally validated instrument with samples of children that reflect of the 2000 US Census is necessary if the field of pediatric sleep medicine is going to produce credible epidemiology studies of sleep disorders in children.

For further information, please see Child Uplift, Inc. at www.sleepdisorderhelp.com or Harcourt Assessment, Inc.

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REFERENCES

1. Rosen RC, Zozula R, Jahn EG, Carson JL. Low rates of recognition of sleep disorders in primary care: comparison of a community-based versus clinical academic setting. Sleep Medicine 2001;2(1):47-55.
2. Billiard M, Besset A, Cadilhac J. The clinical and polygraphic development of narcolepsy. In: Guilleminault C, Lugaresi E, eds. Sleep/Wake Disorders: Natural History, Epidemiology, and Long-term Evolution. New York: Raven Press, 1983:171-185.
3. Luginbuehl, ML. The initial development and validation study of the Sleep Disorders Inventory for Students. *Dissertation Abstracts International Section A: Humanities & Social Sciences, Vol 64(12-A)*, 2004, pp. 4376.
4. Gozal D. Sleep-disordered breathing and school performance in children. Pediatrics 1998;102:616-20.
5. Gozal D, Pope DW. Snoring during early childhood and academic performance at ages thirteen to fourteen years. Pediatrics 2001;107:1394-9.
6. Guilleminault C, Winkle R, Korobkin R, Simmons B. Children and nocturnal snoring: Evaluation of the effects of sleep related respiratory resistive load and daytime functioning. European Journal of Pediatrics 1982;139:165-171.
7. Marcotte AC, Thacher PV, Butters M, et al. Parental report of sleep problems in children with attentional and learning disorders. Journal of Developmental & Behavioral Pediatrics 1998;19:178-186.
8. Broughton RJ, Ghanem Q, Hishikawa Y, et al. Life effects of narcolepsy in 180 patients from North America, Asia, and Europe compared to matched controls. Canadian Journal of Neurological Science 1981;8:299-304.
9. Chervin RD, Guilleminault C. Obstructive sleep apnea and related disorders. In: Koopmann CF, Jr, Moran WB Jr, eds. Sleep Apnea. The Otolaryngologic Clinics of North America 1996;23:4.
10. Dahl RE, Holttum J, Trubnick L. A clinical picture of child and adolescent narcolepsy. Journal of American Academy of Child & Adolescent Psychiatry 1994;33(6):834-841.
11. Ryan ND, Puig-Antich J, Ambrosini P, et al. The clinical picture of major depression in children and adolescents. Archives of General Psychiatry 1987;44(10):854-861.
12. Walters AS, Mandelbaum DE, Lewin DS, et al. and the Dopaminergic Therapy Study Group. Dopaminergic therapy in children with Restless Legs/Periodic Limb Movements in Sleep and ADHD. Pediatric Neurology 2000;22:182-186.
13. Friedman BC, Hendeles-Amitai A, Kozminsky E, et al. Adenotonsillectomy improves neurocognitive functioning in children with Obstructive Sleep Apnea Syndrome. Sleep 2004;26(8):999-1005.
14. Chervin RD, Guilleminault C. Obstructive sleep apnea and related disorders. In: Koopmann CF Jr., Moran, WB Jr., eds. Sleep Apnea: The Otolaryngologic Clinics of North America 1996;23:4.
15. National Commission on Sleep Disorders Research. Wake Up America: A National Sleep Alert. Washington, DC: Government Printing Office 1993(Vol 1):1-76.
16. National Transportation Safety Board. Safety study: fatigue, alcohol, other drugs, and medical factors in fatal-to-driver heavy truck crashes, 1990(Vol. 1):1-181.
17. Aldrich MS. Automobile accidents in patients with sleep disorders. Sleep 1989;12:487-494.
18. Mitler MM, Carskadon MA, Czeisler CA, et al. Catastrophes, sleep and public policy: Consensus report. Sleep 1988;11:100-9.
19. Carmines EG, Zeller RA. Reliability and validity assessment. In: McCune SM series ed., M.S. Lewis-Beck MS vol. ed., Sage University Papers on Quantitative Applications in the Social Sciences. Beverly Hills and London: Sage Publications, 1979:07-001.
20. Chatterji M, ed. Designing and Using Tools for Educational Assessment. Upper Saddle River, NJ: Pearson Education, 2003.
21. Crocker L, Algina J. Introduction to classical modern test theory. New York: Holt, Rinehart and Winston, 1986.
22. Cronbach LJ Coefficient alpha and the internal structure of tests. Psychometrika 1951;16:297-334.
23. Nunnally JC. Psychometric theory (2nd ed.). NY: McGraw-Hill, 1978.
24. Lachenbruch PA. An almost unbiased method of obtaining confidence intervals for the probability of misclassification in discriminant analysis. Biometrics 1967;23:639-645.
25. Fry E. Fry's Readability Graph: Clarifications, Validity, and Extension to Level 17. Journal of Reading 1977b;21:249.
26. Hatcher L. A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equation Modeling (3rd ed.). Cary, NC: SAS Institute Inc, 1998.
27. Kaiser HF. The application of electronic computers to factor analysis. Educational and Psychological Measurement 1960;20,141-151.
28. Cattell RB. The scree test for the number of factors. Multivariate Behavioral Research 1966;1:245-276.
29. Bentler PM, Bonett DG. Significance tests and goodness-of-fit in the analysis of covariance structures. Psychological Bulletin 1980;99:588-606.
30. Bentler PM. EQS structural equations program manual. Los Angeles: BMDP Statistical Software, 1989.
31. Browne MW, Cudeck R. Alternative ways of assessing model fit. In: Bollen KA, Long JS, eds. Testing Structural Equation Models. Newbury Park, CA: Sage, 1989:136-162.