



CLINICAL REVIEW

Pediatric sleep questionnaires as diagnostic or epidemiological tools: A review of currently available instruments

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ARTICLE INFO

Article history:

Received 18 April 2010

Received in revised form

10 July 2010

Accepted 13 July 2010

Available online 8 October 2010

Keywords:

Sleep

Questionnaire

Log

Diary

Child

Reliability

Validity

Apnea

Periodic limb movements

Sleepiness

SUMMARY

An extensive list of published and unpublished instruments used to investigate or evaluate sleep issues in children was collected and assessed based on the fundamental operational principles of instrument development (11 steps). Of all the available tools identified, only a few were validated and standardized using appropriate psychometric criteria. In fact, only 2 fulfill all desirable criteria and approximately 11 instruments seem to adhere to most of the psychometric tool development requirements, and were therefore assessed in greater detail. Notwithstanding, in the rapidly developing scientific world of pediatric sleep, there are too many tools being used that have not undergone careful and methodical psychometric evaluation, and as such may be fraught with biased or invalid findings. It is hoped that this initial effort in categorizing and assessing available tools for pediatric sleep will serve as recognition of the relatively early developmental stage of our field, and provide the necessary impetus for future tool development using multicentered approaches and adequate methodologies.

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Introduction

The great popularity with questionnaires is that they provide a “quick fix” for research methodology. No single method has been so abused.¹

The last several decades have taught us that a long list of potentially misleading conclusions can be drawn when practitioners in the field of pediatrics continue to overlook sleep in their professional activities. There is a pervasive lack of awareness to the relatively frequent presence of sleep problems in children, which in turn can manifest in a myriad of clinical presentations that may be easily misconstrued as other pediatric conditions and mistreated accordingly. In other words: questions about sleep should always be included!

A systematic screening for sleep issues might assist in early identification of academic, behavioral, health and quality of life problems, which if treated will result in a better learning, happier,

and healthier child. In the field of pediatric sleep research, a trend toward implementation of large-scale sleep surveys has surfaced. Unfortunately, only a fraction of the manuscripts seems to report on reliability or validity, and rarely, if at all, will describe endorsement rates. Surprisingly, even the survey itself is missing in a large number of those studies. Notwithstanding, is any sleep question asked a ‘good’ question to ask? In other words, are surveys merely straightforward question-answer scenarios? How valid and comparable are the results from such surveys? Survey instruments are increasingly being created, adapted or translated with little scrutiny regarding their psychometric qualities, their structure, reliability and validity, and therefore, substantial doubts and concerns should emerge regarding their findings. Another consequence of the lack of psychometric validity is that direct comparison(s) of pediatric sleep problems, their prevalence, as well as the understanding of their impact on every day functioning is also substantially hampered. Likewise, the treatment of sleep disorders in children should benefit from well-designed, psychometrically sound tools. The field of pediatric sleep can only continue to grow and exert its impact on other fields if researchers and clinicians thoroughly investigate and report the psychometric properties of the tool(s) they develop and use. In this manuscript,

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Abbreviations

| | | | |
|--------|---|--------|--|
| ASHS | Adolescent Sleep Hygiene Scale | MCISQ | Maternal Cognitions about Infant Sleep Questionnaire |
| ASWS | Adolescent Sleep Wake Scale | MCPS | Missouri Children's Pictures Series |
| BEARS | Bedtime Problems, Excessive daytime sleepiness, Awakenings, Regularity and Snoring screener | MESC | Morningness-Eveningness Scale for Children |
| BEDS | Behavioral Evaluation of Disorders of Sleep Scale | OSA-18 | Obstructive Sleep Apnea – 18 |
| BISQ | Brief Infant Sleep Questionnaire | OSD-6 | Obstructive Sleep Disorders 6-Survey |
| BRQ | Bedtime Routines Questionnaire | PDSS | Pediatric Daytime Sleepiness Scale |
| CASQ | Cleveland Adolescent Sleepiness Questionnaire | PIBBS | Parental Interactive Bedtime Behavior Scale |
| CBCL | Child Behavior Checklist | PLMD | Periodic limb movement disorder |
| CCTQ | Children's ChronoType Questionnaire | PSDQ | Pediatric Sleep Disturbance Questionnaire |
| ChDCQ | Dream Content Questionnaire for Children | PSQ | Pediatric Sleep Questionnaire |
| CRSP | Children's Report of Sleep Patterns | RLS | Restless Legs |
| CSBS | Children's Sleep Behavior Scale | SBQ | Sleep Behavior Questionnaire |
| CSHQ | Children's Sleep Habit Questionnaire | SDIS-A | Sleep Disorders Inventory for Students – Adolescents |
| CSHS | Children's Sleep Hygiene Scale | SDIS-C | Sleep Disorders Inventory for Students – Children |
| CSSQ | Children's Sleep Status Questionnaire | SDQC | Sleep-Disturbance Questionnaire for School-aged Children |
| CSWS | Children's Sleep Wake Scale | SDSC | Sleep Disturbance Scale for Children |
| DFS | Daytime Functioning Scale | SQS | Sleep Quality Scale |
| HK-CSQ | Hong Kong children's sleep questionnaire | SRBD | Sleep-Related Breathing Disorders scale |
| IS | Insomnia Scale | SSHS | School Sleep Habits Survey |
| ISQ | Infant Sleep Questionnaire | SSQ | Sleep and Settle Questionnaire |
| MCBC | Missouri Children's Behavior Checklist | TCSQ | Tayside Children's Sleep Questionnaire |
| | | TISS | Ten Item Sleep Screener |

we have tabulated 'all' existing subjective tools within the field of pediatric sleep medicine, and have attempted to describe their psychometric qualities. As a preamble to this review, we described in greater detail in the preceding paper the 11 methodological steps needed to develop and evaluate a sleep assessment tool, and inherent potential pitfalls were also discussed in greater detail.² The methodological steps should include: 1. Purpose; 2. Research Question; 3. Response Format; 4. Generation of Items; 5. Pilot; 6. Item-analyses and non-response analyses; 7. Structure; 8. Reliability; 9. Validity; 10. Confirmatory analyses; and 11. Standardization and norms development. These psychometric approaches should be implemented using appropriate manuals and scholarly manuscripts on this topic, because inappropriate tools and lack of rigor inevitably lead to poor quality data, misleading conclusions, and inaccurate recommendations.

The dynamic and accelerated expansion of pediatric sleep science has inevitably led to development and utilization of numerous survey instruments that have enabled important discoveries and overall advancement of the discipline. As we now reach a more mature stage in our field, we believe that time has arrived to critically examine the constructs of existing instruments, and delineate not only the specific questions being sought, but also evaluate the steps taken to validate their implementation. An extensive list of published and unpublished instruments used to investigate or evaluate sleep issues in children was therefore collected and assessed based on our 11 step-by-step guide as outlined in the preceding paper.²

Procedure

The MeSH search terms combined were "Sleep" AND ("infant*" OR "child*" OR "adolescent*") AND (questionnaire*, instrument*, scale*, checklist*, assessment*, log*, diary*, record*, report*, interview*, test*, measure*), and implemented in the following search engines: PubMed, PsycINFO, Child Development and Adolescent

Studies, Health and Psychosocial Instruments, Mental Measurements Yearbook, CINAHL, Scopus (also Web crawling), ClinicalTrials.gov, Dissertations and Theses, Google Scholar (Web crawling), ebooks and APSS Sleep abstract books. No limits were set with the exception that the age should pertain to 0–18 year olds, or a mean age falling within that age range. Data based on a single item measuring sleep were when possible excluded.

For completeness we distributed via the PEDSLEEP and International Pediatric Sleep Association (IPSA) listservers an invitation to provide tools used for assessment of sleep in the child.

Results

This comprehensive review led to tabulation of the subjective tools in which psychometric properties as described in the preceding paper were evaluated. Next, tools for which no psychometric properties were evaluated were divided into those that are reported or published, those that are part of established tools, and those that are unpublished or used in clinical practice. As a rule, we focused on the original tool unless translations, modifications etc. were found to contribute clinical relevance, or if it became pertinent to discuss these tools in the realm of our scope.

About 6404 references were flagged by our search criteria, which were further filtered by their title, keywords, through text-mining and manual screening. This process was applied to the abstracts, as well as to the retrieved pdfs. Because of date, language, non-response or outdated contact details, or copyrights issues, some tools could not be retrieved, which ultimately resulted in a pool of about 183 tools being reported (Fig. 1).

Armed with the information provided in the preceding paper,² which aimed to serve as a refresher on the psychometric properties of tools, the reader should be able to readily and independently evaluate the detailed information on each of the 183 available tools as provided in the [Supplemental Tables](#).

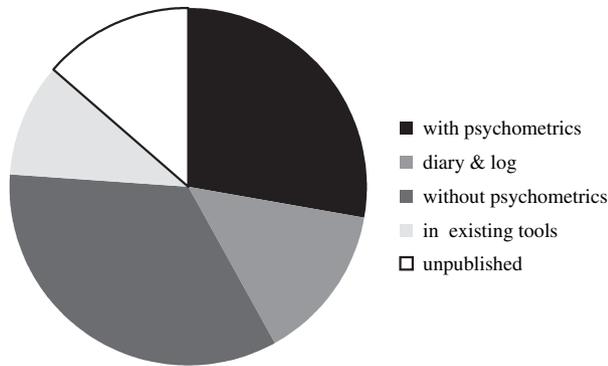


Fig. 1. Simplified pie chart of tools found.

Short history

The potentially first 'diagnostic' sleep questions, historically and not surprisingly, were embedded in daytime 'psychopathology' tools, such as Achenbach's Child Behaviour Checklist (CBCL)³ and Sines Missouri Children's Picture Series (MCPS),⁴ Conners⁵ and the Louisville Behavior Checklist,^{6,7} all of which were developed in the 1970s. As such, 'a' connection between mental health and sleep was made, although their interrelation remained unspecified. Prior to these tools, questions on sleep had primarily data collection purposes, and focused on documenting the sleep–wake patterns, and sleep was not viewed as important. Of interest, is the cooperation of teachers and superintendents, as well as the notion of insufficient or curtailed sleep duration in favor of daytime activities such as learning.^{8–10} These aspects potentially relate to the historical roles of boarding schools and the expectations from educational staff in society, and certainly depict the '(un)importance' given to sleep. The potential interrelation with 'appropriate or expected' daytime behavior of the child and childhood learning (hence not sleeping) was formulated with disregard for sleep as an important contributor to these functions. In the late 1980s, sleep questionnaires gradually surfaced, and only in the last few years has diagnostic accuracy in the use of a tool been evaluated.

Tools in which psychometric properties were evaluated

57 Tools were found to have been psychometrically evaluated to some extent (Table 1, and tabulated in detail in Supplementary Tables 1–3). Tools are ranked chronologically on the lowest age boundary (an alphabetical list for easy reference can be found at the end of this manuscript) being an important criteria upon deciding which tool to use.

Approximately half of the tools (52.6%) are printed together with the paper or are accessible online. The majority of the reported tools⁽⁴³⁾ were published after the year 2000, whereas two tools are older than 1980, 2 are from the 80s, and 10 are from the 90s. Almost half of the reported tools are from USA⁽²⁹⁾, followed by Italy⁽⁶⁾, and UK⁽⁵⁾, Canada⁽³⁾, Australia⁽³⁾, China⁽³⁾ and other research groups. 30 of the 57 tools were applied in community-school settings only, with sample sizes ranging from 20 to 6631 subjects. Based on their lower age boundary, 7 tools are applicable as early as infancy, 7 tools are for toddlers, 11 tools for pre-schoolers, 22 tools for school aged, 9 tools for early adolescence of which 2 are applicable to middle adolescents (Fig. 2). More than half (63.2%) of the tools are parental report tools.

The time to complete the questionnaire was reported only for 21% of the tools. Generally the number of items ranged from about

6 to 140, of which few are of descriptive or demographic nature. During infancy, tools tend to focus on sleep environment and settling, whereas for school age sleep–wake patterns as well as a diversity of sleep behaviors (e.g., snoring, insomnia) are mostly assessed. Towards adolescence, more questions regarding sleepiness or circadian typology and emotional well-being as well as scholastic achievement surface. The period during which sleep is evaluated ranges from 1 week up to a year, with 15 tools covering 1-month and 9 tools surveying 6 months; however, ~17 papers did not report on the time-frame evaluated. About 66% of the questionnaires used solely closed-ended questions with the frequency or Likert-type scale being most common. Noteworthy, open-ended questions from interviews are seldom psychometrically evaluated although some questionnaires have been administered as an interview.

Tools generally combined sleep–wake pattern and sleep problems assessment, although several distinct scales were created for sleepiness, morningness/eveningness, sleep-disordered breathing, insomnia and dreams. About 22 papers had as aim to psychometrically evaluate a tool; conversely few tools created through a dissertation study were eventually peer-reviewed and published. The Sleep Disturbance Scale for Children (SDSC)¹¹ [Supplementary Tables 1–3, nr. 33] and Sleep Disorders Inventory for Students–Children and Adolescent form SDIS–C, SDIS–A^{12,13} [Supplementary Tables 1–3, nr. 12 & 47] have been developed according to the 11 designated steps of tool development. Eleven tools have completed nearly all of the steps: the Dream Content Questionnaire for Children (ChDCQ)¹⁴ [Supplementary Tables 1–3, nr. 40], the Cleveland Adolescent Sleepiness Questionnaire (CASQ)¹⁵ [Supplementary Tables 1–3, nr. 46], the Bedtime Routines Questionnaire (BRQ)¹⁶ [Supplementary Tables 1–3, nr. 9], the Sleep and Settle Questionnaire (SSQ)¹⁷ [Supplementary Tables 1–3, nr. 3], the Maternal Cognitions about Infant Sleep Questionnaire (MCISQ)¹⁸ [Supplementary Tables 1–3, nr. 7], the Parental Interactive Bedtime Behavior Scale (PIBBS)¹⁹ [Supplementary Tables 1–3, nr. 6], the Tayside Children's Sleep Questionnaire (TCSQ)²⁰ [Supplementary Tables 1–3, nr. 8], the Children's Sleep Wake Scale (CSWS)²¹ [Supplementary Tables 1–3, nr. 10], the Sleep Disturbance Scale for Children (SDSC-Dutch)²² [Supplementary Tables 1–3, nr. 29], the Pediatric Sleep Questionnaire (PSQ) – SRBD (Sleep-related Breathing Disorder scale) (PSQ-SRBD)^{23,24} [Supplementary Tables 1–3, nr. 14], the Behavioral Evaluation of Disorders of Sleep Scale (BEDS)²⁵ [Supplementary Tables 1–3, nr. 21] (see further). As stated before, a tool should always be implemented and interpreted based on its purpose and psychometric quality. Furthermore, several instruments are adaptations or translations, and this is reflected by the limited psychometrical evaluation of such instruments, such as the first 4 steps (Purpose – Research Question – Response Format – Item Generation). Foremost reliability does not imply validity! Reliability was assessed in 93% of the instruments, while some degree of validity evaluation was done in only 63.2%. In about 30% of tools, piloting (Step 5), and item-analyses and non-response analyses (Step 6) were performed, and in even fewer (17.5%), a confirmatory analysis was done. Norms (Step 11) were missing in the vast majority, even if cut-off scores were increasingly proposed.

The 2 instruments (SDIS and SDSC)^{11,12} that fulfill all of the steps assess sleep–wake patterns and sleep behaviors, and both have been applied in community and clinical settings. Each of these tools provides T-scores, a type of standardized score that can be mathematically transformed into other types of standardized scores, and has an average range of 40–60, and more importantly about 68% of the sample would score within that range.

Table 1
Tools in which psychometric properties were evaluated: basic information.

| Table nr. | Tool acronym | First author | Year | Age | Number of questions | Respondent | Steps fulfilled (Part 1) |
|-----------|--|--------------|------|------------------------------|---|------------|--|
| 1 | Brief Infant Sleep Questionnaire (BISQ) ⁵⁸ and [extended ⁵⁹] | Sadeh | 2004 | 5–29 months [0–36 months] | ~ 10 [~ 25] | Parent | 1, 2, 3, 4, 8, 9 |
| 2 | Children's Sleep Status Questionnaire (CSSQ) ⁶⁰ | Xiao-na | 2009 | 0–5 yrs | 47 | Parent | 8 |
| 3 | Sleep and Settle Questionnaire (SSQ) ¹⁷ | Matthey | 2001 | 6-week old infants | 34 | Parent | All steps, steps 3 and 10 are not reported in detail |
| 4 | Obstructive Sleep Apnea-18 (OSA-18) ^{36,61,62} | Franco | 2000 | 6 months–12 yrs | 18 | Parent | 1, 2, 3, 4, 8, 9 |
| 5 | Infant Sleep Questionnaire (ISQ) ⁶³ | Morrell | 1999 | 12–18 months | 10 | Parent | 1, 2, 3, 4, 8, 9 |
| 6 | Parental Interactive Bedtime Behavior Scale (PIBBS) ¹⁹ | Morrell | 2002 | 12–19 months | 22 (19) | Parent | All steps, except steps 5, 10 and 11 |
| 7 | Maternal Cognitions about Infant Sleep Questionnaire (MCISQ) ¹⁸ | Morrell | 1999 | 12.9–16.8 months | 20 | Parent | All steps, except steps 10 and 11 |
| 8 | Tayside Children's Sleep Questionnaire (TCSQ) ²⁰ | McGreavey | 2005 | 1–5 yrs | 10 | Parent | All steps, except steps 10 and 11 and step 9 is not reported in detail |
| 9 | Bedtime Routines Questionnaire (BRQ) ¹⁶ | Henderson | 2009 | 2–8 yrs | 29 | Parent | All steps, except steps 5, 10 and 11 |
| 10 | Children's Sleep Wake Scale (CSWS) ²¹ (Sleep 2001 Abstract 360G 370G) | LeBourgeois | 2001 | 2–8 yrs | 39 (43?) | Parent | All steps, except steps 5, 7 and 11 |
| 11 | Children's Sleep Hygiene Scale (CSHS) (Sleep 2002 Abstract 436G) | Harsh | 2002 | 2–8 yrs | 17 | Parent | 1, 2, 3, 4, 8, 9 |
| 12 | Sleep Disorders Inventory for Students –Children (SDIS–C) ^{12,13} | Luginbuehl | 2008 | 2–10 yrs | 25 | Parent | All steps (step 11 a T-score was applied for ROC analyses) |
| 13 | Obstructive Sleep Disorders 6-Survey (OSD-6) ^{35,62} | De Serres | 2000 | 2–12 yrs | 6 | Parent | 1, 2, 3, 4, 5, 8, 9 |
| 14 | Pediatric Sleep Questionnaire (PSQ) ²³ | Chervin | 2000 | 2–18 yrs | 22 which is also referred to as the SRBD, sleep-related breathing disorder scale, being part of the PSQ (see further) | Parent | For the 22-items: all except step 11 |
| 15 | Maternal Attitudes scale ⁶⁴ | Keller | 2004 | 36–68 months | 12 | Parent | 8 |
| 16 | Family Inventory of Sleep Habits ⁵⁰ | Malow | 2009 | 3–10 yrs | 12 | Parent | 8, 9 |
| 17 | Brazilian–Portuguese translation (SDSC) ³⁹ | Ferreira | 2009 | 3–18 years | 26 | Parent | 1, 2, 3, 5, 6, 8, 9 |
| 18 | TuCASA Screening Questionnaire ³⁸ | Goodwin | 2003 | 4–11 yrs | 13 | Parent | 8 Spanish version was piloted |
| 19 | Children's ChronoType Questionnaire (CCTQ) ⁶⁵ | Werner | 2009 | 4–11 yrs | 27 | Parent | 1, 2, 3, 8, 9 |
| 20 | Children's Sleep Habit Questionnaire –preschool and school ages (Rev. 6/19/08) (CSHQ) ^{45,66} | Owens | 2008 | 4–12 yrs | ~ 45 main questions some with sub-questioning | Parent | 1, 2, 3, 8, 9 |
| 21 | Behavioral Evaluation of Disorders of Sleep Scale (BEDS) ²⁵ | Schreck | 2003 | 5–12 yrs | 28 | Parent | All steps, except steps 11, and step 5 was not reported |
| 22 | Sleep-Related Breathing Disorders scale (SRBD) ^{24,67} | Chervin | 2007 | 5–12.9 yrs | 14 | Parent | 9 See PSQ |
| 23 | Hong Kong children's sleep questionnaire (HK-CSQ) ³⁷ | Li | 2006 | 5–15 yrs | 54 | Parent | 1, 2, 3, 4, 8, 9 |
| 24 | Missouri Children's Behavior Checklist (MCBC) ⁴ | Sines | 1969 | 5–16 yrs | 9 | Parent | Daytime instrument |
| 25 | Sleep Questionnaire by Simonds and Parraga ^{68,69} | Simonds | 1982 | 5–20 yrs | 24 | Parent | 1, 2, 3, 4, 5, 8, 9 |
| 26 | Questionnaire by Ferreira ⁷⁰ | Ferreira | 2000 | 6–11 yrs | ~ 14 | Parent | 5, 8 |
| 27 | Sleep-Waking Questionnaire ⁷¹ | Carvalho Bos | 2009 | 6–11 yrs | ~ 32 | Parent | 5, 7, 8, 9 |

| | | | | | | | |
|----|---|--------------------|---------------|----------------------|--|-------------|--|
| 28 | Children's Sleep Behavior Scale (CSBS) ⁷² | Fisher | 1989 | 6–12 yrs | 22 | Parent | 1, 2, 3, 8 |
| 29 | Dutch adaptation SDSC ²² | Spruyt | 2004 | 6–13 yrs | 36 | Parent | All steps, except steps 11, and step 5 is not detailed |
| 30 | Sleep Behavior Questionnaire (SBQ) ⁷³ | Cortesi | 1999 | 6–14 yrs | ~29 | Parent | 1, 2, 3, 4, 8, 9 |
| 31 | Children's Sleep Quality Assessment Questionnaire ⁴⁰ Sleep 2002 (Abstract 437G) (Abstract 2002 A317) | Harnish | 2002 | 6–14 yrs | Not specified | Parent | 8, 9 |
| 32 | Sleep Disturbance Questionnaire for School-aged Children (SDQC) ⁴⁶ | Bruni | 1994 | 6.5–14.10 yrs | 55 | Parent | 1, 2, 3, 4, 8, 9 |
| 33 | Sleep Disturbance Scale for Children (SDSC) ¹¹ | Bruni | 1996 | 6.5–15.3 yrs | 27 | Parent | All steps |
| 34 | Pediatric Sleep Disturbance Questionnaire (PSDQ) ⁷⁴ | Cook | 1990 | 7–20 yrs | 44 | Parent | 1, 2, 3, 7, 8, 9 |
| 35 | Sleep Habits Questionnaire ⁴⁷ | Sadeh | 2000 | 7.2–12.7 yrs | 20 | Parent/Self | 7, 8 |
| 36 | Dysfunctional beliefs about sleep ⁷⁵ | Gregory | 2009 | 8–10 yrs | 28 | Self | 6, 8 |
| 37 | Children's Report of Sleep Patterns (CRSP) ⁴⁸ (version 9/22/08) (Sleep 2008 abstract 0196) | Meltzer | 2008 | 8–12 yrs | 67 | Self | 1, 2, 3, 8, 9 |
| 38 | Missouri Children's Pictures Series (MCPS) ^{28,28,76} | Sines by Dollinger | 1966, 1974 | 8–12 yrs 5–15 yrs | 6 | Self | Daytime instrument |
| 39 | Modification by Bruni (SSHS) ⁷⁷ | Bruni | 2008 | 8–15 yrs | ~34 | Self | 4, 5, 8 |
| 40 | Dream Content Questionnaire for Children (ChDCQ) ¹⁴ | Bruni | 1999 | 9–13 yrs | 44 | Self | All steps, except 11 |
| 41 | Sleepiness Scale ⁴² | Gau | 2003 | 9–16 yrs | 7 | Self | 8 |
| 42 | Morningness/Eveningness questionnaire by Crowley (Sleep 2006 Abstract 0197 A66) | Crowley | 2006 | 10–14 yrs | Not specified | Self | 8, 9 |
| 43 | Spanish version of PDSS ⁷⁸ | Perez-Chada | 2007 | 10–15 yrs | 8 | Self | 8 |
| 44 | Morningness–Eveningness Scale for Children (M/E or MESCS) ⁷⁹ | Carskadon | 1992 | 11–12 yrs | 10 | Self | 7, 8 |
| 45 | Pediatric Daytime Sleepiness Scale (PDSS) ⁴³ | Drake | 2001 and 2003 | 11–15 yrs | 8 | Self | 1, 2, 3, 4, 7, 8, 9, 10 |
| 46 | Cleveland Adolescent Sleepiness Questionnaire (CASQ) ¹⁵ | Spilbury | 2007 | 11–17 yrs | 16 | Self | All steps, except 11 |
| 47 | Sleep Disorders Inventory for Students –Adolescents (SDIS–A) ^{12,13} | Luginbuehl | 2008 | 11–18 yrs | 30 | Parent | All steps (step 11 a T-score was applied for ROC analyses) |
| 48 | Adolescent Sleep Wake Scale (ASWS) ^{80,81} | LeBourgeois | 2005 | 12–18 yrs | 28 | Self | 8 |
| 49 | Adolescent Sleep Hygiene Scale (ASHS) ^{80,81} | LeBourgeois | 2005 | 12–18 yrs | 28 (33?) | Self | 8 |
| 50 | School Sleep Habits Survey (SSHS) ⁴⁹ | Wolfson | 1998 | 13–19 yrs | ~63 main questions several with sub-questioning ~55 | Self | 8, 9 |
| 51 | Modification/translation by Giannotti (SSHS) ⁸² | Giannotti | 2002 | 14.1–18.6 yrs | | Self | 8 |
| 52 | Sleep questionnaire for adolescents ⁸³ | Carskadon | 1991 | 14–20 yrs | 140 | Self | 8 |
| 53 | Questionnaire by Gibson ⁴⁴ | Gibson | 2006 | 14–18 yrs | Not specified | Self | 4, 8, 9 |
| 54 | Insomnia scale (IS) ⁸⁴ ~Arabic Scale of Insomnia ⁸⁵ (ASI) | Abdel-Khalek | 2004/2008 | 14–19 yrs | 12 | Self | 3, 4, 5, 6, 7, 8, 9 |
| 55 | Daytime Functioning Scale (DFS) ⁸⁶ | Warner | 2008 | 15–18 yrs | 15 | Self | 8 |
| 56 | Sleep Quality Scale (SQS) ⁸⁶ | Warner | 2008 | 15–18 yrs | 6 | Self | 8 |
| 57 | Spanish Pediatric Sleep Questionnaire (PSQ) ⁸⁷ | Vila | 2006 | Not specified | 91 | Parent | 8 |

Step 1: Purpose, Step 2: Research question, Step 3: Response format, Step 4: Generation of items, Step 5: Pilot, Step 6: Item-analysis and non-response analysis, Step 7: Structure, Step 8: Reliability, Step 9: Validity, Step 10: Confirmatory analyses, Step 11: Standardization and norms (see²).

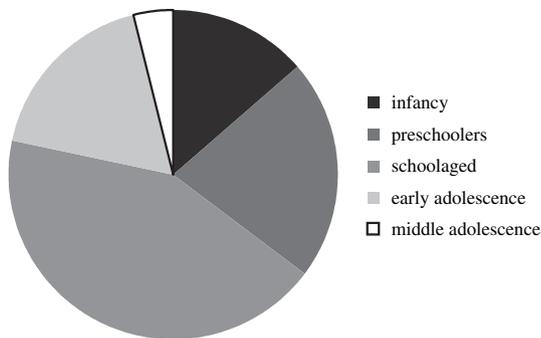


Fig. 2. Age distribution in tools which psychometric properties were evaluated.

*Sleep disorders inventory for students – children and adolescent form*¹² [Supplementary Tables 1–3, nr. 12 & 47]

This tool has just recently become commercially available (Pearson) and is the result of a PhD dissertation in collaboration with an expert panel and seven pediatric sleep centers in four regions of the country. The SDIS comprises 4 to 5 subscales: obstructive sleep apnea syndrome, excessive daytime sleepiness, periodic limb movement disorder, delayed sleep phase syndrome, and narcolepsy disorders. Their combined age-range goes from 2 to 18 year old children and demographics of the population are as reflected by the 2000 US Census. This parental rating tool is also available in Spanish. Items are scored on a 7-point Likert scale questioning the past 6–12 months, and they each take about 10 min to complete. Overall the tool scores adequately on validity and reliability, except for the periodic limb movement disorder/restless leg subscale. Hence, severity and not frequency might provide a better and more appropriate response for such a disorder as periodic legs movement disorder of sleep. The author strongly advocates screening, and therefore has developed a clinician-friendly format of the tool that includes computer scoring, and the generation of graphs and reports. The author further advocates the need for additional studies in clinical populations and Hispanic population (for more details see Supplementary Tables 1–3).

*Sleep disturbance scale for children*¹¹ [Supplementary Tables 1–3, nr. 33]

The SDSC assesses disorders of initiating and maintaining sleep, sleep-disordered breathing disorders, disorders of arousal, sleep–wake transition disorders, disorders of excessive somnolence and sleep hyperhydrosis, and is provided at no cost.¹¹ The 6 subscales are scored on 5-point Likert scale comprising the past 6 months, and this tool has been translated into several languages with adequate results with respect to validity and reliability. Time to complete is about 10 min. It was developed for 6.5–15.3 year old children, yet translations have been applied to other age ranges, whereas norms of the original tool have only been generated for an Italian sample. The subscales of this tool fit into the categories of Association of Sleep Disorders Centers and the Association for the Psychophysiological Study of Sleep diagnostic classification of sleep and arousal disorders.

Tools fulfilling nearly all psychometric methodological steps – recommendations and warnings

As a rule for these tools is the lack of either Steps 5 (Piloting), 10 (Confirmation of its psychometric value), 11 (Standardization/

Norms) or 7 (Structure) and partial discussion of Step 9 (Validity), all of which limit their applicability. However, these tools might be the starting point for the development of a new tool, or tapping a problem of interest (thus supporting their use along with knowledge of the limitations), or they might be in the process of more extensive psychometric evaluation. For example, some items are very weak and should be replaced, generalizability towards other populations or cultures might need to be assessed, etc. Notwithstanding, other steps of tool development have been discussed extensively and are generally satisfactory to adequate.

Sleep problems of infancy can be assessed by use of the Sleep and Settle Questionnaire (SSQ), Maternal Cognitions about Infant Sleep Questionnaire (MCISQ), Parental Interactive Bedtime Behavior Scale (PIBBS), or for older children Bedtime Routines Questionnaire (BRQ), Tayside Children's Sleep Questionnaire (TCSQ) which mainly focus on sleep–wake patterns, routines or hygiene. For pre-schoolers and young school-aged children, these problems can be surveyed by the Children's Sleep Wake Scale (CSWS) or Behavioral Evaluation of Disorders of Sleep Scale (BEDS). The well-known Pediatric Sleep Questionnaire (PSQ) – SRBD (Sleep-related Breathing Disorder scale) has been extensively studied and shows adequate psychometric properties. Conversely, Dream Content Questionnaire for Children (ChDCQ) and Cleveland Adolescent Sleepiness Questionnaire (CASQ), are the only self-report tools in this list, have been somewhat overlooked despite their relatively high psychometric qualities. In fact, the CASQ offers a visual alternative to the verbal sleepiness questionnaires. Nearly all of these tools use a 5-point Likert scale yet depending on the purpose or targeted population the time-frame questioned varies (i.e., recent to past 6 months).

A detailed discussion of each of the 57 tools identified herein would be excessive in relation of the scope of this paper. However, some additional tools deserve recognition based on their attempts to adhere to the psychometric criteria. We like to draw attention to the fact that even if measurement of only one concept is intended, this needs to be assessed using for example principal components or factor analyses (see 2). Furthermore there appears to be limited assessment of validity and conversely, there is clear overreliance on reliability. Nearly all instruments focus on frequency of sleep problems. Also of importance is some tools may have undergone a psychometric evaluation even if such steps are only discussed vaguely, or have not been published.

Recommendations for the future

Regardless of the purpose for tool development, their use and evaluation require excellent working knowledge of tool standards and of the psychometric characteristics of the tool of interest. Tools do not need to be perfect, or even psychometrically exceptional; however, they need to improve clinical decision-making and significantly reduce errors of judgment. This can only be accomplished by the iterative process of Steps 1 to 11 described in companion paper. We therefore strongly advocate a thorough description of each of the steps when tools are being developed or evaluated, or even when merely applied within a clinical setting or research protocol. All too often, Steps 3 (Response Format) and 5 (Pilot Study) are neglected whereas Steps 10 (Confirmatory Factor Analysis) and 11 (Standardize and Develop Norms) are potentially considered beyond the scope of interest, and therefore ignored as well. Furthermore, an over-emphasis on reliability can be observed, but reliability does not imply validity, although a tool cannot be considered valid if it is

not reliable. We also advocate the publication of endorsement rates; i.e., per response format and question, such as to facilitate meta-analyses in the future. Tools sensitive enough to measure change in the characteristic under study are needed; i.e., allowing repeated testing within short time-frames. Additionally, the low concordance between polysomnographic or actigraphic data versus questionnaires might be due to the response format(s) or symptoms of some sleep disorders might vary from night to night and require multi-night data collection by sleep specialists to obtain accurate measures (e.g., periodic limb movement disorder of sleep). Most tools focus on frequency and not on severity, and usually restrict the question to a specified time-frame.

Based on the selection of the appropriate tool, the correct administration, and adept interpretation progress can be made towards sound and clinically efficient interventions of pediatric sleep disorders. In fact, the extreme argument would be to abolish any tool that does not adhere to these steps. A tool forms the bridge between the researcher or clinician and the respondent, and thus it is of utmost importance that their 'perception' of a sleep behavior is nearly identical. In other words, by using the tool we aim to eliminate human 'judgment' which is prone to errors or biases. Gathering unbiased information is the goal. Therefore, we want precise questions that measure what we want to measure, time after time regardless the socio-demographics of the respondents. To date, each of the instruments remains vastly a screening tool and, strikingly, tools for specific clinical populations are lacking. A trend towards emergence of diagnostic tools is noticeable. We should also emphasize that computer-assisted surveying should adhere to the same psychometric prerequisites as any other tools.

To remember:

| Pro's | Con's |
|--|---|
| 2 instruments fulfill all criteria Some unique tools in content or response format have been developed: Dream Content and Cleveland Adolescent Sleepiness Questionnaire | Most instruments are generic in content Most instruments have frequency format Most instruments are parental reports Generation of Items, Piloting and Item-analysis should be more extensive 11 steps need to be implemented and reported in instrument development Focus on nighttime sleep, few tools incorporate napping Tools sensitive to changes in characteristics should be developed Discuss administration, scoring, interpretation and handling of missing data Differentiation between school days and non-school days might be advocated Bedtime, Wake-up time, Sleep Onset Latency, Sleep Duration are often categorical; i.e., hampering potential statistical analysis, boundaries of categories differ |

Diaries, logs and other tools

Instruments were grouped according to self-report¹³ or parental report.¹⁶ 29 diaries and logs are described in [Supplementary Table 4](#). The literature search revealed that these terms are used

interchangeably, and that a clear distinction was not made from the often concomitantly applied actigraphy and its parameter report. Even in these tools, heterogeneity is remarkably apparent in the wording, the order, the lay-out, the number of questions, when to fill-out and in the time-frame, or even calculations based on the tool (e.g., 'oversleep' [Supplementary Table 4](#) nr. 6), inclusion of napping or feelings upon awakening. The lack of any psychometric evaluation is rather striking!

Recommendations and warnings

We strongly advocate intense scrutiny of the available logs and diaries using the 11 steps described in the companion paper. In fact, a daily registration or rating of (nighttime) behavior is more intense than reflecting on a weekly or monthly behavior. Researchers and clinicians implicitly expect to have fulfilled these psychometric criteria, however, for example question order or format potentially has impact on response, and so will additional questions that increase awareness of nighttime behavior or patterns. Therefore, delivery of instructions, training or try-out has to be considered as well as the feasibility of the tool within the home environment, family schedules etc. It might be advisable to have the respondent repeat what is expected, how important the gathered information is, and the need for precision. Also, lay-out plays a crucial role and might affect compliance or completeness. For example, these tools may lack the answer format 'don't know'. When creating or applying a log or diary it is important to try-out the tool for a prolonged period. Aside from bedtime, wake time and sleep onset latency revealed tremendous heterogeneity in question, response format, lay-out and so forth. Furthermore, a clear distinction should be made if a diary/log was used by itself or as part of an actigraphic assessment.

Recommendations for the future

More appealing logs or diary can be easily created, or even electronic (computer or mobile) logs – diaries with reminders can be developed in this high-tech trended media intensive society. For example, adherence might be better when a text-message or signal is sent to a server each time a child awakens. Logs or diaries should be made user-friendly, and we should even consider them to be filled-out by a child for example on the computer, which may have an interactive touch. That is, development of computerized scoring software generating a visual graph and a report with explanations and/or recommendations for parent and child, and so forth should be seriously contemplated in any new tool development. Electronic data storage approaches for research or clinical evaluation should be created, along with web-based links to accredited sleep centers that may enable 24-h interfaces with respondents. Such tools are not currently available in children and much work needs to be done with respect to their creation and implementation in the context of developing logs and diaries.

To remember:

| Pro's | Con's |
|-------|---|
| | No psychometric evaluation Tremendous heterogeneity Differentiation from actigraphic log should be made Lay-out is crucial |

Tools in which psychometric properties were not evaluated

This list is not exhaustive since an overwhelming amount of papers implement a certain 'subjective tool'. The contrast of these unevaluated tools with the limited number of tools that are actually

psychometrically evaluated should prompt caution in their use based on the assumption that they are *a priori* valid. The 70 instruments were ranked based upon the lower age boundary (an alphabetical list can be found at the end of this manuscript). These include not only questionnaires, but also interviews⁽⁷⁾, video-recordings⁽²⁾, and even creative approaches to sleep by Children's Drawings²⁶ or a checking chart used for sleep problem intervention, pictorial sleepiness scale²⁷ (Supplementary Table 5, nrs. 69, 14, 39).

Almost 75.3% of these tools rely on parental report. Similarly as with instruments that were psychometrically evaluated, 2 are from the 70s, 8 from the 80s, 17 are from the 90s and almost the rest⁽⁴²⁾ are from 2000 onwards. Of interest is that the year of publication does not always correspond to the year of survey, or development of the tool; potentially affecting findings for example, endorsement rates might become 'outdated', modifications or adaptations might have been pursued, data-pooling was performed, cultural or societal changes surfaced, and so forth.

Often the method section indicated that a questionnaire was developed for epidemiological purposes, or that a group of questions was pooled to further address the research hypotheses without additional specifications. Using an unvalidated tool, or a tool where not all 11 steps necessary for proper development and validation were maximally implemented for epidemiological predictions may potentially be erroneous and misleading to funding organizations, pediatricians, school districts and families. Misuse of invalid tools may moreover underlie the discrepancies in prevalence and associations reported throughout the literature. In other words, the 11 tool development steps make a 'subjective' tool as objective as possible, thereby eliminating potential misinterpretations while enabling highly reliable and valid results time after time for each assessment.

Strengths and weaknesses

It should be clear by now that surveying is not a simple set of questions-and-answers scenarios. Indeed, piloting a questionnaire on a few colleagues, or the mere fact that it is used in previous studies, or published in peer-reviewed journals does not necessarily imply that it is either valid or reliable. Furthermore, awareness to the pitfalls and limitations is often insufficient when planning research and appraising published studies with tools. However, we should also remember that several of these instruments may have undergone partial evaluation of psychometric criteria indirectly or in an unconventional way through multiple applications in different clinical and research settings, or through the use of modified versions of some of these tools. Noteworthy, some of these instruments have served as a benchmark of other tools, e.g., Brouillette's questionnaire for pediatric sleep apnea. We should also emphasize the unique creativity in approach for some of the instruments being reported here, such as video format [nr. 13, 58], computerized [nr. 38], visualization [nr. 39] or merely their narrowed focus [nr. 63, 64, 3, 4, 21], while for others their recognition being driven through sleep 'mnemonics' (BEARS [nr. 22], TISS [nr. 70]).

Recommendations for the future

As would be anticipated, it would be better not to throw away the baby with the bathwater, but instead, reflect and learn from the tools that are available, in spite of all of their limitations. Collaborative efforts to proceed with tool validation even with respect to the tools enumerated in Online Supplementary Table 7 will definitely strengthen our field. Some tools included in the Tables originally attempted to assess children with special needs or used the original tools in such special populations. As such, it would be important for the readers to become aware of any adaptations or

additions to such tools in published manuscripts by systematically describing the implemented changes in the publications.

To remember:

| Pro's | Con's |
|--------------------------------------|--|
| Some specialized tools are available | Most tools are generic Lack of psychometric validation or discussion of the tool Focus on nighttime sleep, few include napping Focus on frequency (hence not severity) Screen for adherence to 11 steps prior to use |

Sleep questions in other existing tools

Contact with publishers yielded limited results with most instruments probably having just a few items or the publisher being unaware of any 'sleep items' (Supplementary Table 6). Therefore the list tabulated, again chronologically on lower age boundary, is based upon 21 instruments to which we had access. In contrast to the sleep instruments, it becomes apparent that these daytime tools are mostly created in 70–90s. Only a handful of sleep items appear in each of the instruments, and their psychometric properties are diluted within the realm of daytime indicators. For example, the peculiar place of Sleep Problems Syndrome of CBCL³ is stated by not including it either in the Internalizing nor Externalizing grouping. Supplementary Table 6 shows that items remain 'general'. Given that few standardized daytime tools include sleep items, or that currently only 1 sleep questionnaire is published by a test publisher, we can question the importance given to sleep in screening or health care.

Drs. Achenbach, Sines, Conners, and Miller instruments are potentially the first to incorporate sleep into a daytime 'psychopathology' screening tool. Dollinger et al.^{28,29} studied the validity of the sleep disturbance scale of Sines instruments.

Strengths and weaknesses

Having such items in daytime tools also means that the user can cross-verify or check on respondents' behavior, or even run an item-analysis. Additionally, these tools have undergone psychometric evaluation, the interrelation with daytime items (i.e., behavior) might be discussed in the manuals, and more importantly norms have been established, as well as the validity and reliability of the items. Their vagueness and limited number of questions on sleep remains a weakness.

Recommendations for the future

As a field we should promote inclusion of sleep in any new or existing tool whenever possible.

To remember:

| Pro's | Con's |
|--|--|
| Items might be used, or compiled when possible | No sleep expertise No sleep validation of items |

Unpublished tools

This list probably represents only a minority of the tools available, and was created primarily through the willingness of colleagues in the field to share their tool (Supplementary Table 7). 28 instruments are listed. We would like to draw special attention to instruments in development or in press: RLS rating scale [nr. 3], RLS/PLMD pediatric screening questionnaire [nr. 4], sleep paralysis [nr. 5], dream habits [nr. 7], treatment evaluation inventory [nr. 11], hospitalized children's sleep [nr. 12], as well as instruments in submission such as a modification of CSHQ [nr. 26], Pediatric RLS severity scale [nr. 27] and the Gozal's questionnaire [nr. 28]. The year of publication indicates some newer evolutions.

Instruments in practice tend towards a history-taking format with descriptive or demographic questions, and health status of the child, and sometimes of the child's relatives, in addition to sleep–wake patterns and sleep behaviors. Unfortunately, little of such collected data is being entered into a data-base, which would be an incredibly valuable pool towards item-analyses and data-mining.

Recommendations for the future

The exemplary openness and willingness to share their materials as illustrated by the authors or users of instruments listed here should serve as a model for future collaboration and discussion. For instance, sharing endorsement rates or instruments in different languages through a professional discussion forum or through collaborative studies will greatly increase our progress towards screening, and maybe diagnosing sleep problems in children. Implementation of a pediatric sleep-hotline for those who are willing to share IRB approved de-identified data (i.e., not including personal health information or other identifiers) online may further improve the validity of the instruments over time.

To remember:

| Pro's | Con's |
|----------------|---|
| Great resource | Mixed formats Most include history-taking questions Translations or modifications with little psychometric evaluation |

Synopsis

“Begin at the beginning”, the King said gravely, “and then go on till you come to the end; then stop” – Alice's adventures in Wonderland

From this review it is clear that much remains to be done, even if in recent years the psychometric evaluation of tools created and applied within the field of pediatric sleep medicine is growing. Sleep-related breathing and sleepiness disorder questionnaires are probably leading this trend.

The Brouillette's³⁰ questionnaire assessing sleep-related breathing disorder and several of its adaptations (e.g., Carroll's and Gozal's)^{31–34} is mentioned in the Tools in which psychometric properties were not evaluated (Supplementary Table 5). This is because the Brouillette's sleep-disordered breathing questions were subtracted from 57 questions generated from

clinical experience and published signs, and because it plainly focuses on the correct prediction and discrimination of sleep-disordered breathing. Carroll's and Gozal's adaptations address better steps 4–6 (see Part 1; Generation of Items, Piloting, Item-analysis and non-response analysis) (note that only Gozal's is applied as a questionnaire, whereas the other 2 are used as interviews). The quest for an optimal sleep-related breathing disorder diagnostic tool is also apparent from Supplementary Tables 1–3, e.g., PSQ-SRBD,^{23,24} OSD-6,³⁵ OSA-18,³⁶ HK-CSQ,³⁷ TuCASA,³⁸ with the PSQ-SRBD being the most discussed. Of interest, is the increasing surge aiming at validation compared against objective measurements such as polysomnography or oximetry. Note that most of the tools rate frequency, that severity is rarely included, and that the tools address a longer time-frame than for example one overnight sleep study. Additionally, no consensus about these objectively measured sleep-disordered breathing parameters exists. Comparison of validity with respiratory indices from polysomnographic recordings has been done for OSA-18,³⁶ SDIS,^{12,13} PSQ,^{23,24} Brazilian–Portuguese SDSC,³⁹ HK-CSQ,³⁷ Children's Sleep Quality Assessment Questionnaire,⁴⁰ CASQ,¹⁵ and Gozal's questionnaire^{32–34} with some degree of success. In contrast, others have embedded Brouillette's questions, or derived from their own tool a similar classification. As recently outlined,⁴¹ a huge diversity in ‘how – which – number – type’ is evident, which likely influences comparison with objective measures. We suggest the generation of a substantive pool of *only* sleep-related breathing items, and through piloting with tedious item-analyses and analyses of underlying structures, a potential comprehensive and consistent set of indicators of sleep-disordered breathing may be ultimately found.

Sleepiness assessed as a scale or subscale is similarly popular, as seen in Supplementary Tables 1–3 and 5; i.e., PSQ,^{23,24} sleepiness scale,⁴² PDSS,⁴³ CASQ,¹⁵ Questionnaire by Gibson,⁴⁴ SDIS,^{12,13} TuCASA,³⁸ CSHQ,⁴⁵ SDQC,⁴⁶ Sleep habits questionnaire,⁴⁷ CRSP,⁴⁸ SSHS.⁴⁹ The morningness–eveningness tools follow in popularity, and have been widely translated and adapted. More recently chrono-typing [Supplementary Tables 1–3 nr. 19] tools have surfaced, and the increasing comparisons with actigraphy are apparent. Likewise encouraging is BRQ [Supplementary Tables 1–3 nr. 9] assessing bedtime routines, which is different from sleep–wake or sleep hygiene assessments, but helps us to capture the construct of sleep. Another trend is the application of sleep questionnaires, and especially diaries or logs in children with developmental disabilities; e.g., Family Inventory of Sleep Habits⁵⁰ [Supplementary Tables 1–3 br. 16], PSQ adaptation for children with microsomia,⁵¹ CSHQ,⁵² Sleep questionnaire (Bruni).^{53–55} Most of them are adaptations; however, the effort should be encouraged.

The majority of sleep questionnaires assesses the frequency or the occurrence, whereas questioning the severity of sleep complaints is seldom performed. It is possible that other response formats might be more suitable and could be explored in the future. Furthermore, SSQ,¹⁷ BRQ,¹⁶ OSD-6,³⁵ OSA-18³⁶ and PIBBS¹⁹ are some of the few instruments also measuring ‘change’. Though infrequently reported, endorsement rates could help us towards meta-analyses of sleep items, and would further allow visualization of cultural boundaries. Analyzing cultural equivalence as was done in the Brazilian–Portuguese SDSC³⁹ will aid in comparability within the field. Carelessness with the wording, the response format, the period evaluated, as well as many other attributes of the tools will adversely impact on the use of the tool. Given that tool development is an extremely time-consuming process, increasing sample sizes

when evaluating reliability and validity is clearly advocated (some of published tools include only 10 subjects). Not surprisingly, the reliability and validity evaluations reported are in the moderate to satisfactory range. We should further note that quantity does not guarantee quality; i.e., if the item or question is not psychometrically adept administering it to a large sample will not enhance its psychometric quality. It is clear that in comparison with daytime tools we still have long ways to go.

Recently Tryon⁵⁶ posed several important questions: (i) what is the conceptual domain of sleep? (ii) does the construct sleep limit to objective measures? (iii) does the subjective measure need to include *all* facets of sleep? (iv) how well do subjective measures correlate or discriminate? (v) what are the underlying dimensions of sleep? Although a perfect instrument does not exist, a tool needs to be evaluated by weighing its pros and cons. Dimensionality, or the underlying structure of the sleep question-pool undoubtedly needs to be assessed, especially since sleep problems are interrelated.²² In resemblance with daytime tools, taping nighttime behaviors from diverse angles might reveal interesting sleep profiles, and their development throughout childhood.

We propose that this review should be viewed as the starting block of a process that will ultimately lead to increased cooperation and improved methodologies when developing instruments aiming to assess sleep in children. We hope that the information compiled herein will foster critical reflection when developing, applying and interpreting currently available or future tools. Finally, we hope that the efforts by sleep experts towards more psychometrically sound instruments will further increase the awareness and screening process for sleep problems in children.

Conclusions

In 1981, the textbook ‘The Mismeasure of Man’ symbolized the previous hazards of measuring intelligence as a single quantity and its possible adverse consequences (e.g., Goddard’s belief in intelligence testing). This review was written solely to allow critical reflection upon the risk of ‘the mismeasure of sleep’, and thus promote and enhance collaborative studies on measurement of pediatric sleep. This interesting journey in the world of pediatric sleep tools revealed that efforts have been made, and trends have periodically surfaced (e.g., correlations with daytime behaviors remain ‘weak-moderate’, enuresis takes a peculiar place, sleep-disordered breathing is top ranked in number of tools). Very few tools fulfill all the necessary psychometric properties, and few standardized tool exists thus far. None of the tools has any diagnostic power. Noteworthy, alpha is not the panacea⁵⁷ and needs to be interpreted in terms of the number of items, item-inter correlations, and dimensionality. Also the influence of response format needs to be considered. Furthermore, without factor analysis one is apt to make erroneous conclusions. The risk of relying primarily on internal consistency is that we only know that the ‘tool’ measures something consistently, but *what* it measures remains unknown, making other validation steps compulsory. To summarize, decisions on the psychometric properties of tools is indisputably dependent upon the decision(s) made with the tool. As such we kindly ask each of the readers to scrutinize the tools that are applied when collecting, identifying and diagnosing sleep problems in children.

Practice points

In evidence based medicine it is vital that assessment tools adhere to a stringent psychometric evaluation, such as for example item-analyses, validity, reliability and norms. This approach will ultimately prevent difficulties and uncertainties in interpreting results, and will concomitantly and favorably impact clinical or educational practices.

During the process of considering using an available instrument in either clinical or research projects or during the process of developing a custom instrument, careful adherence to the following principles will enable correct data acquisition, scoring, interpretation and comparison of results:

1. Assess the psychometric criteria based on which ‘a tool’ was developed and used
2. Apply adept statistics and adhere to guidelines of tool development
 - a. Fulfill the preliminary work – literature searches, piloting, equivalence, etc.
 - b. Decide on: how, which, number and type
 - c. Select the method of sampling (or distribution of your tool)
 - d. Pilot and revise, until the tool fulfills desired psychometric properties
 - e. Launch your study, and discuss initial findings
3. Remember that an unreliable tool cannot be valid; *however*, a reliable tool may still be invalid
4. To date only few standardized pediatric sleep tools exist
5. Some items are by nature ‘statistically’ weak but might be clinically relevant, and need to be interpreted accordingly
6. Interpret results of the tool by its psychometric properties (strengths and weaknesses)
7. Remain critical (e.g., response format).

Research agenda

To develop universally adopted and validated tools for sleep in children to:

- compile internationally collected data
- data-mine; perform item-analyses and meta-analyses on collected data
- launch international multi-center studies
 - form a international-expert panels
 - conduct pilot studies on pilot versions
- develop and provide a web-based questionnaire or tool pool
- develop self-reporting tools
- develop tools towards sleep interventions

Conflict of interest

The authors have no conflict of interest to declare pertaining to this manuscript.

Acknowledgments

We would like to express our gratitude to Drs. Oliviero Bruni and Avi Sadeh for distributing our request via their pediatric sleep listservers. The following individuals not only expressed their enthusiasm towards the review, but each added to its value by

providing tools or contact persons or references (alphabetically): Thomas M. Achenbach, Rosana Cardoso Alves, Jessica M. Bennett, Sarah Biggs, Luigia Brunetti, Oliviero Bruni, Sandra Carvalho Bos, Ronald Chervin, Martin Delatycki, Pernilla Garmy, Beth L. Goodlin-Jones, Paul Gringas, Oskar Jenni, Athanasios Kaditis, Monique LeBourgeois, Niki Lindblom, Kurt Lushington, Carole Marcus, Maria Elena Mazzola, Lisa Meltzer, Magda Lahorgue Nuñez, Teresa Paiva, Daniel Picchietti, Giora Pillar, Aroonwan Preuthippan, Amanda Richdale, Avi Sadeh, Angelika Schlarb, Sabine Scholle, Jacob O. Sines, Michael S. Urschitz, Stijn Verhulst, Abby Wagner, Teresa M. Ward, Macrin Zarowski and the unidentified reviewers of this manuscript.

We also like to express our gratitude to Drs. Achenbach and Sines for their interest, and for providing us with the necessary documentation.

Appendix

Alphabetical List of tools within the review (details in [Supplementary Tables](#)).

| Table | Nr. | Tool |
|-------|-----|---|
| 7 | 10 | 17-item symptom profile for parental report of risk for sleep-disordered breathing |
| 7 | 24 | 6-page Sleep Questionnaire by Bruni |
| 4 | 11 | 7-day sleep journal |
| 7 | 9 | A 111 item questionnaire |
| 5 | 66 | Adolescent Sleep Habits Survey Boys self-report |
| 5 | 67 | Adolescent Sleep Habits Survey Girls self-report |
| 5 | 68 | Adolescent Sleep Habits Survey Parent report |
| 1–3 | 49 | Adolescent Sleep Hygiene Scale |
| 1–3 | 48 | Adolescent Sleep Wake Scale |
| 5 | 56 | American Thoracic Society Children's Questionnaire |
| 6 | 5 | BASC 2.5–5 yrs |
| 6 | 11 | BASC 6–11 yrs |
| 6 | 14 | BASC 12–18 yrs |
| 5 | 22 | Bedtime Problems, Excessive daytime sleepiness, Awakenings, Regularity and Snoring screener |
| 4 | 7 | Bedtime routine Questionnaire |
| 5 | 52 | Bedtime routine Questionnaire and Modified Pittsburgh sleep Quality index to reflect 1 week |
| 1–3 | 9 | Bedtime Routines Questionnaire |
| 6 | 10 | Behavior Assessment System for Children BASC-2 |
| 1–3 | 21 | Behavioral Evaluation of Disorders of Sleep Scale |
| 1–3 | 17 | Brazilian–Portuguese translation SDSC |
| 1–3 | 1 | Brief Infant Sleep Questionnaire |
| 5 | 5 | Brief Rating of Infant sleep |
| 5 | 28 | Caretaker Sleep Participation Scale |
| 5 | 14 | Checking chart – closing door chart |
| 6 | 3 | Child Behavior Checklist |
| 6 | 9 | Child Health Questionnaire |
| 6 | 2 | Child Health Questionnaire (Physical Functioning 28 scale) |
| 6 | 17 | Child Sleep Depression Inventory |
| 5 | 48 | Child sleep Questionnaire |
| 6 | 8 | Child Symptom Inventory-4 |
| 4 | 24 | Child's sleep questionnaire CSQ |
| 5 | 47 | Child's sleep questionnaire CSQ |
| 1–3 | 19 | Children's ChronoType Questionnaire |
| 5 | 69 | Children's Drawings |
| 1–3 | 37 | Children's Report of Sleep Patterns |
| 5 | 19 | Children's Sleep and Habits Questionnaire a modification of Sleep-symptom questionnaire |
| 1–3 | 28 | Children's Sleep Behavior Scale |
| 5 | 19 | Children's Sleep Habit Questionnaire – modification for toddlers and preschool children |
| 1–3 | 20 | Children's Sleep Habit Questionnaire – preschool and school ages |
| 5 | 36 | Children's Sleep Habit Questionnaire – preschool and school-aged abbreviated |
| 1–3 | 11 | Children's Sleep Hygiene Scale |
| 1–3 | 31 | Children's Sleep Quality Assessment Questionnaire |
| 1–3 | 2 | Children's Sleep Status Questionnaire |
| 1–3 | 10 | Children's Sleep Wake Scale |

Appendix (continued)

| Table | Nr. | Tool |
|-------|-----|--|
| 1–3 | 46 | Cleveland Adolescent Sleepiness Questionnaire |
| 6 | 15 | Conners-Wells' Adolescent Self-Report scale |
| 7 | 26 | CSHQ – M(odified) |
| 4 | 16 | Daily Logs with Sleep Habits Questionnaire |
| 4 | 15 | Daily Sleep Log with BSIQ |
| 4 | 14 | Dairy (log) with SSTQ |
| 1–3 | 55 | Daytime Functioning Scale |
| 4 | 13 | Diary (log) with CCTQ |
| 4 | 1 | Diary with SSHS |
| 1–3 | 40 | Dream Content Questionnaire for Children |
| 7 | 7 | Dream Habits |
| 1–3 | 36 | Dysfunctional beliefs about sleep |
| 6 | 6 | Early childhood inventory-4 |
| 1–3 | 16 | Family Inventory of Sleep Habits |
| 6 | 19 | General Health Questionnaire |
| 7 | 28 | Gozal's Questionnaire |
| 5 | 38 | HealthTracker – Sleep Symptoms Report Survey |
| 5 | 43 | Hong Kong Children Sleep Survey Questionnaire |
| 1–3 | 23 | Hong Kong children's sleep questionnaire |
| 5 | 9 | Infant sleep position |
| 5 | 10 | Infant sleep position questionnaire |
| 1–3 | 5 | Infant Sleep Questionnaire |
| 1–3 | 54 | Insomnia scale |
| 5 | 35 | Interview |
| 5 | 11 | Interview in Paret |
| 4 | 20 | Log in Paret |
| 6 | 20 | Louisville Behavior Checklist |
| 1–3 | 15 | Maternal Attitudes scale |
| 1–3 | 7 | Maternal Cognitions about Infant Sleep Questionnaire |
| 1–3 | 24 | Missouri Children's Behavior Checklist |
| 1–3 | 38 | Missouri Children's Pictures Series |
| 5 | 24 | Modified Epworth Sleepiness Scale |
| 5 | 52 | Modified Pittsburgh sleep Quality index to reflect 1 week |
| 1–3 | 42 | Morningness–Eveningness questionnaire by Crowley |
| 1–3 | 44 | Morningness–Eveningness Scale for Children |
| 4 | 23 | Nap log in Ward |
| 4 | 21 | Nursing child assessment sleep/wake activity |
| 1–3 | 4 | Obstructive Sleep Apnea-18 |
| 5 | 6 | Obstructive Sleep Apnea Syndrome expanded Childhood Questionnaire of Brouillette |
| 1–3 | 13 | Obstructive Sleep Disorders 6 – Survey |
| 6 | 7 | Parental Concern Questionnaire |
| 1–3 | 6 | Parental Interactive Bedtime Behavior Scale |
| 7 | 17 | Patient Information Questionnaire |
| 6 | 21 | Pediatric Behavior Scale |
| 6 | 13 | Pediatric Quality of Life PedsQL – self |
| 7 | 27 | Pediatric RLS Severity Scale P-RLS-SS |
| 5 | 65 | Pediatric Sleep Clinic Questionnaire (4–12 year olds) |
| 1–3 | 34 | Pediatric Sleep Disturbance Questionnaire |
| 1–3 | 14 | Pediatric Sleep Questionnaire |
| 5 | 41 | Pediatric Sleep Questionnaire-Sleepiness Subscale |
| 5 | 62 | Pediatric Sleep Survey |
| 6 | 16 | Pediatric Symptom Checklist |
| 6 | 1 | Post Hospitalization Behavior Questionnaire |
| 7 | 1 | Pediatric Sleep Questionnaire modified |
| 5 | 26 | Questionario Sognare Eta Evolutiva QEEE |
| 5 | 37 | Questionnaire by Ali |
| 7 | 20 | Questionnaire by Alves |
| 5 | 59 | Questionnaire by Billiard |
| 5 | 16 | Questionnaire by Brouillette |
| 5 | 31 | Questionnaire by Brunetti |
| 5 | 29 | Questionnaire by Castronovo |
| 5 | 92 | Questionnaire by Ersu |
| 1–3 | 26 | Questionnaire by Ferreira |
| 5 | 2 | Questionnaire by Fraser |
| 1–3 | 53 | Questionnaire by Gibson |
| 5 | 8 | Questionnaire by Gislason |
| 5 | 20 | Questionnaire by Gozal |
| 5 | 32 | Questionnaire by Hering |
| 5 | 21 | Questionnaire by Kahn |
| 5 | 46 | Questionnaire by Kahn |
| 5 | 51 | Questionnaire by Meijer |
| 5 | 33 | Questionnaire by Onodera |
| 5 | 55 | Questionnaire by Sanchez-Armengol |

(continued on next page)

Appendix (continued)

| Table | Nr. | Tool |
|-------|-----|---|
| 5 | 50 | Questionnaire by Schlaud |
| 5 | 45 | Questionnaire by Van Der Heijden |
| 5 | 54 | Questionnaire by Yamaguchi |
| 5 | 17 | Questionnaire by Zarowski |
| 5 | 12 | Questionnaire on sleep behavior in the first years of life |
| 5 | 63 | Questionnaire on sleep paralysis |
| 5 | 23 | Questionnaire-interview by Liu |
| 4 | 29 | Richman Diary |
| 7 | 3 | RLS rating scale |
| 7 | 4 | RLS/PLMD Pediatric Screening Questionnaire RPSQ |
| 7 | 13 | Schedule of Day-night Habits SDNH |
| 7 | 21 | Sleep problems of children 2–6 yrs – parent Schlafstörungen bei schulkindern – fragebogen fur eltern 2–6 |
| 7 | 22 | Sleep problems of children 6–16 yrs – parent Schlafstörungen bei schulkindern – fragebogen fur eltern 6–16 |
| 7 | 23 | Sleep problems of children 6–16 yrs – self Schlafstörungen bei schulkindern – patientenfragebogen 6–16 |
| 1–3 | 50 | School Sleep Habits Survey |
| 1–3 | 29 | SDSC-Dutch adaptation |
| 7 | 8 | Self-developed Questionnaire |
| 5 | 15 | Semi-structured interview on qualitative tradition |
| 1–3 | 32 | Sleep – Disturbance Questionnaire for School-aged Children |
| 7 | 16 | Sleep and Lifestyle Questions |
| 1–3 | 3 | Sleep and Settle Questionnaire |
| 1–3 | 30 | Sleep Behavior Questionnaire |
| 7 | 14 | Sleep Diary |
| 4 | 4 | Sleep Diary Children |
| 4 | 5 | Sleep Diary Adolescent |
| 4 | 17 | Sleep Diary in Honomichl |
| 4 | 25 | Sleep Diary in Lopez |
| 4 | 18 | Sleep Diary in Skuladottir |
| 4 | 26 | Sleep Diary in Sneddon |
| 4 | 12 | Sleep Diary in Ward |
| 1–3 | 12 | Sleep Disorders Inventory for Students – Children |
| 1–3 | 47 | Sleep Disorders Inventory for Students – Adolescents |
| 1–3 | 33 | Sleep Disturbance Scale for Children |
| 7 | 6 | Sleep Habits |
| 1–3 | 35 | Sleep Habits Questionnaire |
| 5 | 53 | Sleep Habits Survey part II |
| 7 | 12 | Sleep In Children's Hospital (SinCH) Questionnaire |
| 5 | 7 | Sleep Interview |
| 4 | 8 | Sleep length |
| 4 | 2 | Sleep Log Children |
| 4 | 3 | Sleep Log Adolescent (Rev. 9/12/02) |
| 4 | 27 | Sleep Log in Hampel |
| 4 | 22 | Sleep Log in Ward |
| 4 | 6 | Sleep Log in Warner |
| 4 | 9 | Sleep Log in Wrobel |
| 4 | 19 | Sleep observation and diary |
| 7 | 5 | Sleep Paralysis Questionnaire |
| 5 | 27 | Sleep patterns and problems Questionnaire |
| 5 | 30 | Sleep Practices Questionnaire |
| 5 | 44 | Sleep problem Checklist |
| 5 | 61 | Sleep Quality Index |
| 1–3 | 56 | Sleep Quality Scale |
| 5 | 25 | Sleep Questionnaire |
| 7 | 18 | Sleep Questionnaire by Kaditis |
| 1–3 | 25 | Sleep Questionnaire by Simonds and Parraga |
| 7 | 19 | Sleep Questionnaire by Verhulst |
| 1–3 | 52 | Sleep Questionnaire for adolescents |
| 5 | 3 | Sleep, Feeding and Crying Questionnaire |
| 1–3 | 41 | Sleepiness Scale |
| 5 | 60 | Sleepiness Subscale |
| 5 | 4 | Sleeping arrangements interview |
| 7 | 2 | Sleeping habits – descriptive data collection |
| 1–3 | 22 | Sleep-Related Breathing Disorders scale |
| 5 | 34 | Sleep-Schedule Time Questionnaire |
| 4 | 10 | Sleep-wake Diary |
| 4 | 28 | Sleep-wake Diary in LeBourgeois |
| 1–3 | 27 | Sleep-Waking Questionnaire |
| 1–3 | 57 | Spanish Pediatric Sleep Questionnaire |

Appendix (continued)

| Table | Nr. | Tool |
|-------|-----|---|
| 1–3 | 43 | Spanish version of PDSS |
| 1–3 | 39 | SSHS Modification by Bruni |
| 1–3 | 51 | SSHS Modification/translation by Giannotti |
| 5 | 57 | Structured face to face diagnostic interview with focus on sleep-disordered breathing |
| 7 | 15 | Sun Valley Pain and Sleep Center |
| 1–3 | 8 | Tayside Children's Sleep Questionnaire |
| 5 | 64 | Teacher Daytime Sleepiness Questionnaire |
| 5 | 40 | Technion Sleep Questionnaire |
| 5 | 70 | Ten Item Sleep Screener |
| 5 | 18 | Toddler Sleep Habits Questionnaire |
| 7 | 25 | Translations of Brouillette, Gozal, PSQ (Chervin), SDSC (Bruni), ESS (parent and child version), PDSS (Drake) and CSHQ (Owens, child and parent), own questionnaire |
| 7 | 11 | Treatment Evaluation Inventory-Short Form |
| 1–3 | 18 | TuCASA Screening Questionnaire |
| 5 | 13 | Video-observation |
| 5 | 58 | Visual Analogue Scale questionnaire with symptom |
| 6 | 12 | What I think and Feel |

Appendix. Supplementary data

Supplementary data associated with this article can be found in the online version, at doi:10.1016/j.smr.2010.07.005

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