Pediatric Sleep Tools: An Updated Literature Review

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Since a thorough review in 2011 by Spruyt, into the integral pitfalls of pediatric questionnaires in sleep, sleep researchers worldwide have further evaluated many existing tools. This systematic review aims to comprehensively evaluate and summarize the tools currently in circulation and provide recommendations for potential evolving avenues of pediatric sleep interest. 144 "tool"-studies (70 tools) have been published aiming at investigating sleep in primarily 6–18 years old per parental report. Although 27 new tools were discovered, most of the studies translated or evaluated the psychometric properties of existing tools. Some form of normative values has been established in 18 studies. More than half of the tools queried general sleep problems. Extra efforts in tool development are still needed for tools that assess children outside the 6-to-12-year-old age range, as well as for tools examining sleep-related aspects beyond sleep problems/disorders. Especially assessing the validity of tools has been pursued vis-à-vis fulfillment of psychometric criteria. While the Spruyt et al. review provided a rigorous step-by-step guide into the development and validation of such tools, a pattern of steps continue to be overlooked. As these instruments are potentially valuable in assisting in the development of a clinical diagnosis into pediatric sleep pathologies, it is required that while they are primary subjective measures, they behave as objective measures. More tools for specific populations (e.g., in terms of ages, developmental disabilities, and sleep pathologies) are still needed.

Keywords: sleep duration, sleep quality, sleep hygiene, questionnaire, child, review

INTRODUCTION

There is significant power in the efficiency and cost-effective nature of questionnaires and surveys as contributors to aetiological discoveries of a wide range of medical disorders. These instruments however, do not always possess the objective nature of medically advised and established tools, e.g., polysomnography, and can become a hindrance to adequate diagnoses, particularly when neglecting recommendations of their development (1). Despite these problems, there has been considerable effort to transform the structure of health questionnaires, specifically in the field of pediatric sleep, to reflect a systematic approach of the highest concordance to medical diagnostic standards.

Abbreviations: AAP, American Academy of Pediatrics; ADHD, attention deficit hyperactivity disorder; ASDC, Association of Sleep Disorders Centers classification; DSM, Diagnostic and Statistical Manual of Mental Disorders; ICD, International Classification of Diseases; ICSD, International Classification of Sleep Disorders; PSG, polysomnography; RLS, Restless Legs Syndrome; ROC, Receiver Operating Characteristic curve.
The systematic review by Spruyt et al. (2, 3) in 2011, publicly summarized the shortcomings of questionnaires and their developmental standards while advising a thorough procedure in which to follow to adequately evaluate or develop a tool.

Since this time, a variety of tools have been established, both adhering to and overlooking the recommended steps. More detailed information on the 11 steps can be found in Spruyt et al. (3). Briefly, Step 1 is to reflect on the variable(s) of interest and targeted sample(s). Step 2 is to consider the research question that the instrument will be used to address. Thus, the goal of this step is to reflect on whether the tool will be suitable to collect the type of data required to address your hypothesis. Steps 3 (response format) and Step 4 (items) build on the two preceding steps. They allow us to reflect not only on “which” questions and “which” answers assess the variable(s) of interest, but also on “how” a question is formulated and “how” it can be answered. The common goal of steps 1–4 is that we want the underlying “concepts” and/or “assumptions” contained in the questions, such as language (e.g., jargon), meaning and interpretation of the wording to be identically understood by all respondents. Getting as close as this ideal as possible will minimize errors of comprehension and completion. Step 5 involves piloting of your drafted tools. Piloting also prevents disasters with the actual data collection. In fact, Steps 2–5 should be an iterative process, meaning that we do them repeatedly, until a consensus has been reached among experts and/or respondents.

Steps 6 and 7 are about assessing the reliability and validity, respectively. Reliability does not imply validity, although a tool cannot be considered valid if it is not reliable! Several statistical, or psychometric, tests allow us to assess a tool’s reliability and validity (cfr. textbooks written on this topic). For instance, validation statistics of the tool may involve content validity, face validity, criterion validity, concurrent validity or predictive validity. Step 10 is about verifying the stability, or robustness, of the aforementioned steps. It is the step in which you assess the significance, inference, and confidence (i.e., minimal measurement error) of your tool, using the sample(s) for which it was designed. Step 11 involves standardization and norm development, allowing large-scale usage of your tool.

This review aims to conclude the trends associated with these questionnaires, and reinforce the importance of certain stages of tool development and highlight the direction of research that would be ideal to follow.

MATERIALS AND METHODS

To achieve consistency and retrieve relevant studies to the Spruyt (2, 3) review, the search terms(*) and databases were mirrored; “Sleep” AND (“infant” OR “child” OR “adolescent”) AND (“questionnaire,” “instrument,” “scale,” “checklist,” “assessment,” “log,” “diary,” “record,” “interview,” “test,” “measure”). The databases included PubMed, Web of Science (WOS), and EBSCOHOST (per PRISMA guidelines). Additional limitations to the search criteria were applied for date and age range of the respective study populations. Database-wide searches were conducted between 18th of April 2010 (Spruyt, 2011 publication date of search) and 1st of January 2020. Age categories listed in PubMed filters between 0 and 18 years were also applied to restrict the search to pediatric populations alone. Contrastingly, language criteria were not specified but post hoc constrained to English. Papers in other languages could not be evaluated by one of the authors, in case a consensus on the psychometric evaluation was needed. The search for relevant studies extended to authors in listserver groups PedSleep2.0 and the International Pediatric Sleep Association (IPSA) in order to achieve maximal inclusion. The refinement of these study characteristics ensured that the systematic review would evaluate relevant studies in pediatric tool development, adaptation, and validation. Final search count was sizeable (refer to Figure 1).

Full-text access was achieved through the literary database “Library Genesis” or author contact if necessary (see Acknowledgments). All flagged citations were then manually screened for relevant keywords in their respective titles, abstracts and methods to further refine studies relevant to the systematic review—these being 11 psychometric steps (2, 3) and 7 sleep categories (sleep quantity, sleep quality, sleep regularity, sleep hygiene, sleep ecology, and sleep treatment) (4). Consequently, independent studies were highlighted and screened, and each study’s descriptive variables were extracted and collated. Any absence of indispensable information regarding the tools use was addressed through contact of authors.

Statistical Analysis

A total of 11 steps (2) and 7 sleep categories (4) were extracted and were statistically analyzed for frequency and descriptive assessment (refer to Tables 1 and 2). Any variables unmentioned or neglected were described as “empty,” and tabulated as such in the forthcoming interpretations. Continuous variables will be described as mean values (+ standard deviation) and categorical variables will be shown as absolute and relative values. Statistical analyses were performed with Statistica version 13 (StatSoft, Inc. (2009), STATISTICA, Tulsa, OK).

RESULTS

Studies Included

As described by Figure 1, the total number of studies generated from the database search was sizeable, at n=341. Key emphasis of a pediatric diagnostic tools’ use, development or validation deemed it eligible for review, as well as the general translation and consequent adaptation of any pediatric questionnaire, survey, log, diary, etc. The titles and abstracts of each report
were screened accordingly, resulting in the omission of 193 articles and final inclusion of 144 articles. Exported abstracts were then assigned their respective full-text. Complete text access was not available for 14, while retrieved from either the literature database “Library Genesis” or via author permission (n=4, see Acknowledgments), leaving 144 or 70 tools eligible for review based on the search conducted.

A more thorough examination of methodological processes was then executed to reveal categories to which each article was suitably assigned for ease of future assessment (refer to Table 1): “New Development (N),” “Psychometric Analysis (P),” and “Translation (T)/Adaptation (A),” or a combination thereof. Each paper was assigned to the appropriate criteria; “Development” if the report’s main purpose was to produce an unprecedented tool, “Psychometric Analysis” if the explicit objective was to assess the reliability and validity of said tool, and “Translation and/or Adaptation” for all studies that in any way translated or altered a tool to suit a specific population, culture, and/or nation. Overall (Table 2), 36.8% of the studies aimed to merely psychometrically evaluate a pediatric sleep tool, while 9% additionally translated it. 24.3% of the studies aimed to independently translate while 4.2% additionally adapted their tool. As for lone adaptations, there were 4.2% of studies that performed this, while 18.8% created an entirely new tool. 1.4% of the studies conducted both a new tool development and translation and alike, 0.7% of studies adapted their new tool to particular population, culture, or other.

Study Characteristics

The structural organization and publication features of each study are detailed in Table 1. In the Appendix are the acronyms for each tool reviewed. Since the 2011 Spruyt review on pediatric diagnostic and epidemiological tools, approximately 144 “tool”-studies have been published. The focus into pediatric tool evaluation peaked in 2014 where 16.7% of all studies were conducted, closely followed by 2017 (13.9%), and 2016 and 2019, each at 13.2% as well as 2015 at 12.5%. As for the remaining years of this decade, between 2010 and 2014, 2018, the percentage of total studies published ranged from 0.7%–9.7% (n=1–10) per year. Over a third of the total studies were published in Europe (38.9%), followed by North America (25%), Asia (18.1%), Middle East (2.8%), South America (7.6%), Australia and Oceania (6.3%), and the United Kingdom (1.4%).

Across all 144 studies evaluated, it was evident that sleep tools were predominantly developed and evaluated for a combination of children and adolescents between the ages of 6–18 years (27.1%), followed closely by tools for preschool-aged children (2–5 years) at 22.2% and children 6–12 years alone at 16.7%. Only 10 studies covered the 0–18 years age range, and one did not define its range (82). Meanwhile, only 5.6% of all the studies assessed tools for preschool-aged children (2–5 years) alone and 1.4% for infants (0–23 months) alone. As for the studies remaining, a combination of age ranges was investigated with the most predominant combination being both preschool children and children (ages of 2–12 years) at 8.3% of the total studies. The
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|--------------------|-------|------------|-----------|----------------------------|-----------------|
| AIS (5)      | Chung        | 2011 | Hong Kong, China| 1,516       | 12–19       | 8                  | three-point Likert | self | in the last month | no              | 1,2,4,5,6,7,8,9 |
| ASHS (6)     | Storfer-Isser| 2013 | Boston, USA     | 514         | 16–19       | 32                 | six-point ordinal | self | in the past month | no              | 1,2,6,7,8,9,10 |
| ASHS (7)     | de Bruin     | 2014 | Amsterdam, Netherlands | 186 normal and 112 insomnia | 12–19 | 28 | six-point rating | self | in the past month | yes          | 1,2,8,9 |
| ASHS (8)     | Chehri       | 2017 | Basel, Switzerland | 1,013       | 12–19       | 24                 | six-point rating | self | in the past month | no              | 1,2,4,6,7,8,9,10 |
| ASHS (9)     | Lin          | 2018 | Qazvin, Iran    | 389         | 14–18       | 24                 | six-point rating | self | in the past month | no              | 1,2,4,5,6,7,8,9,10 |
| ASQ (10)     | Arroll       | 2011 | Auckland, New Zealand | 36         | >15          | 30 | mixed | mixed | mixed | yes          | 1,2,3,4,5,6,9 |
| ASWS (11)    | Sufrinko     | 2015 | north Carolina, USA | 467       | 12–18       | 10                 | self | no | 1,2,6,7,8,9,10 |
| ASWS (12)    | Essner       | 2015 | Seattle, USA    | 491         | 12–18       | 28                 | six-point Likert | self | previous month | no              | 1,2,7,8,9 |
| BEARS (13)   | Bastida-Pozuelo | 2016 | Murcia, Spain  | 60          | 2–16        | 7                  | yes/no | parent | no | 1,2,4,6,9 |
| BEDS (14)    | Ebenson      | 2017 | Ohio, USA       | 30          | 6–17        | 28                 | five-point Likert | parent | in last 6 months | no              | 1,2,6,8,9 |
| BISQ (15)    | Casanello    | 2018 | Barcelona, Spain| 87          | 3–30 months | 14                 | mixed | parent | yes | 1,2,4,5,6,8,9 |
| BRIAN-K (16) | Berny        | 2018 | Porto Alegre, RS, Brazil | 373        | 7–8         | 17                 | three-point Likert | parent | in the last 15 days | yes | 1,2,3,4,5,6,7,8,9 |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|---------------------|-------|-------------|-----------|----------------------------|----------------|--------------------------|
| CAS-15 (17)  | Goldstein    | 2012 | New York, USA   | 100         | 2–12        | 15                  | mixed | clinician   | yes       | all steps except 10       |                 |
| CBCL (18)    | Becker       | 2015 | Cincinnati, OH, USA | 383         | 6–18        | 7 sleep items       | three-point Likert | parent/self | no         | 1,2,6,8,9                  |                 |
| CCTQ (19)    | Dursun       | 2015 | Erzurum, Turkey | 101         | 9–18        | 27                  | mixed | parent      | on work and free days | no         | 1,2,6,8,9                  |                 |
| CCTQ (20)    | Ishihara     | 2014 | Tokyo, Japan    | 346         | 3–6         | 27                  | mixed | parent      | on work and free days | no         | 1,2,6,8,9                  |                 |
| CCTQ (21)    | Yeung        | 2019 | Hong Kong, China| 555         | 7–11        | 27                  | mixed | parent      | no         | 1,2,3,4,5,6,8,9            |                 |
| CRSP (22)    | Cordts       | 2016 | Kansas, USA     | 155         | 9.82        | 62                  | self  | no          | 1,2,6,7,9,10              |                 |
| CRSP (23)    | Meltzer      | 2013 | Denver, Colorado, USA | 456         | 8–12        | 60                  | mixed | self        | mixed     | yes                       | 1,2,4,8,9,10   |                 |
| CRSP (24)    | Meltzer      | 2014 | Denver, Colorado, USA | 570         | 13–18       | 76                  | mixed | self        | mixed     | no                       | 1,2,4,7,8,9,10 |                 |
| CRSP (25)    | Steur        | 2019 | Amsterdam, Netherlands | n= 619 general | 7–12        | 26 (total score on 23) | three-point Likert | self | one week | no (English items listed) | 1,4,7,8,9,10,11 |                 |
| CRSP-S (26)  | Meltzer      | 2012 | Denver, Colorado, USA | 388         | 8–12        | 5                   | 5-point rating | self  | no         | 1,2,6,7,8,9,10             |                 |
| CSAQ (27)    | Chuang       | 2016 | Taichung, Taiwan | 362         | 8–9         | 44                  | four-point Likert | parent | no         | all steps except 11       |                 |
| CSHQ (28)    | Markovich    | 2015 | Halifax, Canada  | 30          | 6–12        | 45 (33 scored question) | three-point Likert | parent | in the previous week | no         | 1,2,8,9                  |                 |
| CSHQ (29)    | Dias         | 2018 | Braga, Portugal  | 299         | 2 weeks–12 months | 48                  | four-point Likert | parent | mixed      | yes                    | 1,2,4,5,6,7,8,9 |                 |
| CSHQ (30)    | Ren          | 2013 | Beijing, China   | 912         | 6–12        | 33                  | three-point Likert | parent | no         | 1,2,6,7                   |                 |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|----------------|-------------|-------------|---------------------|-------|-------------|-----------|----------------------------|-----------------|
| CSHQ (31)    | Liu          | 2014 | Chengdu, China  | 3,324       | 3–6         | 33                  | three-point Likert  | parent     | a typical week            | no              | 1,2,6,7,8,9,10          |
| CSHQ (32)    | Tan          | 2018 | Shanghai, China | 171         | 4–5         | 33                  | three-point and four-point Likert | parent   | no                          | 1,2,6,7,8,9,10  |
| CSHQ (33)    | Waumans      | 2010 | Amsterdam, Netherlands | 1,502       | 5–12        | 33                  | four-point Likert   | parent     | no                          | 1,2,4,5,6,7,8,10 |
| CSHQ (34)    | Steur        | 2017 | Amsterdam, Netherlands | 201         | 2–3         | 33                  | three-point Likert  | parent     | 1-week                     | no              | 1,2,4,6,7,8,10,11    |
| CSHQ (35)    | Mavroudi     | 2018 | Thessaloniki, Greece | 112         | 6–14        | 45                  | four-point Likert   | parent     | a “common” recent week     | no              | 1,2,8,9                  |
| CSHQ (36)    | Johnson      | 2016 | Florida, USA     | 310 (177+34+99) | 2–10       | 33                  | a 1–3 rating + yes/no | parent | no                          | 1,2,6,7,8            |
| CSHQ (37)    | Sneddon      | 2013 | Vancouver, BC, Canada | 105         | 2–5         | 33                  | three-point Likert  | mother     | no                          | 1,2,6,7,8,9        |
| CSHQ (short) (38) | Masakazu | 2017 | Tokyo, Japan      | 178; 432; 330 | 6–12        | 19                  | three-point rating  | parent     | a typical recent week      | no              | 1,2,3,4,5,6,8,9,10     |
| CSHQ (39)    | Schlarb      | 2010 | Tübingen, Germany | 298:45      | 4–10        | 48                  | three-point + yes/no | parent     | no                          | 1,2,4,6,7,8,9      |
| CSHQ (40)    | Silva        | 2014 | Lisbon, Portugal  | 315         | 2–10        | 33                  | three-point rating  | parent     | a recent more typical week | no              | 1,2,4,5,6,7,8,9       |
| CSHQ (41)    | Lucas-de la Cruz | 2016 | Cuenca, Spain | 286         | 4–7         | 33                  | three-point rating  | parent     | no                          | 1,2,4,6,7,8,9      |
| CSHQ (42)    | Falahzadeh   | 2015 | Kashan, Iran     | 300         | 5–10        | 33                  | three-point rating  | parent     | no                          | 1,2,4,5,6,7,8,9  |
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|--------------------|-------|-------------|-----------|--------------------------------|-----------------|
| CSHQ (43)    | Loureiro     | 2013 | Lisbon, Portugal | 574         | 7–12        | 26                 | three-point Likert | parent | no          | 1,2,4,5,6,8,9               |
| **setting**: community and clinical samples |
| CSHQ (short) (44) | Bonuck | 2017 | Boston, Massachusetts | 151,218 | 4–10; 24–66 months | 23 | parent | no | 1,2,6,9 |
| **setting**: clinic sample data (two datasets were reused for this study: Owens (1997/8) and Goodlin-Jones (2003-5), respectively) |
| CSHQ (14) | Esbensen | 2017 | Cincinnati, OH, USA | 30 | 6–17 | 33 | three-point Likert | parent | no | 1,2,6,8,9 |
| **setting**: community-based study in children with Down syndrome |
| CSM (45) | Jankowski | 2015 | Warsaw, Poland | 952 | 13–46 | 13 | mixed | self | yes | 1,2,4,6,8,9 |
| **setting**: residents from Warsaw and Mielec districts |
| CSRQ (46) | Dewald | 2012 | Amsterdam, Netherlands | 166; 236 | 12.2–16.5; 13.3–18.9 | 20 | ordinal response categories ranging from 1 to 3 | self | previous 2 weeks | no | 1,2,4,6,7,8,10 |
| **setting**: five high schools in and around Amsterdam and from five high schools in Adelaide and Outer Adelaide |
| CSRQ (47) | Dewald-Kaufmann | 2018 | Amsterdam, Netherlands | 298 | | 20 | ordinal response categories ranging from 1 to 3 | self | previous 2 weeks | no | 1,2,9,11 |
| **setting**: participants were recruited from high schools around Amsterdam; referred to the Centre for Sleep–Wake Disorders and Chronobiology of Hospital Gelderse Vallei in Ede, the Netherlands; adolescents who received cognitive behavioural therapy for their sleep onset and maintenance problems (see de Bruin et al) |
| CSWS (48) | LeBourgeois | 2016 | Boulder, CO, USA | 161; 485; 751; 55; 85 | 2–8 (different across studies) | 25 (different across studies) | four-point Likert | parent | no | all steps except 11 |
| **setting**: 5 studies with independent samples (different across studies) |
| DBAS (49) | Lang | 2017 | Basel, Switzerland | 864 | 17.9 | 16 | 10-point Likert | self | no | 1,2,4,6,7,8,9,10 |
| **setting**: students in vocational education and training; in a classroom setting |
| DBAS (50) | Blunden | 2012 | Queensland Australia | 134 | 11–14 | 10 | mixed | self | no | 1,2,3,4,5,6,7,8,9 |
| **setting**: From sleep education intervention |
| ESS (51) | Krishnamoorthy | 2019 | Puducherry, India | 789 | 10–19 | 8 | four-point Likert | self | no | all steps |
| **setting**: villages of rural Puducherry, a union territory in South India |
| ESS (52) | Crabtree | 2019 | Memphis, Tennessee | 66 | 6–20 | 8 | four-point Likert | self | in various everyday situations | no | 1,2,8,9,11 |
| **setting**: children and young adults (ages 6 to 20 years) were assessed by the M-ESS after surgical resection, if performed, and before proton therapy |
| ESS-CHAD (53) | Janssen | 2017 | Victoria, Australia | 297 | 12–18 | 8 | four-point Likert | self | thinking of the last two weeks | no | 1,2,6,7,8,9,10 |
| **setting**: Part of a broader research project; schools in regional Victoria (Qualtrics survey) |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|--------------------|-------|------------|-----------|-----------------------------|----------------|
| FoSI (54)    | Brown        | 2019 | Washington, DC, USA | 147         | 14–18       | 11                 | five-point Likert | self      | last month  | no            | 1,2,6,7,8,9,10 |
| setting: two school-based health centers in the Washington Metropolitan Area |
| I SLEEPY (55) | Kadmon       | 2014 | Ontario, Canada  | 150         | 3–18        | 8                  | yes/no | parent/self | yes        | 1,2,4,5,6,9 |
| setting: referred for evaluation at a pediatric sleep clinic |
| IF SLEEPY (55) | Kadmon       | 2014 | Ontario, Canada  | 150         | 3–18        | 8                  | yes/no | parent/self | yes        | 1,2,4,5,6,9 |
| setting: referred for evaluation at a pediatric sleep clinic |
| I'M SLEEPY (55) | Kadmon       | 2014 | Ontario, Canada  | 150         | 3–18        | 8                  | yes/no | parent/self | yes        | 1,2,4,5,6,9 |
| setting: referred for evaluation at a pediatric sleep clinic |
| ISI (5)      | Chung        | 2011 | Hong Kong, China | 1,516       | 12–19       | 8                  | five-point Likert | self      | in last 2 weeks | no            | 1,2,4,5,6,7,8,9 |
| setting: three schools with different levels of academic achievement |
| ISI (56)     | Kanstrup     | 2014 | Solna, Sweden    | 154         | 10–18       | 5                  | five-point rating | self      | past 2 weeks  | no            | 1,2,4,6,8,9 |
| setting: patients with chronic pain referred to a tertiary pain clinic upon first visit |
| ISI (57)     | Gerber       | 2016 | Basel, Switzerland | 1,475 adolescents, 862 university students and 533 adults | 11–16 | 7 | eight-point Likert | self      | yes | 1,2,4,6,7,8,9,10 |
| setting: 3 cross-sectional studies; via schools |
| JSQ (58)     | Kuwada       | 2018 | Osaka, Japan     | 4,369; 100  | 6–12        | 38                 | mixed (6 point intensity rating) | parent | no | 1,2,7,8,9,10,11 |
| setting: 17 elementary schools; 2 pediatric sleep clinic |
| JSQ (preschool) | Shimizu     | 2014 | Osaka, Japan     | 2,998;102   | 2–6         | 39                 | six-point Likert | parent | no | 1,2,4,6,7,8,9,11 |
| setting: private kindergarten, nursery school, and recipients of regular physical examinations at the age of 3 years; two pediatric sleep clinics |
| LSTCHQ (60)  | Garmy        | 2012 | Lund, Sweden     | 116 child respondents; 44 parent respondents | 6–13 | 11 | mixed | parent/self | yes | 1,2,4,5,8,9 |
| setting: school-based distriution |
| MCTQ (61)    | Roenneberg   | 2003 | Basel, Switzerland | 500 (142 being <21 years) | 6–18 | 9 | seven-point rating; mixed | self | free/work days | yes | 1,2,5,6 |
| setting: distributed in Germany and Switzerland in high schools, universities, and the general population. This paper was added because of its relevance despite being outside the timeframe of the current review |
| MEQ (62)     | Cavallera    | 2015 | Milan, Italy     | 292         | 11–15       | 17                 | self | no | 1,2,4,5,7,8,9 |
| setting: convenience school-based samples |
| (r)MEQ (63)  | Danielsson   | 2019 | Uppsala, Sweden  | 671         | 16–26       | 5                  | self | no | 1,2,6,7,8,9 |
| setting: selected randomly from the Swedish Population Register |
| aMEQ (64)    | Rodrigues    | 2016 | Aveiro district, Portugal | 300         | 12–14       | 19                 | mixed | self | no | 1,2,4,5,6,8,9,11 |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|---------------------|-------|-------------|-----------|----------------------------|-----------------|
| aMEQ-R (65) | Rodrigues    | 2019 | Aveiro district, Portugal | n1=300 (same 2016), n2= 217 | 12–14 | 10 | mixed | self | no | 1,2,4,5,6,8,9,11 |
| setting: several schools of the Aveiro district |
| MESC (66) | Díaz-Morales | 2015 | Madrid, Spain | 5,387 | 10–16 | | self | no | 1,2,4,6,7,8,9,10 |
| setting: public high schools in Madrid and the surrounding area |
| MESSi (67) | Demirhan     | 2019 | Sakarya, Turkey | 1,076 | 14–47 | 15 | five-point Likert | self | yes | 1,4,5,7,8,9,10 |
| setting: high school and university students |
| MESSi (68) | Weidenauer   | 2019 | Tuebingen, Germany | 215 | 11–17 | 15 | five-point Likert | self | yes | 1,6,8,9,10 |
| setting: three different gymnasia (highest stratification level of school teaching) in SW Germany, Baden-Wuerttemberg |
| My Sleep and I (69) | Rebelo-Pinto | 2014 | Lisbon, Portugal | 654 | 10–15 | 27 | five-point Likert | self | no | 1,2,3,4,7,8,9,10 |
| setting: schools in Portugal part of project Sleep More to Read Better |
| My children's sleep* (69) | Rebelo-Pinto | 2014 | Lisbon, Portugal | 612 | 21–68 | 27 | five-point Likert | parent | no | 1,2,3,4,7,8,9,10 |
| setting: schools in Portugal part of project Sleep More to Read Better |
| NARQoL-21 (70) | Chaplin      | 2017 | Gothenburg, Sweden | 158 | 8–13; 15–17 | 21 | five-point Likert | self | no | all steps |
| setting: patient and control group |
| NSD (71) | Yoshida       | 2011 | Tochigi, Japan | 40 | 6 months–6 years | 2 | | parent | diary | yes | 1,2,3,4,5,6 |
| setting: take home diary |
| NSS (72) | Ouyang       | 2019 | Beijing, China | n=53 pediatric n= 69 adult | 2–6 years | 15 | | | no | 1, 2, 7, 8, 9 |
| setting: sleep lab |
| OSA Screening Questionnaire (73) | Sanders | 2015 | Southampton, UK | infancy to 6 years | | 33 | | parent | over a week | yes | 1,2,3,4,5,6,9 |
| setting: via a local Down syndrome parent support group |
| OSA-18 Questionnaire (74) | Huang | 2015 | Hsinchu, Taiwan | 163 | 6–12 | 18 | seven-point ordinal | parent | past 4 weeks | yes (English) | 1,2,4,7,8,9,10 |
| setting: via schools |
| OSA-18 Questionnaire (75) | Kang | 2014 | Taipei, Taiwan | 109 | 2–18 | 18 | seven-point ordinal | parent | yes | 1,2,4,6,8,9 |
| setting: recruited from the respiratory, pediatric, psychiatric, and otolaryngologic clinics |
| OSA-18 Questionnaire (76) | Bannink    | 2011 | Rotterdam, Netherlands | 119 patients; 162 (child);459 parent | 2–18 | 18; OSA-12 in children, OSA-18 in parents | seven-point ordinal | parent/self | yes | 1,2,4,6,8,9 |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|---------------------|-------|-------------|-----------|----------------------------|----------------|
| OSA-18 Questionnaire (77) | Mousailidis | 2014 | Athens, Greece | 141 | 3–18 | 18 | seven-point ordinal | parent | yes | 1,2,4,6,8,9 |
| setting: patients with syndromic craniosynostosis; convenience sample of parents |
| OSA-18 Questionnaire (78) | Fernandes | 2013 | Guimarães, Portugal | 51 | 2–12 | 18 | seven-point ordinal | parent | past 4 weeks | yes (English) | 1,2,4,5,6,8,9 |
| setting: children who were referred for overnight polysomnography at the Sleep Disorders Laboratory |
| OSA-18 Questionnaire (79) | Chiner | 2016 | Alicante, Spain | 60 | 2–14 | 18 | seven-point ordinal | parent | 4 weeks | yes | 1,2,4,6,7,8,9 |
| setting: children with suspected apnea-hypopnea syndrome were studied with polysomnography |
| OSA-5 Questionnaire (short) (80) | Soh | 2018 | Melbourne, Australia | 366 and 123 | 2–17.9 | 5 | four-point Likert | parent | past 4 weeks | yes | all steps except 11 |
| setting: Melbourne Children’s Sleep Centre for polysomnography |
| OSD-6 QoL Questionnaire (81) | Lachanas | 2014 | Larissa, Greece | 91 | 3–15 | 6 | seven-point ordinal | parent | yes (Greek and English) | 1,2,4,5,6,8,9 |
| setting: children undergoing polysomnography |
| OBD and AT (82) | Links | 2017 | Baltimore, USA | 32 | 39 | three-point rating | parent | yes | 1,2,4,6,8,9 |
| setting: via online Questionnaire |
| OSPQ (83) | Biggs | 2012 | Adelaide, Australia | 1,904 | 5–10 | 26 | four-point Likert | parent | last typical school week | no | 1,2,4,5,6,7,8,10,11 |
| setting: via 32 elementary schools in Adelaide |
| PADSS (84) | Arnulf | 2014 | Paris, France | 73; 98 | >15 | 17 | self | no | 1,2,3,4,5,6,7,8,9 |
| setting: patients with sleepwalking or sleep terror referred to the sleep disorder unit; controls |
| PDSS (85) | Felden | 2015 | Curitiba, Brazil | 90 | 10–17 | 8 | five-point Likert | self | yes | 1,2,4,5,8,9 |
| setting: two private schools |
| PDSS (86) | Komada | 2016 | Tokyo, Japan | 492 | 11–16 | 8 | self | no | 1,2,4,5,6,7,8,9 |
| setting: one elementary school, one junior high school and one high school, located in suburbs of Japan |
| PDSS (87) | Bektas | 2015 | Izmir, Turkey | 522 | 5–11 | 8 | four-point Likert | self | no | 1,2,4,5,6,7,8,9,10 |
| setting: students were in grade 5-11 |
| PDSS (88) | Ferrari Junior | 2018 | Florianópolis, SC, Brazil | 773 | 14–19 | 8 | five-point Likert | self | no | 1,7,8,9,10 |
| setting: state schools of Paranaguá, Paraná |
| PDSS (89) | Randler | 2019 | Petrozavodsk, Russia | n1 = 285 | n2 = 267 | n3 = 204 | 7–12 | five-point Likert | self | yes | 1,2,4,5,6,7,8,9,10 |
| setting: Schools from six different settlements located in North-Western Russia (Murmansk region) participated in the study during our framework project “Sleep Health in Russian Arctic” |
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|--------------------|-------|-------------|-----------|----------------------------|----------------|
| Pediatric Sleep CGIs (90) | Malow | 2016 | Nashville, USA | 20 | 5.3 | 14 | seven-point rating | parent | yes (link) | 1,2,4,5,6,9 |

setting: participants in a 12-week randomized trial of iron supplementation in children with autism spectrum disorders

| PedsQL (fatigue scale) | Al-Gamal | 2017 | Amman, Jordan | 70 | 5–18 | 18 | three- and five-point Likert | self | no | 1,2,4,5,6,8,9 |

setting: oncology outpatient clinic

| PedsQL (fatigue scale) | Qimeng | 2016 | Guangzhou, China | 125 | 2–4 | 18 | five-point Likert | parent | no | 1,2,4,5,6,7,8,9 |

setting: diagnosed to have acute leukemia for 1 month at the least

| PedsQL (fatigue scale) | Nascimento | 2014 | São Paolo, Brazil | 216; 42 children (8–12 years), 68 teenagers (13–18 years), and 106 caregivers (parents or guardians) | 8–18 | 18 | five-point Likert | parent/self | no | 1,2,4,6,7,8,9,10 |

setting: oncology inpatient and outpatient pediatric clinics

| PIISI (94) | Byars | 2017 | Cincinnati, OH, USA | 462 | 4–10 | 6 | six-point Likert | parent | yes | 1,2,4,6,7,8,9,10 |

setting: behavioral sleep medicine evaluation clinic

| PNSS (95) | Whiteside-Mansell | 2017 | Little Rock, Arkansas, USA | 72 | 1 week to 28 weeks | 14 | four-point scale | professional | no | 1,2,8 |

setting: a naturalistic study of participants enrolled in two home visitation support programs

| PosaST (96) | Pires | 2018 | Porto Alegre, Brazil | 60 | 3–9 | 6 | five-point rating | self | yes | 1,2,4,5,8,9 |

setting: children undergoing polysomnography

| PPPS (97) | Finimundi | 2012 | Porto Alegre, Brasil | 144 | 10–17 | mixed | five-point rating | self | no | 1,2,9 |

setting: adolescent students attending elementary school in two public schools in the state of Rio Grande do Sul (municipalities of Esteio and Farroupilha – great Porto Alegre, and Serra Gaúcha)

| P-RLS-SS (98) | Arbuckle | 2010 | Cheshire, United Kingdom | | 6–17 | | cognitive debriefing interviews with 21 of the same children/adolescents and 15 of their parents | | no | 1,2,4,5,6 |

setting: four pediatric sleep disorders specialists

| PROMIS (99) | van Kooten | 2016 | Amsterdam, Netherlands | 6 experts, 24 adolescents and 7 parents | 12–18 | 27 (PROMIS-SD), 16 (PROMIS-SR) | through Computerized AdapTive Testing | self/parent/expert | no | 1,2,9 |

setting: distributed to the adolescents in the classroom

| PROMIS (100) | van Kooten | 2018 | Amsterdam, Netherlands | 1,046 | 11–19 | 27 (PROMIS-Sleep) | Self | no | 1,2,6,7,9,10 |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|---------------------|-------|-------------|-----------|----------------------------|-----------------|
| PROMIS (101) | Forrest      | 2018 | Philadelphia, PA, USA | 1,104 children (8–17 years old) and 1,477 parents of children 5–17 years old | 5–17 | 43; the final item banks included 15 items for Sleep Disturbance and 13 for Sleep-Related Impairment | frequency-based (1: never, 2: almost never, 3: sometimes, 4: almost always, 5: always) | self/parent | 7-day | yes | 1,2,6,7,8,9,10 |
| PROMIS (102) | Bevans       | 2019 | Philadelphia, PA, USA | 8 expert sleep clinician-researchers, 64 children ages 8–17 years, and 54 parents of children ages 5–17 years | children ages 8–17 and parents of children ages 5–17 | The final item pool contains 43 child-report items and 49 parent-report items | five-point Likert | Self/Parent | In the past 7 days | yes | 1,2,3,4,5,6,9 |
| PSIS (103)   | Smith        | 2014 | Texas, USA       | 155         | 3–5         | 12                  | five-point Likert | parent | no   |   | 1,2,6,8,9 |
| PSQ (104)    | Ishman       | 2016 | Ohio, USA        | 45          | 16.7        | 22                  | yes/no/don’t know | parent | no   |   | 1,2,6,8 |
| PSQ (105)    | Yüksel       | 2011 | Manisa, Turkey   | 111         | 2–18        | 22                  | yes/no and I don’t know | parent | no   |   | 1,2,4,5,6,8,9 |
| PSQ (106)    | Bertran      | 2015 | Santiago, Chile  | 83          | 0–15        | 22                  | yes/no/don’t know | parent | no   |   | 1,2,6,7 |
| PSQ (107)    | Hasniah      | 2012 | Kuala Lumpur, Malaysia | 192:554 | 6–10 | 22 | *yes=1,* *No=0,* and "Don’t know=Missing" | parent | no |   | 1,2,4,5,6,8,9 |
| PSQ (108)    | Chan         | 2012 | Hong Kong, China | 102         | 2–18        | 22                  | yes/no/don’t know | parent | no   |   | 1,2,9,11 |

*Continued*
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|-----------------|-------------|-------------|---------------------|-------|-------------|-----------|--------------------------|----------------|
| PSQ (109)    | Ehsan        | 2017 | Cincinatti, USA | 160         | 2–18        | 22                  | yes/no/don't know | parent     | no          | 1,2,6,9                  |
| setting: underwent overnight sleep polysomnography studies for suspected OSA in the sleep laboratory |
| PSQ (110)    | Li           | 2018 | Beijing, China  | 9,198       | 3.0–14.4    | 22                  | yes/no/don't know | parent     | no          | 1,2,6,7,8,9               |
| setting: using an existing clinical database encompassing all children referred to the Cincinnati Children's Hospital Sleep Center for polysomnography |
| PSQ (111)    | Longlalerng  | 2018 | Chiang Mai, Thailand | 62         | 7–18        | 22                  | yes/no/don't know | parent     | no          | 1,2,4,5,8,9               |
| setting: 11 kindergartens, 7 primary schools and 8 middle schools from 7 districts of Beijing, China |
| PSQ (112)    | Raman        | 2016 | Ohio, USA       | 636         | 4–25.5      | 36                  | parent           | yes        | 1,2,4                  |
| setting: patients scheduled for a sleep study |
| PSQ (113)    | Certal       | 2015 | Porto, Portugal | 180         | 4–12        | 22                  | yes/no          | self       | yes        | 1,2,4,5,6,8,9               |
| setting: via schools north Portugal |
| PSQ (114)    | Jordan       | 2019 | Paris, France   | 201         | 2–17        | 22                  | *yes,* "no" or *don't know," | parent     | yes        | 1,2,4,5,6,7,8,9,10         |
| setting: clinic based retrieval classified as overweight or obese according to the International Obesity Task Force and diagnosed with obstructive sleep apnea |
| PSQ (115)    | Passos       | 2017 | Pernambuco, Brazil | 309       | 10–19       | 19                  | 0–3 rating       | self       | no         | 1,2,4,5,6,7,8,9,10         |
| setting: subjects who engaged in amateur sports practice |
| PSQ (116)    | Raniti       | 2018 | Melbourne, Australia | 889       | 12.08–18.92 | 18                  | four-point Likert scale | self       | 1 month    | no         | 1,7,8,9,10                  |
| setting: 14 Australian secondary schools |
| RLS (117)    | Schomöller   | 2019 | Potsdam, Germany | 33 (11 RLS) | 6–12 and 13–18 | 12                  | mixed           | self/parent | yes        | 1,2,3,4,6,8,9               |
| setting: with the support of medical somnologists, who recruited pediatric patients from their practice or sleep laboratories, newsletter announcements in the Restless Legs Association journal, and via local selfhelp groups. |
| SDIS (118)   | Graef        | 2019 | Cincinnati, Ohio | 392         | 2.5–18.99   | SDIS-C, 41 items, 2.5–10 years; SDIS-A, 46 items, 11–18 years | seven-point Likert scale | parent     | no         | 1,9                     |
| setting: Youth with insomnia, of whom 392 underwent clinically indicated diagnostic PSG within ± 6 months of SDIS screening |
| SDPC (119)   | Daniel       | 2016 | Philadelphia, USA | 20;6       | 3–12        | 41                  | 0–4 rating       | parent     | Interview modelling | no         | 1,2,4,6,9                  |
| setting: parents of children with acute lymphoblastic leukemia and medical providers |
| SDSC (120)   | Huang        | 2014 | Guangzhou, China | 3,525       | 5–16        | 26                  | five-point scale | parent     | six months | 1,2,4,5,6,7,8,9,10,11     |
| setting: selected from five primary schools in Shenyang |
| Tool acronym | First author   | Year | Place of origin       | Sample size | Age (years) | Number of questions | Scale                  | Respondent | Timeframe       | Reference has questionnaire | Steps fulfilled |
|--------------|----------------|------|-----------------------|-------------|-------------|---------------------|------------------------|-------------|-----------------|----------------------------|-----------------|
| SDSC* (125)  | Moo-Estrella   | 2018 | Yucatan, Mexico       | 838         | 8–13        | 25                  | number of days: 0 = 0 days, 1 = 1–2 days, 2 = 3–4 days, 3 = 5–6 days, and 4 = 7 days. | self        | during the last week | no                          | 1,2,3,4,5,6,7,8,9,10 |
| setting: between the third and sixth grades of elementary school, recruited by convenience sampling |
| SHI (126)    | Ozdemir        | 2015 | Konya, Turkey         | 106         | 16–60       | 13                  | Always, Frequently, Sometimes, Rarely, Never | self        | no                    | 1,2,6,7,8,9,10 |
| setting: university based retrieval |
| SHIP (127)   | Rabner         | 2017 | Boston, USA           | 1,078       | 7–17        | 15                  | three-point Likert    | parent/self | no                       | 1,2,6,8,9 |
| setting: parents and children each completed questionnaires individually within 1 week prior to the child’s multidisciplinary headache clinic evaluation |
| Sleep Bruxism (128) | Restrepo   | 2017 | Medellin, Colombia    | 37          | 8–12        | 1                   | yes/no                 | parent      | 5-day diary       | yes (English)           | 1,2,4 |
| setting: recruited from the clinics at Universidad CES |
| SNAKE (129)  | Blankenburg    | 2013 | Datteln, Germany      | 224         | <10         | 54                  | 1–4 rating (mixed)    | parent      | yes (English)     | all steps                |                       |
| setting: children with severe psychomotor impairment; questionnaire-based, multicenter, cross-sectional survey |
| SQI (5)      | Chung          | 2011 | Hong Kong, China      | 12–19       | 8           | three-point Likert  | self                   | in past 3 months | no                          | 1,2,4,5,6,7,8,9,10 |
| setting: three schools with different levels of academic achievement |
| SQ–SP (130)  | Maas           | 2011 | Maastricht, Netherlands| 345         | 1–66        | 45                  | seven-point Likert    | parent      | last three months | yes                          | 1,2,6,7,8,9,10 |

(Continued)
| Tool acronym | First author | Year | Place of origin | Sample size | Age (years) | Number of questions | Scale | Respondent | Timeframe | Reference has questionnaire | Steps fulfilled |
|--------------|--------------|------|----------------|-------------|-------------|---------------------|-------|-------------|-----------|----------------------------|-----------------|
| SQS-SVQ (131) | Önder | 2016 | Sakarya, Turkey | 1,198 | 11–15 | 15* | self | yes | 1,2,4,7,8,9,10 |
| SRSQ (132) | van Maanen | 2014 | Amsterdam, Netherlands | 951;166;236;144;66 | 14.7 (mean) | 9 | three-point ordinal | self | previous 2 weeks | no | 1,2,6,8,9 |
| SSR (133) | Orgiles | 2013 | Alicante, Spain | 1,228 | 8–12 | 26 | three-point | self | yes | 1,2,4,6,7,8,9,10 |
| SSR (43) | Loureiro | 2013 | Lisbon, Portugal | 306 | 7–12 | 26 | three-point | self | no | 1,2,4,5,6,8,9 |
| SSSQ (134) | Yamakita | 2014 | Koshu, Japan | 58 | 9–12 | | self log | no | 1,2,8,9 |
| STBUR (135) | Tait | 2013 | Michigan, USA | 337 | 2–14 | 5 | yes/no, and don’t know | parent | yes | 1,2,3,4,6,7 |
| STQ (136) | Tremaine | 2010 | Adelaide, Australia | 65 | 11–16 | 18 | time | self | no | 1,2,9 |
| The Children’s Sleep Comic (137) | Schwerdtle | 2012 | Landau, Germany | 201 | 5–10 | 37 | tick in applicable square | self | no (examples) | 1,2,4,9 |
| The Children’s Sleep Comic (138) | Schwerdtle | 2015 | Würzburg, Germany | 176;393 | 5–11 | 20 | tick in applicable square | parent/self | no (examples) | 1,2,3,4,6,8,9,11 |
| TuCASA (139) | Leite | 2015 | São Paolo, Brazil | 62 | 4–11 | 13 | parent | yes | 1,2,4,8,9 |
| YSIS (140) | Liu | 2019 | Shandong Province, China | 11,626 | 15.0 ±1.5 | 8 | five-point Likert | self | past month | yes | 1,2,4,5,6,7,8,9,10,11 |

Steps: 1: purpose; 2: research question; 3: response format; 4: generate items; 5: pilot; 6: item-analysis, nonresponse; 7: structure; 8: reliability; 9: validity; 10: confirmatory analyses; 11: standardize and develop norms
TABLE 2 | Overview of psychometric analyses performed.

| Tool acronym | NPTA | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|------|------------------|-----------------|---------------------|------------------|----------------------|-----|--------------------------|-----------------------|-------------------|
| AIS (5)      | P    | quality          | structure       | test-retest;       | convergent/      | yes; a total score ≥7 |     |                          | original AIS developed per ICD-10 | DSM-IV-TR diagnosis of insomnia by interview |
| ASHS (6)     | P    | yes              | regularity, hygiene, ecology | structure       | internal          | confirmatory         |     |                          |                      | insomnia per DSM-IV-TR |
| ASHS (7)     | P    | yes              | regularity, hygiene, ecology | test-retest;     | internal          | confirmatory         |     |                          |                      | |
| ASHS (8)     | PT (Farsi) | yes        | regularity, hygiene, ecology | test-retest;     | internal          | confirmatory         |     |                          |                      | |
| ASHS (9)     | PT (Persian) | yes        | regularity, hygiene, ecology | test-retest;     | internal          | confirmatory         |     |                          |                      | |
| ASQ (10)     | N    | quality, sleepiness | face            |                     |                  |                      |     |                          | ICSD                  |                  |
| ASWS (11)    | P    | yes              | quantity, hygiene | structure       | internal          | confirmatory         |     |                          |                      |                  |
| ASWS (12)    | P    | yes              | quantity, hygiene | structure       | internal          | confirmatory         |     |                          |                      |                  |
| BEARS (13)   | P    | yes              | quantity, quality, sleepiness | test-retest;     | internal          | criterion            |     |                          | ICD-10 diagnoses assigned to these children, prior to the commencement of the parent group intervention were: F90, F98.2, F93.3, F80.1, F93.0, Z62 Down syndrome |
| BEDS (14)    | A    | yes              | quantity, quality, hygiene, ecology | test-retest;     | internal          | construct            |     |                          |                      |                  |
| BISQ (15)    | T (Spanish) | yes         | quantity, hygiene | test-retest;     | interrater/observer | construct            |     |                          |                      |                  |
| BRIAN-K (16) | N    | regularity, hygiene, ecology | structure       | internal          | content             |                      |     |                          |                      |                  |
| CAS-15 (17)  | P    | yes              | quality          | structure       | test-retest;     | construct            | yes; a score ≤32 |                          |                      |                  |
| CBCL (18)    | P    | yes              | quantity, quality, sleepiness | test-retest;     | internal          | construct            |     |                          | patients were diagnosed with sleep disorders according to ICSD-2 |                  |
| CCTQ (19)    | T (Turkish) | yes         | quantity, regularity | internal        | content             |                      |     |                          |                      |                  |

(Continued)
| Tool acronym | NPTA in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|----------------------|------------------|----------------|---------------------|------------------|----------------------|-----|--------------------------|-----------------------|------------------|
| CCTQ (20) P  | quantity, regularity | test-retest; internal criterion | | | | | | | | | |
| CCTQ (21) PT (Chinese) | quantity, regularity | test-retest; internal | content; construct | | | | | | | |
| CRSP (22) P  | quantity, quality, sleepiness, hygiene | test-retest; internal | construct; criterion; convergent/ discriminant | | | | | | | |
| CRSP (23) N  | quantity, quality, sleepiness, hygiene | internal | construct; criterion; convergent/ discriminant | | | | | | | |
| CRSP (24) P  | quantity, quality, sleepiness, hygiene | test-retest; internal | construct; criterion; convergent/ discriminant | | | | | | | |
| CRSP (25) PT | quantity, quality, sleepiness, hygiene | internal | convergent/ discriminant construct; criterion; convergent/ discriminant | | | | | | | |
| CRSP-S (26) P | | test-retest; internal | convergent/ discriminant construct; criterion; convergent/ discriminant | | | | | | | |
| CSAQ (27) N  | quantity, quality, sleepiness | test-retest; internal; interrater/ observer | content; construct; criterion; convergent/ discriminant | | | | | | | |
| CSHQ (29) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest | construct; criterion | | | | | | | |
| CSHQ (29) AT (Portuguese) | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest | convergent/ discriminant | | | | | | | |
| CSHQ (30) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest | convergent/ discriminant | | | | | | | |
| CSHQ (31) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest; internal | content; construct | | | | | | | |
| CSHQ (32) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest | content; construct | | | | | | | |
| CSHQ (33) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest | construct | | | | | | | |
| CSHQ (31) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest; internal | content; construct | | | | | | | |
| CSHQ (32) P  | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest | content; construct | | | | | | | |

(Continued)
| Tool acronym| NPTA in Spruyt et al. | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|------------|------------------------|------------------|----------------|---------------------|-----------------|----------------------|-----|-----------------------------|----------------------|-------------------|
| CSHQ (33)  | T (Dutch)              | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | test-retest; internal; interrater/observer internal | confirmatory |                |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (34)  | T (Dutch)              | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | test-retest; internal; interrater/observer internal | confirmatory |                |        | a mean total CSHQ score of 41.9±5.6 | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (35)  | A                      | quantity, quality, regularity, sleepiness, hygiene, ecology | internal | convergent/discriminant |                |        |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (36)  | A                      | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | internal |                |        |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (37)  | P                      | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | internal | criterion |        |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (short) (38) | A                  | quantity, quality, regularity, sleepiness, hygiene, ecology | internal | convergent/discriminant | confirmatory | yes; a total CSHQ score of ≥ 24 |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (39)  | PT (German)            | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | test-retest; content internal |                | yes; per subscale provided |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (40)  | T (Portuguese)         | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | test-retest; face internal |                |        |        |                            | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (41)  | PT (Spanish)           | quantity, quality, regularity, sleepiness, hygiene, ecology | structure | test-retest; face; content; construct |                |        |        |                            | original was designed to identify sleep problems based on ICSD-1 |

(Continued)
| Tool acronym | NPTA in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|----------------------|------------------|----------------|---------------------|------------------|----------------------|-----|---------------------------|----------------------|------------------|
| CSHQ (42)    | T (Persian)           | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest; internal | face; content; construct; convergent/ discriminant | yes; a cutoff total score of 44 | original was designed to identify sleep problems based on ICSD-1 | Down syndrome |
| CSHQ (43)    | T (Portuguese)        | quantity, quality, regularity, sleepiness, hygiene, ecology | test-retest; internal | content | yes; a cutoff total score of 30 | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (short) | A                    | quantity, quality, regularity, sleepiness, hygiene, ecology | convergent/ discriminant | | yes; a cutoff total score of 30 | original was designed to identify sleep problems based on ICSD-1 |
| CSHQ (14)    | P                    | quantity, quality, regularity, sleepiness, hygiene, ecology | construct; convergent/ discriminant | | | original was designed to identify sleep problems based on ICSD-1 |
| CSM (45)     | T (Polish)            | regularity, sleepiness | content; construct | accumulated percentile distribution | | original was designed to identify sleep problems based on ICSD-1 |
| CSRQ (46)    | T (English)           | yes quantity, regularity, sleepiness | structure internal | confirmatory | | original was designed to identify sleep problems based on ICSD-1 |
| CSRQ (47)    | P                    | quantity, regularity, sleepiness | criterion | yes; ≥35; optimal sensitivity: 27.5; optimal specificity: 50.5 | | children with Sleep- Onset Association Problems per ICSD |
| CSWS (48)    | P                    | yes quantity, regularity, sleepiness | test-retest; internal | content; construct | confirmatory | | |
| DBAS (49)    | T (German)            | quantity, quality, regularity, sleepiness | internal | content | confirmatory | | |
| DBAS (50)    | P                    | quantity, quality, regularity, sleepiness | test-retest; internal | content | confirmatory | | |
| ESS (51)     | PT (Tamil)            | yes quantity, regularity, sleepiness | structure internal | face; content; construct | confirmatory | >11 = excessive daytime sleepiness; 11-14 = moderate and >15 = high |
| ESS (52)     | P                    | sleepiness | internal | convergent/ discriminant | yes, cutoff score of 6 |
| ESS-CHAD (53)| P                    | sleepiness | structure internal | construct; criterion | confirmatory |
| FoSI (54)    | PA                   | quality | structure internal | convergent/ discriminant | confirmatory | | |
| Tool acronym | NPTA in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|----------------------|------------------|----------------|---------------------|------------------|----------------------|-----|--------------------------|-----------------------|---------------------|
| I SLEEPY (55) | N                    | quality, sleepiness | criterion     |                     |                  |                      |     | yes; those endorsing three or more symptoms or complaints on the questionnaires | DSM-IV-TR diagnosis of insomnia by interview |                    |
| IF SLEEPY (55) | N                    | quality, sleepiness | criterion     |                     |                  |                      |     | yes; those endorsing three or more symptoms or complaints on the questionnaires | chronic pain |                    |
| I'M SLEEPY (55) | N                    | quality, sleepiness | criterion     |                     |                  |                      |     | yes; those endorsing three or more symptoms or complaints on the questionnaires | partially diagnostic criteria of insomnia in DSM-IV |                    |
| ISI (56)      | P                    | quality, structure | test-retest; internal criterion; convergent/ discriminant |                  |                  |                      |     | yes; a total score ≥9 | partially diagnostic criteria of insomnia in DSM-IV |                    |
| ISI (56) T (Swedish) | quality | structure | internal criterion | | | | | | DSM-IV-TR diagnosis of insomnia by interview | |
| ISI (57) T (German) | quality | structure | internal convergent/ discriminant confirmatory | | | | | | chronic pain | |
| JSQ (58)      | P                    | quantity, quality, regularity, sleepiness, hygiene | structure internal content confirmatory | | | | | yes; 80 for total score | partially diagnostic criteria of insomnia in DSM-IV | |
| JSQ (preschool) (59) | P | quantity, quality, regularity, sleepiness, hygiene | structure internal face; criterion | | | | | yes; cutoff 84 | partially diagnostic criteria of insomnia in DSM-IV | |
| LSTCHQ (60)   | N                    | quantity, regularity, sleepiness, hygiene, ecology | test-retest face; content; construct | | | | | | | |
| MCTQ (61)     | N                    | no, therefore added here | regularity | | | | | | | |

(Continued)
| Tool acronym | NPTA | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|------|----------------|----------------------|-------------------|----------------------|-----|---------------------------|-----------------------|---------------------|
| MEQ (62)     | T (Italian) | regularity, sleepiness | structure | internal | content | | | | |
| MEQ (63)     | P | regularity, sleepiness | structure | internal | convergent/ discriminant | | | | |
| aMEQ (64)    | PT (European Portuguese) | regularity, sleepiness | internal | | | | | | |
| aMEQ-R (65)  | PA | regularity, sleepiness | internal | | content; criterion; convergent/ discriminant | | | | mean ± 1SD; percentiles 10 and 90, and the less restrictive percentiles 20/80; cut-points for the males and females aMEQ (≤45 and ≥60); aMEQ-R (≤23 and ≥33) |
| MESC (66)    | P | yes | regularity, sleepiness | structure | internal | convergent/ discriminant | confirmatory | | |
| MESSI (67)   | PT (Turkish) | regularity, sleepiness | structure | internal | face; content | | | | |
| MESSI (68)   | P | | regularity, sleepiness | internal | | convergent/ discriminant | confirmatory | | |
| My Sleep and I (69) | P | quantity, hygiene, ecology | structure | internal | convergent/ discriminant | confirmatory | | |
| My children's sleep (69) | P | quantity, hygiene, ecology | structure | internal | convergent/ discriminant | confirmatory | | |
| NARQoL-21 (70) | NT (English) | quality, sleepiness | structure | test-retest; internal | content; construct; convergent/ discriminant | confirmatory | yes; a NARQoL-21 score below 42 | | diagnostic criteria for narcolepsy according to ICSD-3 |
| NSD (71)     | NA | quality | | | | | | Asthma per Global Initiative for Asthma classification |
| NSS (72)     | AT (Chinese) | sleepiness | structure | internal | face; content | | | ICSD-3 criteria |
| OSA Screening Questionnaire (73) | N | quality | | face; content | | | | Down syndrome |
| OSA-18 Questionnaire (74) | T (Chinese) | quality | structure | test-retest; internal | construct; convergent/ discriminant | confirmatory | yes; cutoff scores ranging from 55 to 66 | OSA per ICSD 2 |
| Tool acronym | NPTA | in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|------|----------------|------------------|----------------|---------------------|------------------|---------------------|-----|-----------------------------|------------------------|-------------------|
| OSA-18       | T (Chinese) | quality | test-retest; construct; | | | | | | | | craniostenosis |
| Questionnaire (75) | | | | | | | | | | | |
| OSA-18       | T (Dutch) | quality | test-retest; internal criterion | | | | | | | | |
| Questionnaire (76) | | | | | | | | | | | |
| OSA-18       | T (Greek) | quality | test-retest; internal criterion | | | | | | | | |
| Questionnaire (77) | | | | | | | | | | | |
| OSA-18       | T (Portuguese) | quality | test-retest; internal criterion | | | | | | | | |
| Questionnaire (78) | | | | | | | | | | | |
| OSA-18       | T (Spanish) | quality | test-retest; internal criterion | | | | | | | | |
| Questionnaire (79) | | | | | | | | | | | |
| OSA-5        | A | quality | test-retest; internal criterion | | | | | | | | |
| Questionnaire (short) (80) | | | | | | | | | | | |
| OSD-6 QoL    | T (Greek) yes | quality | test-retest; internal criterion | | | | | | | | |
| Questionnaire (81) | | | | | | | | | | | |
| oSDB and AT  | N | quality, treatment | internal face; content; construct; criterion | | | | | | | | |
| (82)          | | | | | | | | | | | |
| OSPQ (83)    | N | quality, regularity, sleepiness | test-retest; internal face | | | | | | | | |
| PADSS (84)   | N | quality | test-retest; internal face; construct yes; cutoff for the overall scale was located at 13/14 | | | | | | | | sleepwalking or sleep terror per ICSD |
| PDSS (85)    | T (Brazilian Portuguese) | quantity, regularity, sleepiness | test-retest; internal content | | | | | | | | |
| PDSS (86)    | T (Japanese) | quantity, regularity, sleepiness | test-retest; internal content | | | | | | | | |
| PDSS (87)    | T (Turkish) | quantity, regularity, sleepiness | test-retest; internal content | | | | | | | | |
| PDSS (88)    | P | quantity, regularity, sleepiness | test-retest; internal content | | | | | | | | |
| PDSS (89)    | PAT (Russian) | quantity, regularity, sleepiness | test-retest; internal face; content | | | | | | | | |
| Pediatric Sleep CGIs (90) | N | quantity, hygiene, ecology | convergent/discriminant | | | | | | | | |
| Autism Spectrum Disorders (91) | | | | | | | | | | | |
| Tool acronym | NPTA in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|-----------------------|------------------|-----------------|---------------------|------------------|----------------------|-----|--------------------------|-----------------------|--------------------|
| PedsQL (fatigue scale) (91) | AT (Arabic) | sleepiness | internal | content; construct; convergent/discriminant | | | | | cancer |
| PedsQL (fatigue scale) (92) | AT (Chinese) | sleepiness | structure | internal | content; construct; criterion | confirmatory | | | acute leukemia |
| PedsQL (fatigue scale) (93) | PT (Brazilian Portuguese) | sleepiness | structure | internal | content; construct; convergent/discriminant | confirmatory | | | cancer |
| PISI (94) | P | quality | structure | test-retest; internal | content; construct; convergent/discriminant | confirmatory | | | |
| PNSSS (95) | P | ecology | | | | | | | |
| PossaST (96) | T (Brazilian Portuguese) | quality | internal | criterion | yes; using the cumulative score ≥2.72 of the original scale | | | | |
| PPPS (97) | P | quantity; regularity, sleepiness, hygiene | internal | | | | | | |
| P-RLS-SS (98) | N | quality | face; content | | | | | | |
| PROMIS (99) | P | quality, regularity, sleepiness | internal | face; content | | | | | |
| PROMIS (100) | P | quality, regularity, sleepiness | structure | content | confirmatory | | | | |
| PROMIS (101) | P | quality, regularity, sleepiness | structure | internal | content; construct | confirmatory | | | |
| PROMIS (102) | PA | quality, regularity, sleepiness | | | content | | | | |
| PSIS (103) | P | quality, regularity | internal | content; construct | | | | | |
| PSQ (104) | P | quality | internal | | | | | | |
| PSQ (105) | T (Turkish) | quality | internal | content; construct | | | | | |
| PSQ (106) | T (Spanish) | quality | structure | | yes; cutoff score >0.33 | | | | |

(Continued)
| Tool acronym | NPTA in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|----------------------|------------------|----------------|---------------------|------------------|----------------------|-----|---------------------------|-----------------------|---------------------|
| PSQ (107)    | T (Malay)            | quality          | test-retest;   | face;               |                  |                      |     | yes; original AHI>1.5     | insomnia per ICD 9   |                     |
| PSQ (108)    | P                    | quality          | test-retest;   | face;               |                  |                      |     | yes; cutoff of 0.72–0.76. |                       |                     |
| PSQ (109)    | P                    | quality          | test-retest;   | face;               |                  |                      |     | yes; a cutoff of >0.33    |                       |                     |
| PSQ (110)    | PT (Chinese)         | quality          | test-retest;   | face;               |                  |                      |     | yes; a cutoff of >0.33.   |                       |                     |
| PSQ (111)    | T (Thai)             | quality          | test-retest;   | face;               |                  |                      |     | yes; a cutoff of >0.33.   |                       |                     |
| PSQ (112)    | P                    | quality          | test-retest;   | face;               |                  |                      |     | yes; a cutoff of >0.33.   |                       |                     |
| PSQ (113)    | PT (Portuguese)      | quality          | test-retest;   | face;               |                  |                      |     | yes; a cutoff of >0.33.   |                       |                     |
| PSQ (114)    | PT                   | quantity, quality, regularity | test-retest; internal | face; content | confirmatory | |
| PSQI (115)   | T (Brazilian Portuguese) | quantity, quality, regularity | test-retest; internal | face; content | confirmatory | |
| PSQI (116)   | P                    | quantity, quality, regularity | test-retest; internal | face; content | confirmatory | |
| RLS (117)    | NP                   | quality          | test-retest;   | face;               |                  |                      |     | calculated RLS index (difference in score between 14 day time points); one control subject had a higher index value (14) than two RLS-diagnosed (10 and 13) |                       |                     |
| SDIS (118)   | P                    | quantity, quality, sleepiness | convergent/ discriminant | content |           | |
| SDPC (119)   | P                    | quantity, quality, sleepiness | convergent/ discriminant | content |           | |
| SDSC (120)   | T (Chinese)          | quantity, quality, sleepiness | structure | internal | confirmatory | |
| SDSC (121)   | T (French)           | quantity, quality, sleepiness | structure | internal | confirmatory | |

(Continued)
| Tool acronym | NPTA in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|----------------------|------------------|----------------|---------------------|------------------|----------------------|-----|--------------------------|----------------------|---------------------|
| SDSC (122)   | T (Persian)          | yes              | quantity, quality, sleepiness | internal         | construct; convergent/ discriminant | original SDSC fits ASDC |
| SDSC (14)    | P                    | yes              | quantity, quality, sleepiness | internal         | construct; convergent/ discriminant | original SDSC fits ASDC |
| SDSC (123)   | P                    | yes              | quantity, quality, sleepiness | internal         | construct; convergent/ discriminant | Down syndrome |
| SDSC (124)   | P                    | yes              | quantity, quality, sleepiness | internal         | confirmatory     | original SDSC fits ASDC |
| SDSC* (125)  | N                    | yes              | quantity, quality, sleepiness | structure        | content           | neurocritical care acquired brain injury |
| SHI (126)    | T (Turkish)          | quantity, quality, sleepiness | structure        | test-retest; internal | construct; convergent/ discriminant | ADHD |
| SHIP (127)   | N                    | quantity, regularity, sleepiness | internal         | content; construct; criterion; convergent/ discriminant | chronic headache per International Headache Classification |
| Sleep Bruxism (128) | N    | quantity, quality, sleepiness | structure        | test-retest; internal | construct; convergent/ discriminant | per ICSD-2 severe psychomotor impairment |
| SNAKE (129)  | N                    | quantity, quality, regularity, sleepiness, hygiene, ecology | structure        | test-retest; internal | confirmatory     | T-score and percentage rank for raw score per factor |
| SQI (5)      | P                    | quality          | structure        | internal         | convergent/ discriminant | DSM-IV-TR diagnosis of insomnia by interview individuals with intellectual disability |
| SQ–SP (130)  | P                    | yes              | quantity, quality, sleepiness, | structure        | test-retest; internal | confirmatory     | sleep quality items comparable to DSM IV insomnia criteria |
| SQS-SVQ (131) | AT (Turkish)       | quantity, regularity, ecology | structure        | test-retest; internal | construct; convergent/ discriminant | severe psychomotor impairment |
| SRSQ (132)   | N                    | quantity, quality, regularity, sleepiness | test-retest; internal | content           | yes; a cutoff of 17.3 | original items per ICSD |
| SSR (133)    | T (Spanish)          | quality, regularity, sleepiness | structure        | internal         | construct; convergent/ discriminant | original items per ICSD |
| Tool acronym | NPTA | in Spruyt et al | Sleep categories | Factor analysis | Reliability analyses | Validity analyses | Confirmatory analysis | ROC | Normative values or cutoffs | Clinical classification | Specific population |
|--------------|------|----------------|-----------------|----------------|---------------------|------------------|----------------------|-----|---------------------------|----------------------|-------------------|
| SSR (43)     | T    | Spruyt et al   | quality, regularity, sleepiness | internal content | test-retest criterion | yes; 10.40 (1.37–218.3) for 5 items | | | original items per ICSD |
| SSSQ (134)   | N    | Spruyt et al   | quantity, regularity quality structure | | | | | | |
| STBUR (135)  | N    | Spruyt et al   | quality structure | | | yes; a total intensity of sleep problem score of 9 | | | ICSD-2 |
| STQ (136)    | P    | Spruyt et al   | quantity, regularity | | | yes; a total intensity of sleep problem score of 9 | | | ICSD-2 |
| The Children's Sleep Comic (137) | N | | quantity, quality, regularity, sleepiness, hygiene | content; construct | | yes; a total intensity of sleep problem score of 9 | | | ICSD-2 |
| The Children's Sleep Comic (138) | P | | quantity, quality, regularity, sleepiness, hygiene | internal content; convergent/ discriminant | | yes; a total intensity of sleep problem score of 9 | | | ICSD-2 |
| TuCASA (139) | AT   | Spruyt et al   | yes quality | internal content; convergent/ discriminant | | | yes; a total intensity of sleep problem score of 9 | | | ICSD-2 |
| YSIS (140)   | NT (English) | | quality structure test-retest; internal face; content; construct; convergent/ discriminant | | | yes; Normal :< 22 (< 70th percentile); Mild insomnia : 22 (70th percentile)–25; Moderate insomnia/ clinical insomnia : 26 (85th percentile)–29; Severe insomnia/ clinical insomnia : ≥ 30 (95th percentile) | | | based on ICSD-3 [12] and DSM-V [13] diagnostic criteria |
lesser frequent combinations of age ranges for which tools were assessed in these studies, ranged from 0.7–7.6% per combination.

As for the sample size, this ranged between 20 and 11,626 children inclusive of adult (6–13) participants across all publications, where 15.6% of all studies used a sample size >1,000 participants large (Table 2). Of these study samples, approximately 46.5% of respondents were parents, 41% were self-report, and 11.1% either a combination of experts, children, mothers, and parents. For two, the respondent is primarily a professional (17, 95).

Sleep Categories
As exemplified in Table 2, the overall focus of these studies was overwhelmingly directed at tools measuring the quality of sleep or identification of sleep pathologies in all pediatric age classifications (68.1%), followed by the levels of sleepiness (55.6%) and duration of sleep (48.6%). Various secondary coobjectives of these studies were to investigate tools measuring the sleep regularity (46.5%) and sleep hygiene practices (29.2%). Rarely but in existence, was the singular assessment of sleep ecology and treatment around sleep pathologies at a frequency of 21.5% and 0.7%, respectively. About 19 studies (13.2%) queried the sleep regularity (77.8%), followed by the levels of sleepiness (77.1%), quantity (48.6%), and sleepiness (48.6%).

The 11 Steps
Regarding the psychometric evaluation step-by-step guide proposed by Spruyt (2, 3), less than half the required 11 steps (chiefly 1, 2, 6, 8, and 9 were done) were fulfilled across all studies. Steps 3 and 10 were often not reported (i.e., 84.7% and 63.2%, respectively). Three studies reported all steps (2.1%), three only lack step 11 (2.1%), and four (2.8%) only lack steps 10 and 11. The most common combination of steps (7.7%) reported are 1, 2 and 4 joined with 5, 6, 8, 9 or 6, 7, 8, 9, 10. After a decade, only 18 papers (12.5%) reported some form of norms. An in-depth description of the steps fulfilled is described in the categorically-divided (per purpose, see Methods) results below.

Tools Newly Developed
According to our search criteria, a total of 27 novel pediatric sleep tools were developed between 2010 and 2020 (refer to Table 2 and shaded). Of these, approximately eight were published in Europe (29.6%), eight in North America (29.6%), four in Asia (14.8%), three in South America (11.1%), two in Australia and Oceania (7.4%), and two in the United Kingdom (7.4%). The majority were developed for child-adolescent age ranges (66.7%), while one for preschool children (2–5 years) and one for all three aforementioned ages (2–18 years). All newly developed tools possessed a multipurpose objective, most of which assessed sleep quality (77.8%), followed by the assessment of sleepiness (51.9%) and sleep regularity (41.7%) and sleep quantity (41.7%), while more rarely assessing hygiene (25%), ecology (12.5%), and treatment (4.2%).

In addition, three tools being newly created are an English translation of the NARQoL-21 (70) and YSIS (140), and also an adaptation, the nighttime sleep diary (NSD) (71). The latter being a diary adapted to monitor nighttime fluctuations in young children with asthma.

Only two tools were developed according to the 11 aforementioned steps required for psychometric validation of a tool; the NARQoL-21 (70) and SNAKE (129) (refer to Table 2). One other tool, OSPQ (83) also developed normative scores for widespread usage while fulfilling most steps but steps 3 and 9. Whereas the CSAQ (27) fulfilled all steps except step 11, and the BRIAN-K (16), PADSS (84), and SDSC* (125) except steps 10 and 11. The outstanding tools were mostly absent of steps 5, 7, 8, 9, and 10. For the newly developed diary, NSD (71) steps 1–6 were fulfilled.

Almost half of the tools queried general sleep problems (41.7%). Twenty-five percent aimed at surveying sleep disordered breathing. While others such as sleep bruxism (128), PADSS (84), P-RLS-SS (98), RLS (117), NARQoL-21 (70), YSIS (140), and NSD (71) focused on a specific sleep problem (16.7%). Tools aimed at investigating sleep complaints in children with (developmental) disabilities are besides NSD (71), the OSA Screening Questionnaire (73), Pediatric Sleep CGIs (90), SHIP (127), and SNAKE (129).

Tools Translated
In total, 35 out of the total 144 studies primarily aimed to translate an existing tool alone (refer to Table 2). Namely, 17 tools have been translated: BISQ (15), CCTQ (19), CSHQ (29, 33, 34, 40–43), CSM (45), CSQ5 (46), DBAS (49), ISI (56, 57), MEQ (62), OSA-18 (74–79), OSD-6 (81), PDSS (85–87), PosaST (96), PSQ (105–107, 110, 111, 113), PSQI (115), SDSC (120–122), SHI (126), and SSR (43, 133). The most frequently translated tools were: OSA-18 (17.1%), CSHQ (14.3%), and PSQ (11.4%). The most common translation was to Portuguese (n=4), Spanish (n=4), and Turkish (n=4), followed by Brazilian Portuguese (n=3), Chinese (n=3), and Dutch (n=3). Less often, tools were translated to German, Persian, and Greek as well as English, Italian, Polish, Swedish, Japanese, French, Malay, and Thai. Again, primarily tools for child/adolescent age ranges as parental reports have been translated. Of these, the main categorical foci, and often overlapping, were sleep quality (77.1%), quantity (48.6%), and sleepiness (48.6%).

When ranked from most to least prevalent step, apart from steps 1 and 2, we found: step 8 (97.1%), step 4 (91.4%), step 9 (88.6%), step 6 (85.7%), step 5 (57.1%), step 7 (51.4%), and step 10 (34.3%) being performed across the studies. The CSHQ (34) and SDSC (120, 121) included norm development (step 11). Step 3 is missing in all translations. Only the translation of the SDSC fulfilled nearly all steps with (121) missing step 3 and (120) missing steps 3 and 9. Receiver Operator Curve (ROC) analyses were performed in five : OSA-15 (74), PosaST (96), PSQ (106, 111), and CSHQ (43).

Tools Adapted
Moreover, six studies (see Table 2) specifically aimed to adapt a tool from a preexisting one, most notably the Children’s Sleep Habits Questionnaire (CSHQ) (66.7%), among these a shortened version and infant adaptation, along with the BEDS (14) (16.7%) adapted toward children with Down syndrome, and the OSA-18 Questionnaire (16.7%), which was also shortened toward OSA-5 (80) to suit the sample of interest. Although the number of items
may have changed, no substantial changes to the answer categories could be noted. Only 33.3% reported steps 3, 4, 5, 7, 10 yet steps 6, 8, 9 were analyzed in 83.3%. None developed norms. In two studies (38, 44) ROC analyses were pursued for the CSHQ.

Tools Adapted and Translated
Six studies adapted and also translated existing tools (see Table 2): CSHQ (29), PedsQL (91, 92), SQS-SVQ (131), TuCASA (139), and NSS (72). The CSHQ and TuCASA were adapted and translated to Portuguese, the PedsQL to Arabic and Chinese, while SQS-SVQ to Turkish and NSS to Chinese. The adaptations involved an infant version of CSHQ and child-sample for NSS, the PedsQL to children with cancer and acute leukemia, and the TuCasa was adapted toward children of low socioeconomic status. Regarding the SQS-SVQ it was modified based on personal communication with the authors of the original version. That is, four items were added.

For these tools Steps 3 and 11 were not performed, while Steps 8 and 9 were performed in all. About half (50%) did steps 5, 6, and more than half did step 7 (66.7%) and less than half did step 10. Some aspects of step 4 were inconsistently applied across 83.3% of the studies (e.g., expert perspective).

Tools Psychometrically Evaluated
Approximately 53 studies were published that focused solely on psychometric evaluation of questionnaires between 2010 and 2020 (refer to Table 2). Of these, commonly investigated were CSHQ (11.3%), CRSP, and PSQ (each 7.5%), followed by SDSC and PROMIS (each 5.7%). The greatest number were printed in 2014 (15.1%), as well as 2018 and 2019 (each 13.2%) and 2015, 2016, 2017 (each 11.3%), and a lesser number of instruments were evaluated in the other years. In terms of location, the majority were published in North America (43.4%) followed by Europe (22.6%) and Asia (18.9%), Australia and Oceania (11.3%), and the South America (3.8%). Especially tools for adolescent age range (34%) were psychometrically evaluated, followed by child-adolescent age range (22.6%). 9.4% involved tools for preschoolers (2–5 years) and 15.1% are for child (6–12 years) alone. The remainder are combinations: preschooler child (3.8%), preschool to adolescent (9.4%), and all (0–18 years; 3.8%).

Ranked on sleep category, the tools examined: 64.2% sleep quality; 58.5% sleep quantity; 47.2% sleep regularity; 58.5% sleepiness; 35.8% sleep hygiene, 20.8% sleep ecology but none for treatment. Among all 53-instrument validations, none adhered to all eleven recommended steps of tool evaluation. Besides steps 1 and 2, especially steps 9 (90.6%) and 8 (75.5%), 6 (64.2%) have been reported upon psychometrically evaluating tools, and less common have been steps 7 (54.7%), 10 (41.5%), and 4 (34%). Least common in psychometric screening were steps 5 (13.2%), 3 (13.2%), and again 11 (15.1%). ROC analyses were performed in 11 studies (20.8%): ESS (52), AIS and SQI (5), JSQ (58, 59), PSQ (108, 109, 112), CAS-15 (17), CSRQ (47), and Comics (138). Almost fulfilling all steps were: CAS-15 (Goldstein et al., 2012) and Comics (137, 138).

Tools Psychometrically Evaluated and Adaptations
Three tools underwent evaluation but were simultaneously modified: FoSI was adapted for adolescents (54), and a reduced itemset was suggested for aMEQ-R (65) and PROMIS (102).

Tools Psychometrically Evaluated and Translated
In addition to the 53 instruments validated, there were 13 studies flagged that additionally translated their respective tools (refer to Table 2); the ASHS to Persian, the BEARS to Spanish, CCTQ to Chinese, the CSHQ to German and Spanish, the ESS to Tamil, the MEQ to European Portuguese, the MESSI to Turkish, the PSQ to Chinese, Portuguese and French, and the PedsQL to Brazilian Portuguese. Step 9 was performed in all studies, closely followed by steps 4, 6, and 8 (93.3% each). Step 7 (69.2%) and 5 (53.8%) and 10 (46.2% each) were not as frequently pursued. Again, steps 3 and 11 (15.4%) were nearly absent in the psychometric evaluation. Of these, the ESS (51) underwent all steps.

Tools Psychometrically Evaluated, Translated With Adaptations
The Russian version of the PDSS (89) did not report step 3, but executed to a certain extent all the steps to psychometrically evaluate a translated tool to its population. Based on the advice of the area specialist and the focus group of children questions #3 (Trouble getting out of bed in the morning), 4 (Fall asleep/drowsy during class), 7 (Fall back to sleep after being awakened), and 8 (Usually alert during the day (reverse coded)) were modified for better understanding.

Some Extra Remarks
Translations of Tools
Although the studies reported here are English papers, popular translations are Chinese, Portuguese, Spanish, and Turkish. The CSHQ, PSQ, and OSA-18 were the most frequently translated tools.

Tools With Norm Scores
Psychometric studies of particular interest are those that developed normative values or clinical/community cutoff scores for widespread usage, of which there were overall 18. Norms have been developed for CAS-15 (17), ESS (51, 52), JSQ (58, 59), SDSC (120, 121), CSHQ and CRSP (25, 34), CSRQ (47), MEQ (64, 65), NARQoL-21 (70), OSPQ (83), PSQ (108), SNAKE (129), Comic (138), and SYSIS (140) (refer to Table 2).

The CAS-15, PSQ, CSRQ, and ESS studies provided “normative” ROC cutoff scores, with the Krishnamoorthy et al. (51) providing cutoffs for moderate and high excessive sleepiness.

Population-based norms were developed for preschoolers and school-aged children of JSQ. Average T-scores for all as well as for boys/girls in age bands of 2–3, 4–5 years separately are available for each subscale: restless legs syndrome, sensory; obstructive sleep apnea syndrome; morning symptoms; parasomnias; insomnia or circadian rhythm disorders; daytime excessive sleepiness; daytime behaviors; sleep habit; insufficient
sleep; and restless legs syndrome, motor. For school-aged median T-scores are available for 1st–2nd, 3rd–4th, 5th–6th grade per the following subscales: restless legs syndrome, sleep disordered breathing, morning symptoms, nighttime awakenings, insomnia, excessive daytime sleepiness, daytime behavior, sleep habit, and irregular/delayed sleep phase.

Regarding the SDSC, French (France and French speaking Switzerland) as well as Chinese T-scores are available. The Chinese study reports average T-scores per the subscales sleep-wake transition disorders; disorders of initiating and maintaining sleep; disorders of excessive somnolence; disorders of arousal; sleep hyperhidrosis; and sleep breathing disorders. Whereas the French study copied the approach of the original report, i.e., tabulated the full T-score range from 31 to 100 including marks for clinical ranges.

The CSHQ study aimed to validate the Dutch version of the tool for toddlers while developing norms due to the current inaccessibility of the CSHQ in this age group. Norm values were decidedly the mean total score in the sample population and while the factor-structure was unsupported, the normative score developed was still representative of the presence and severity of sleep problems in 25% of toddlers. Authors report the mean total score for lower/higher socioeconomic status, 2 and 3 year olds, girls and boys, yes/no problem sleepers. The authors similarly provided means and standard deviations for the 23 items of the CRSP.

The MEQ studies are comparable providing means and standard deviations as well as percentiles. Also percentiles are reported in the YSIS study. For the NARQoL-21 a comparison was made with a validated health-related quality of life tool, and a cutoff of <42 was deemed as sensitive and specific, supplementary available are cutoff scores for differentiating between optimal and suboptimal quality of life.

T-scores for subscales by gender and age (5–7 and 8–10 years old) are provided for OSPQ: sleep routine, bedtime anxiety, morning tiredness, night arousals, sleep disordered breathing and restless sleep.

For SNAKE a t-distribution was generated for Disturbances going to sleep, Disturbances remaining asleep, Arousal disorders, Daytime sleepiness, and Conduct disorders for children in ages between 1 and 25 years old. For the Children’s Sleep Comic (ages 5 to 11) stanines were generated for the raw intensity of sleep problem score.

Tools With ROC Analyses
Twenty-eight (19.4%) studies reported ROC findings. This was primarily done for (refer to Table 2) CSHQ (n=4) and PSQ (n=5). That is, in 20% the ROC was calculated given clinical versus control/community samples, while in 48% of the papers a PSG parameter was used (e.g., apnea-hypopnea index, obstructive index). Another criterion was used in 32% of the cases (e.g., validated questionnaire, parental report, or optimal cutoff from original paper).

Papers With Questionnaires Available
In Table 1, the studies (32.6%) that printed or made available their questionnaire in supplementary files or appendix are shown.

Use of Classification Systems
Primarily the ICSD classification system was used to generate/mimic items for the following new tools: the Pediatric Sleep CGIs (90), RLS (117), SDSC* (125), SNAKE (129), the Children’s Sleep Comic (137), and YSIS (140). When tools were psychometrically evaluated and/or translated/modified such as the CSHQ or the SDSC the classification system upon which their original items were generated remains.

Tools Used in Specific Populations
The SNAKE has been specifically developed for children with psychomotor disabilities, and hence serves as a good example of tool development. Whereas the vast majority of studies involved tools that are modifications or compilations, as well as a psychometric evaluation of the tool utility in an “atypical” population.

DISCUSSION
Since the 2011 Spruyt (2, 3) review, it has been encouraged that further psychometric validation is pursued for all questionnaires to develop a broader and more reliable range of tools. While “tools do not need to be perfect or even psychometrically exceptional, they need to counterpart clinical decision-making and reduce errors of judgment when screening for poor sleep,” suggested Spruyt (personal communication). This is done through the descriptive, iterative process of a tool protocol and often requires all steps of psychometric evaluation. Without this we have observed that tools rely on minor aspects of their psychometric validity for (clinical) application when this is often fallacious and nonspecific to the study population. Following the systematic review however, a dramatic increase in tool translations and adaptations has been observed which is to be irrefutably applauded. Nonetheless, it is important to develop standardized tests that are culture-free and fair in order to identify sleep issues across the board based on an unbiased testing process.

Twenty-seven new tools have been developed, while most of the papers published reported translations/adaptations or a psychometric evaluation of an existing tool. More than half of the tools queried general sleep problems. Irrespective of the infrequency of tools developed in categories like sleep ecology and treatment, there is an emerging need for further research into these areas given the environmental impact of technology on pediatric sleep in the 21st century (141, 142).

The two new tools that underwent all 11 steps aimed at investigating sleep problems either in terms of a quality of life tool for narcoleptics (NARQoL-21) (70) or as a sleep disorder tool for children with severe psychomotor impairment (SNAKE) (129). Several other tools accomplished nearly all steps (see Tables: OSPQ, CSAQ, BRIAN-K, PADSS, SDSC*, NSD, and YSIS).

Since the 2011 review, tools for specific populations (e.g., in terms of ages, developmental disabilities, sleep pathologies) are still needed. Epidemiological tools assessing sleep in adolescents specifically have received some focus, where they were second in
publication frequency. This dramatic influx of relevant research can be a result of the rising sleep-reduction epidemic in teenage populations influenced by biological, psychological and sociocultural factors. In addition, the investigation into the effects of sleep hygiene and ecology (143), which are heavily influenced by sociocultural phenomena, have slowly presented themselves across children and adolescents (6–18 years). With the introduction of technology at the forefront of childhood influence (144, 145), pediatric sleep habits and consequently quality is slowly gaining traction where studies flagged here are acknowledging the underlying weight of sleep hygiene on sleep quality and sleep quantity. Although at present, these tools are still demanding attention for further psychometric validation.

An urgent call for tools with adequate psychometric properties is concluded in several recent reviews (146–148). Especially assessing the factor structure of tools toward construct validation has been pursued, while other steps continue to be overlooked. Similarly, general tools to screen for sleep pathologies remain preponderant since the 2011 review. Alternatively, a file-drawer problem can be expected. Combined with the difficulty of finding a suitable journal to publish a tool validation study, this may lead to a skewed scientific literature toward commonly published and used tools. This is potentially echoed in atypical populations as seen by the influx of psychometric evaluations of existing tools. Undoubtedly, more studies are needed in an era where sleep is rapidly gaining public interest, and the need for a scientifically sound answer on the consequences of a “poor sleep” endemic is pressing.

Several tools pop out for diverse reasons. The first tool of note is the JSQ (58, 59) validated for Japanese children investigating sleep in a large population-based sample flagged by our search and developing normative values for this tool at a 99% confidence interval. This tool is notable in that given its statistical validity and reliability in a large population sample, the plausibility of this being mirrored in other cultures is possible. Important to note however, is that sleeping habits in Japanese children may vary greatly to those in western countries. Therefore, the changes in sociocultural sleep habits when adapting for other populations should be considered. Secondly, SNAKE the sleep questionnaire for children with severe psychomotor impairment underwent all 11 steps and was uniquely developed (hence not modified) for a specific population. More alike are needed (149). Thirdly, PADSS, and BRIAN-K both newly developed tools drew our attention because they examine arousal level and biological rhythm. Although the PADSS may need some further validation studies toward diagnosing, monitoring, and assessing the effects of treatment in arousal disorders in childhood particularly, it addresses the need for more specialized tools. Whereas the BRAIN-K being a modification of an adult version may benefit from additional psychometric evaluations beyond the current age range. Also, the FoSI, measuring fear, being based on the adult version assessing fear in a rural trauma-exposed sample (150) warrants further psychometric scrutiny. In contrast to others, the RLS (117) proposes a difference in scores between two time points 14 days apart to identify RLS-related symptoms. Lastly, addressing the need for tools allowing the child to express themselves regarding sleep is the Children’s Sleep Comic, being an adapted version of the unpublished German questionnaire “Freiburger Kinderschlafcomic” and providing pictures for items and responses. Hence, pinpointing to the “un”published tools in the field and a welcomed child’s perspective regarding inquiring about sleep in an alternative way.

Adhering to the words of Spruyt, that instruments should be enhancing clinical decision-making and significantly reducing errors of judgment, the study by Soh et al. identified, developed, and abbreviated the OSA-5 questionnaire after recognising preexisting faults in the original 18-item version. It was identified that the OSA-18 was initially designed as a disease-specific quality of life tool that does not predict obstructive sleep apnea (OSA) symptoms consistent with the gold-standard PSG. Recently Patel et al. (151) scrutinized the accuracy of such clinical scoring tools. Additionally, the study by Soh et al. (80) acknowledged that there exists a lack of parental understanding of some items and their wording in the original instrument. As a result, the OSA-18 was abbreviated to 11-items and then to 5- so that ultimately it would “perform better as a screening tool for use in triage and referral planning.”

Our review also revealed other tools addressing this sleep problem: I’m sleepy (55). While OSA is increasingly relevant in pediatric epidemiology due to the rise in obesity, parental knowledge of the condition and consequent treatment options is imperative. A recent 2017 study regarding the development of a questionnaire informing parents of this treatment was designed by Links et al. (82). The tool aims to alleviate parental conflict around the choice for or against this treatment in children and is a first in its approach as a questionnaire focusing on medical treatment decision making. Like the objectives of OSA-5, this tool is notable in that it aims to “improve the quality and impact of patient and family decisions about OSA diagnosis and treatment” (82). As part of the personalized/precision medicine era, the CAS-15 (17) and PROMIS-papers pop out. The CAS-15 is one of the few tools where the respondent is the professional. The PROMIS, although presented as a potential screening/diagnostic tool, recently underwent several psychometric evaluations. It involves an item bank of Patient Reported Outcomes Measurement, or better it is intended to measure the subject’s “view” of their health status (e.g. sleep). Although these patients reported outcome measures (PROM) adhere to the same psychometric characteristics as diagnostic/screening tools, the scope of a PROM is very different. Namely, PROMs allow the efficacy of a clinical “intervention” to be measured from the patients’ perspective. Unfortunately, these specific instruments have not undergone all steps, accordingly, they would benefit from further validation and possible cultural/linguistic adaptation to achieve a more widespread use in the future.

As for the majority of tools that lack the detailed mention above, there is need for comment on the gradually increasing recognition for disease-specific instruments or instruments for specific populations. Alternatively, measuring the severity of sleep conditions over the frequency is still much needed. It was observed by Spruyt that nearly all questionnaires up until the 2010 search, focused on the frequency of sleep problems,
however since then, several tools have aimed to increase the specificity and sensitivity of sleep tools to the severity of common pediatric illnesses and specific age groups associated with them e.g. Down syndrome, Narcolepsy (148), infancy, etc. This specificity of condition severity and age may help to refine treatment measures and streamline clinical interventions.

Additionally, in contrast to our review in 2011, the studies reported here are English papers, although popular translations are Chinese, Portuguese, Spanish, and Turkish. That is, between 2010 and 2020 especially the CSHQ, PSQ, and OSA-18 were translated. This is likely an approximation due to the exclusion of non-English papers and of dissertations etc. In 2011, we observed that the development or modification of tools may not always evolve into a scientific paper.

Vis-à-vis fulfillment of psychometric criteria, preliminary and confirmative factor analysis methods have been included in the scope of, and completed in either partially or completely, most the studies which was lacking prior. Primarily construct and content validity via factor structure or item correlation, and Cronbach alpha statistics are noticed. Standardized scoring and item generation however, is still ill-managed as a requirement and is an important step in developing a diagnostic tool or adapting/translate an existing one. Nonetheless, generally, it can be said that much of the studies into tool-psychometrics deserve recognition for endeavoring to adhere to steps 1 through 11. But the overarching suggestion thus far, is to more thoroughly fulfill the facets of validation; i.e. content, convergence, discriminative, and criterion-related validity (steps 8 and 9), pilot questionnaires in the event of an adaptive change made (step 5), examine the underlying factors to ensure (uni) dimensional structure of a said tool (steps 7 and 10) and develop norms alongside cutoff scores (step 11). Furthermore, although several tools mimic classification systems a more thorough psychometric scrutiny thereof is still needed. As a consequence, to date, the vast majority of tools reflect an appraisal of the frequency of a sleep complaint.

Several limitations should be noted. We post hoc limited our flagged studies to only English language given that they reach the broader scientific community. Furthermore, several of the tools included are not 100% sleep tools (e.g. health related). In addition, our way of presenting being “New Development (N),” “Psychometric Analysis (P),” and “Translation (T)/Adaptation (A),” or a combination thereof, involved overlaps in descriptive analyses. Contrary to the original paper by Spruyt, this one did not apply searches in Dissertations and Theses, Google Scholar (Web crawling), ebooks and conference Sleep abstract books, and as a consequence might not be an exhaustive list of tools. Alternatively, studies involving app’s did “hit” our search terms yet were not retained during further screening toward our aims. Lastly, given that this is a systematic review we didn’t pursue a quality assessment of study designs investigating sleep tools. Nevertheless, in Spruyt et al. (2) each of the necessary steps are stipulated.

**Recommendations**

It is recommended that future tools further the investigation into sleep hygiene, ecology (see [143]) and schedules of pediatric populations as this is becoming a highly relevant field of research upon the introduction of technology into sleeping habits and routines. The increasing prevalence of sleep deprivation in children (152–155) requires in depth discovery as to what damage or lack thereof is being done as a result of a 21st century society.

In addition to this, it is suggested that pediatric tools should be further introduced and adapted or validated for reporting by children older than 8 years of age. Since there is evidence to suggest that children as young as eight years can report information critical to their own health, it is recommended that a large proportion of questionnaires be designed for children in this age category as well as parents (1). Conjunctional use of these however, is advised to develop any diagnosis.

Although several tools listed mimic classification systems, or were psychometrically evaluated in samples that underwent clinical diagnoses upon a classification system, there is still room for improvement. Combined with primarily convenience samples such as clinical referrals and lack of details on (at risk of being poor) sampling techniques, the internal and external validity of studies might be seriously jeopardized.

Sensitivity and specificity are key in differencing screening versus diagnostic tools. Yet also, the sample on which this difference is determined plays a key role, where the diagnostic tools chiefly aims at subjects believed to have the problem. Thus, screening tests are chosen toward high sensitivity while diagnostic tests are chosen toward high specificity (true negatives).

Lastly, caution is warranted upon a general positive score regarding reliability and validity assessment, and readers are advised to remain critical concerning the statistical techniques applied in the individual studies. Several recommendations for future tool development or evaluation have been listed in Box 1.

**BOX 1 | Research agenda: a need for**

- Tools assessing sleep ecology, sleep routines/hygiene, regularity, treatment
- Psychometric evaluation of apps
- Tools for daytime sleep
- Tools per sleep pathology
- Tools for specific populations
- Tools sensitive and specific regards classification systems
- Tools adept to developmental changes
- Tools differentiating between school days and nonschool days
- Tools as a PROM, Patient-Reported Outcome Measures
- A venue to publish psychometric evaluations of tools
- Methodological scrutiny regarding sampling (patient/population), statistical techniques, the aim(s), and type of study
- Availability of the tools published, especially translations
- Equal attention to all 11 steps; e.g. step 3 such as answer but also time format
- Replication studies
- Self-reporting tools for school-aged children
- Question and/or Response formats beyond frequency
- Sleep duration not being a categorical answer
- Caution regarding “child”-modifications of adult tools or applications beyond the intended age range
- Culture-free or fair tools
- Reviews and meta-analyses on criterion validity of subjective tools
Tool development and evaluation, as mentioned in the past is time and labor-intensive (2). In short, scientific copycats (i.e. replication studies) are needed!

AUTHOR CONTRIBUTIONS

TS performed first search, extracted data, and wrote the first draft during her internship. Her work was updated, verified and finalized by KS.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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### APPENDIX

| Tool acronym | Tool |
|--------------|------|
| AIS | Athens Insomnia Scale |
| ASHS | Adolescent Sleep Hygiene Scale |
| ASQ | Auckland Sleep Questionnaire |
| ASWS | adolescent sleep wake scale |
| BEARS | Bedtime problems (B) Excessive daytime sleepiness (E), Awakenings During the night (A) Regularity of sleep (R) and Snoring (S) |
| BEDS | Behavioral Evaluation of Disorders of Sleep |
| BISQ | Brief Infant Sleep Questionnaire |
| BRIAN-K | Biological Rhythm Interview of Assessment in Neuropsychiatry – Kids |
| CAS-15 | Clinical Assessment Score-15 |
| CBCL | Child Behavior Checklist sleep items |
| CCTQ | Children’s ChronoType Questionnaire |
| CRSP | Children’s Report of Sleep Patterns |
| CRSP-S | Children’s Report of Sleep Patterns – Sleepiness Scale |
| CSAQ | Children’s Sleep Assessment Questionnaire |
| CHHQ | Children’s Sleep Habits Questionnaire |
| CSM | Composite Scale of Morningness |
| CSRO | Chronic Sleep Reduction Questionnaire |
| CSWS | Children’s Sleep-Wake Scale |
| DBAS | dysfunctional beliefs and attitudes about sleep scale |
| ESS-GHAD | Epworth Sleepiness Scale for Children and Adolescents |
| FoSI | Fear of Sleep Inventory |
| I SLEEPY | I SLEEPY, short pediatric sleep apnea questionnaire |
| IF SLEEPY | IF SLEEPY, short pediatric sleep apnea questionnaire |
| I'M SLEEPY | I’M SLEEPY, short pediatric sleep apnea questionnaire |
| ISI | Insomnia Severity Index |
| JSQ | Japanese Sleep Questionnaire |
| LSTCHQ | Sleep Length and Television and Computer Habits of Swedish School-Age Children |
| MCTQ | Munich ChronoType Questionnaire |
| MEQ | Morningness-Eveningness Questionnaire |
| aMEQ-R | reduced Morningness-Eveningness Questionnaire |
| MESC | Morningness–Eveningness Scale for Children |
| MESSi | Morningness–Eveningness Stability Scale improved |
| My Sleep and I | My children’s sleep |
| NARQol-21 | Narcolepsy-specific HiQol self-report questionnaire |
| NSD | nighttime sleep diary |
| NSS | Narcolepsy Severity Scale (Chinese) |
| OSA Screening Questionnaire | Obstructive Sleep Apnea Screening Questionnaire |
| OSA-18 Questionnaire | Obstructive Sleep Apnea Questionnaire |
| OSD-6 | obstructive-sleep-disorders-6-survey |
| QoLQuestionnaire | Obstructive Sleep-Disordered Breathing and Adenonsillectomy Knowledge Scale for Parents |
| OSPP | omnibus sleep problems questionnaire |
| PADSS | Paris Arousal Disorders Severity Scale |
| PDSS | Pediatric Daytime Sleepiness Scale |
| Pediatric Sleep CGI's | Pediatric Sleep Clinical Global Impressions Scale |
| PedsQL | Pediatric Quality of Life (PedsQL) Multidimensional Fatigue Scale |
| PISI | Pediatric Insomnia Severity Index |
| PNSSS | Parent Newborn Sleep Safety Survey |
| PsotaST | pediatric obstructive sleep apnea screening tool |
| PPPS | Puberty and Phase Preference Scale (also cited as Morningness Eveningsness Scale) |

(Continued)