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Becking, B.E.; Verweij, J.P.; Jonkman, R.E.G.; Merkesteyn, J.P.R. van; Marle, M.E.

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Cross-cultural validity of the Dutch sleep-related breathing disorder scale of the Pediatric Sleep Questionnaire in a general population

Bibi E. Becking [a,*], Jop P. Verweij [b], Ronald E.G. Jonkman [c], J.P. Richard van Merkesteyn [a], M. Elske Van den Akker-Van Marle [d]

[a] Department of Oral and Maxillofacial Surgery, Leiden University Medical Center, P.O Box 9600, 2300 RC, Leiden, the Netherlands
[b] Department of Oral and Maxillofacial Surgery, Amphia Hospital, Breda, the Netherlands
[c] Private Practice, Roosendaal, the Netherlands
[d] Department of Biomedical Data Sciences, Section Medical Decision Making, Leiden University Medical Center, the Netherlands

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ABSTRACT

Background: Pediatric sleep-disordered breathing is associated with multiple health problems. Polysomnography is the reference standard for identifying this disorder, but availability is limited. Therefore, an alternative screening tool is needed. Globally, the Sleep-Related Breathing Disorder scale of the Pediatric Sleep Questionnaire (PSQ) has proven to be a feasible tool. Consequently, this study aimed to translate and culturally adapt the PSQ into Dutch and then to examine the cultural validity, internal consistency, and test-retest reliability of the Dutch version among a general population visiting oral healthcare centers.

Methods: The translation, review, adaptation, pretest, and documentation approach was used to ensure cross-cultural adaptation of the PSQ. Then, 220 children (2.4–18 years) were sampled for clinimetric evaluation. We estimated the cross-cultural validity by comparing the factor analyses of the original PSQ and the Dutch version. Reliability was assessed using Cronbach's alpha, Spearman's correlation, the intraclass correlation coefficient, the standard error of measurement, and a Bland-Altman plot.

Results: The factor loading patterns of the Dutch version matched with the original study around the four predetermined factors: breathing, sleepiness, behavior, and other. The internal consistency, with a Cronbach's α of 0.77, was acceptable. The test-retest reliability with an intraclass correlation coefficient and Spearman's correlation of 0.89 and 0.93, respectively, was good to excellent.

Conclusions: Cultural adaptation was ensured and the results support cross-cultural validity, internal consistency, and test-retest reliability of the Dutch Sleep-Related Breathing Disorder scale of the PSQ. This questionnaire could therefore be a valuable tool for screening disordered breathing in Dutch children.

1. Introduction

A sleep-related breathing disorder (SRBD), also defined as sleep-disordered breathing (SDB), is a syndrome involving upper airway dysfunction during sleep [1]. SRBD is caused by partial and/or complete upper airway obstruction that clinically manifests in exacerbating forms, from primary snoring, disruption of normal sleep patterns and normal breath ventilation to partial or complete obstructive sleep apnea (OSA) [1–5]. SDB can also affect children and adolescents, with a reported prevalence ranging from 4 to 11 % [5]. One important predisposing factor for pediatric SDB (PSDB) is hypertrophic adeno-tonsillar tissue, but other risk factors may also be contributors, such as obesity or severe neurologic and craniofacial anomalies [4,6]. PSDB is associated with multiple complications related to general health and disturbed sleep problems, behavioral disorders, learning disabilities, and growth impairment but also complications related to oral health [2,6]. Several studies have reported complications such as dentofacial deviations and decrease in oral health and oral health-related quality of life [6–10]. Consequently, it is important to recognize PSDB among the general population, such as in oral health care settings, because affected children will benefit from early diagnosis and treatment. Actually, the American Association of Orthodontics recommends orthodontists to

* Corresponding author. Department of Oral and Maxillofacial Surgery, Leiden University Medical Center, P.O Box 9600, 2300, ZA, Leiden, the Netherlands.
E-mail addresses: b.e.becking@lumc.nl (B.E. Becking), j.p.verweij@hotmail.com (J.P. Verweij), ronald@ortho-jonkman.nl (R.E.G. Jonkman), J.P.R.van_Merkesteyn@lumc.nl (J.P.R. van Merkesteyn), m.e.van_den_akker_van_marle@lumc.nl (M.E. Van den Akker-Van Marle).

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familiarize themselves with the signs and symptoms of OSA and refer children at risk for further definitive diagnosis [6].

In PSDB, children's snoring sounds, unlike those of adults, are characterized by noisy mouth breathing, often with snorting and gasping. Snoring can also be distinguished by increased respiratory effort, often described by parents as "struggling" to breathe during sleep. Other signs of PSDB include day-time mouth breathing, restless sleep, increased movement during sleep, frequent arousals and awakening, enuresis, morning headaches, inattentive/hyperactive behavior, and impaired cognitive performance [2,11,12]. The gold standard diagnostic test for PSDB is a full overnight polysomnography (PSG) [6]. However, PSG is costly, time consuming, a burden for children, and minimally available in routine settings such as oral health care. More feasible diagnostic tools could contribute to the early detection of PSDB, thereby enhancing timely diagnosis and treatment. One such tool is the SRBD scale, which is a validated component of the Pediatric Sleep Questionnaire (PSQ) [11,13].To our knowledge, all systematic reviews of this topic have confirmed that the SRBD scale is a useful tool for the screening of PSDB [14–16]. The original SRBD scale validation study reported both a sensitivity and specificity of >0.80 and an acceptable test-retest reliability, with a Spearman correlation of >0.75 [11,13,17]. Consequently, the European Respiratory Society Task Force has stated that although the SRBD scale is not a substitute for polysomnography, it is a useful screening tool for predicting PSDB [1]. Translated versions of the scale, such as Spanish, German, Turkish, Malaysian, Chinese, Portuguese, Italian, Hindi, French, Thai, Hebrew, Brazilian Portuguese, Arabic, and Danish, have been validated worldwide [18–31]. The validated SRBD scale is therefore a simple screening tool that allows for the global assessment of PSDB. However, to date, no validated Dutch translation of the PSQ exists, even though a minimally invasive screening instrument to detect PSDB would be beneficial in the Netherlands. Therefore, in this study, we sought to produce a Dutch translation and culturally adapted version of the questionnaire, followed by an assessment among a general population in an oral health care setting, of the validity and the reliability of the Dutch version of the SRBD scale of the PSQ.

2. Methods

2.1. Study design

The study consisted of two phases. The first phase involved translating and culturally adapting the original English version of the PSQ while following the Cross-Cultural Survey Guidelines (CCSG) [32]. The second phase entailed assessing the cross-cultural validity and reliability of the Dutch translation of the PSQ while following the study design checklist for patient-reported outcome measurement instruments of the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) [33]. An independent medical ethical committee evaluated the study and concluded it to be exempt from ethical approval (Medical Ethics Committee Leiden The Hague Delft, file number N19.106).

2.2. The sleep-related breathing disorder scale of the pediatric sleep questionnaire

The SRBD scale of the PSQ is a parent-reported questionnaire containing 22 questions-items. It has been validated as part of a reflective model for the measurement of PSDB for children between the ages of 2–18 years [11,13]. The scale contains three subscales, A, B, and C, which reflect the prominent symptom complexes for PSDB, that is, snoring, sleepiness, and behavioral problems, respectively. The SRBD scale has three response options, "yes," "no," or "don't know," with values of 1, 0, or missing, respectively. The scores are calculated using the proportion of questions answered positively ("yes") divided by the number of "yes" and "no" answers, thereby excluding the "don't know" answers. The scores range between 0 and 1. A cut-off value of >0.33 for the total score has been established for the identification of PSDB [11]. To assess the scores of the subscales, we used the questions-items A2, A3, A4, and A5 for the snoring score; B1, B2, B4, and B6 for the sleepiness score; and C3, C5, C8, C10, C14, and C18 for the behavioral score to correspond with the validation of the original study [11].

2.3. First phase: Translation and cultural adaptation

Permission to translate the English source version of the PSQ into Dutch was granted by the Regents of the University of Michigan and the corresponding author of the original study [11]. The translation and cultural adaptation were performed according to the Translation, Review, Adjudication, Pretesting, and Documentation (TRAPD) team translation model to conform with the CCSG (Fig. 1). The Translation and Verification Follow-up Form (TVFF), an Excel-based template recommended by the European Social Survey (ESS), was used to document the steps in the translation process [34]. Primarily, two certified professional translators both independently created a fully drafted translation of the whole source version of the SRBD scale in the Dutch language. Important principles for the translation were to retain comprehensible and simple language with a consistent and comparable tone to the English source questionnaire by aiming to use the "ask the same question" approach. Subsequently, two reviewers (B.B. and J.V.) provided comments on both translations and corresponded with the translators to discuss improvements. A pre-final version was produced and approved by the adjudicator for pretesting (RvM). This pre-final version was tested in a pretest group of 50 participants that consisted of parents visiting an orthodontic practice. Comments from this group concerning the clearness and the comprehensibility of the questionnaire and the individual question-items were documented. Following this, professionals from various disciplines relevant to this topic, including a Dutch language professional, a pediatrist, a pulmonologist, a sleep center technician, several oral health care professionals, and an epidemiologist, were asked to comment on the final version. Finally, we conducted cognitive interviews with three parents with children of different ages about their thoughts while filling in the questionnaire using the "thinking-aloud" method. The purpose of these interviews was to identify problems with the Dutch question-items and to evaluate whether respondents interpreted the questions as intended [35]. Final adjudication and documentation followed after any necessary adaptations. This final version was used in the second phase (Appendix A).

2.4. Second phase: Cross-cultural validity and reliability of the Dutch sleep-related breathing disorder scale

2.4.1. Sampling

The protocol for the study's analysis was registered on the AsPredicted platform (https://aspredicted.org/blind.php?x=DFZ_CYN). A "Castor" database was built to capture the electronic data of the study in a safe and secure manner. Parents/caregivers of 220 children aged between 2 and 18 years were consecutively recruited from 23 November 2020 to 20 March 2022. Participants from three different primary oral health care locations were included: one in the west and two in the east of the Netherlands. These were a mixed general dental and orthodontic clinic, a general dental clinic, and a pediatric dental clinic, respectively.

At the recruitment, parents/caregivers and children older than 12 years were asked to read an information letter and sign an informed consent form if they wished to participate in the study. Paper-administrations of the questionnaires were then completed by one of the parents/caregivers in the waiting room or at home. The questionnaires that were completed at home were returned at the next visit or by email. We planned the recruitments to occur on special pre-selected days, with qualified staff available to ensure proper data collection and storage. In the orthodontic clinic, all the questionnaires were completed in the first consultations before any treatment. An

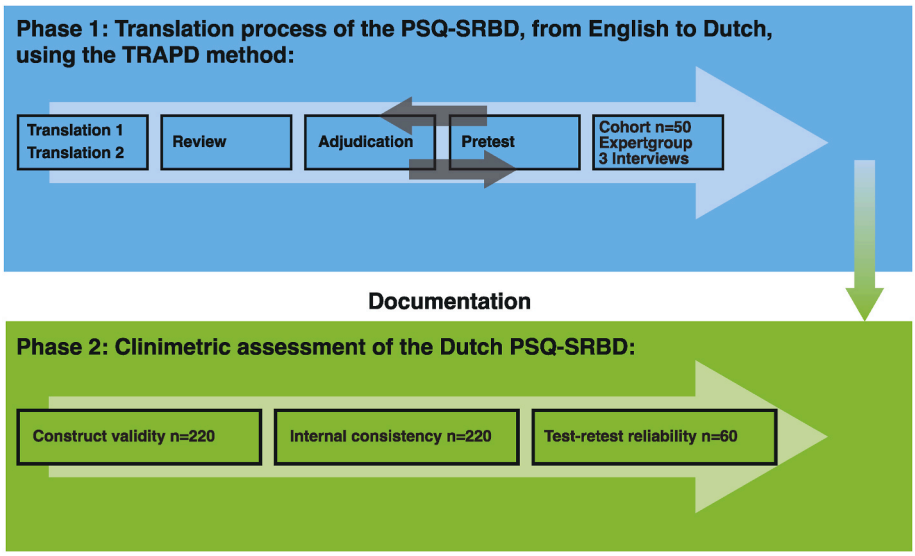

Fig. 1. Phase 1: The translation and cultural adaptation of the PSQ/SRBD scale according to the translation, review, adjudication, pretesting, and documentation team translation model. Phase 2: Clinimetric assessment of the construct (i.e. cross cultural) validity, the internal consistency and the test-retest validity of the PSQ/SRBD scale.

anonymous list of the non-respondents was also retained, noting the age and sex of the child and the reason for not participating. Participants with incomplete questionnaires were excluded from the analysis. The frequency of non-respondents and incomplete questionnaires was assessed in the evaluation of the study.

Descriptive analyses were performed for age, sex, BMI, comorbidity, sleep times, and the outcomes of the SRBD (sub)scales. Comorbidity was assessed by asking about long-term medical problems. If confirmed, participants were further interrogated about these medical problems, with particular attention paid to allergies due to their presumed prevalence in the study population. For BMI, children were rated as normal, overweight, or obese according to Dutch guidelines for obesity in children, which were differentiated for sex and age [36].

2.4.2. Cross-cultural validity

Factor analysis (FA) for the estimation of cross-cultural validity was applied to evaluate whether the performance of the Dutch question-items was an adequate reflection of the question-items in the English version while also showing a similar factor structure [11,37]. Before FA was conducted on the 22 question-items of the Dutch SRBD scale, the suitability of the data was checked with the Bartlett sphericity test and the Kaiser-Meyer-Olkin measure of sampling adequacy. These tests verify whether sufficient correlation exists among the question-items [38]. The first phase of the FA consisted of factor extraction using principal component analysis. The decision concerning the number of factors to retain was based on the following criteria:

a. The eigenvalue one test: An eigenvalue of a factor in FA is the amount of total variance explained by that factor. Only factors with an eigenvalue of more than one were retained [38].
b. Cattell's scree test for the identification of meaningful factors was performed by looking for a break in the slope of the scree plot, which suggests that after the break, where the flatter portion of the curve begins, the next factor is not adding much extra information [38].
c. The guidance of the four predetermined factors "breathing," "sleepiness," "behavior," and "others" in the original study [11].

The second step consisted of the component analysis, with oblique, promax rotation.

Reliability, through the estimation of internal consistency as defined by the degree of inter-relatedness among the question-items of the total scale and subscales, was assessed on the sample of 220 respondents using Cronbach's α. Correlation coefficients for the internal consistency above 0.7 were defined as acceptable [39,40].

Test-retest reliability was measured with 60 parents/caregivers who visited for a first orthodontic consultation in the mixed clinic. The participants completed the questionnaire twice with an interval of 2–6 weeks and were blinded to their earlier responses. Test-retest reliability was quantified using Spearman's correlation and the intraclass correlation coefficient (ICC). The ICC estimates and their 95 % confidence intervals (CIs) were based on a single measurement, absolute-agreement, 2-way random effect model. Based on the 95 % CI of the ICC estimates, values between 0.5 and 0.75, 0.75–0.9, and greater than 0.9 are considered moderate, good, and excellent reliability, respectively [41]. The standard error of measurement (SEM) was calculated with the following formula:

$$SEM = SD_{pooled} \sqrt{(1\text{-}ICC)}.$$

The SD_{pooled} is the $\sqrt{0.5*(SD_1^2 + SD_2^2)}$, where SD_1 and SD_2 are derived from the mean score of the first and second measurement [39]. The systematic error (mean difference between the first and second mean scores), the limits of agreements (LoA), and smallest detectable change (SDC) were assessed with the Bland-Altman method.

Sample size calculation was executed for the cross-cultural validity analysis, suggesting a sample of 10 subjects per question-item [39]. The SRBD scale contains 22 question-items, therefore, 220 respondents were recruited. For test-retest reliability, a sample size of 60 was estimated, with an ICC of 0.80 approximated from former studies to obtain an acceptable width for a 95 % CI of ±0.1 [27,39,42]. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, version 29).

3. Results

3.1. First phase: Translation and cultural adaptation

A synthesis of the two draft translations was made by choosing the best option for every question-item. Questions A6 ("Have trouble breathing, or struggle to breathe"), B9 ("… stop growing at a normal rate"), C10 ("… or squirms in seat"), and C18 ("or intrudes") required discussion and cultural adaptation. After the first adjudication, this synthetized version was pretested by a group of 50 parents/caregivers

who completed the questionnaires. The feedback in this stage resulted in the adaptation of question C14 "often acts as if driven by a motor." Furthermore, the instructions and layout were also clarified. The subsequent feedback by different experts mostly involved minor modifications and further simplification of the Dutch language. Finally, three mothers, with children aged 13, 6, and 3 years gave their thoughts in a cognitive interview and they commented on the text of the informed consent and on the snoring and behavior subscale questions. For question-item A6, they commented on whether having trouble breathing applied to every night and that the term "often" was difficult to estimate for the behavior subscale. Despite these latter comments, we decided to retain the wording given the absence of a better translation and to maintain semantic equivalence with the source version.

3.2. Second phase: sampling

In the second phase of the study, the Dutch questionnaires were collected until 220 children (135 girls, 85 boys) were included within the analysis. The median, mean, standard deviations, age ranges, sex, and relevant population characteristics are described in Table 1.

During the sampling, 12 patients did not participate, mostly because they were simply reluctant to complete the questionnaire or seemed to have difficulty understanding Dutch. Another 35 participants were excluded because their responses to the SRBD scale were incomplete. No specific pattern was observed for the question-items that received no responses.

Of the respondents, 8.2 % replied that their children used medication for sleep, behavior, or attention, of which 3.6 % and 9.1 %, respectively, had seen a doctor for sleep problems and behavior or attention problems. The response distributions for the 22 question-items of the Dutch SRBD scale are shown in Table 2. The total test scores for the SRBD scale and the validated subscales are shown in Table 3. The question-items with the highest positive scores for the subscales snoring, sleepiness, and behavior were A25: dry mouth on awakening (22.3 %), B6: hard to wake up (16.4 %), and C8: easily distracted (39.5 %), respectively (Table 2). Most parents/caregivers reported problems in the behavioral domain (Tables 2 and 3).

Table 1
Descriptive data of the study population.

Characteristics		N	na[a]	Mean (sd)	Median	Range
Age (yrs)		220	–	10.8 (2.9)y	11.1	2.4–18 y
Gender girls	61.4 %	135	–			
boys	38.6 %	85	–			
BMI (kg/m2)		178	42	17.8 (3.4)	17.2	11.1–36.7
Normal	84.8 %	151				
Overweight	14.1 %	25				
Obese	1.1 %	2				
Normal education	98.1 %	212	8			
Dutch language at home (always or mostly)	97.7 %	218	2			
Long term medical problems	14.5 %	32				
Allergy	9.1 %	20	1			
Other medical problems	8.2 %	18	1			
Bed time (h:m)	time	215	5	20:36	21:00	19:00–00:30
Wake-up time (h:m)	time	215	5	07:07	07:00	05:00–10:00
Sleep time (h:m)	hrs	215	5	10.20	10.15	08.00–12.30

[a] Not available.

Table 2
Descriptive statistics of the scores of the 22 question-items of the Dutch PSQ/SRBD scale.

Descriptive statistics of scores of the 22 items of the Dutch PSQ-SRBD, n = 220					
Item-questions			Yes n (%)	No n (%)	Don't know n (%)
1	A2	usually snores	12 (5.5)	196 (89.1)	12 (5.5)
2	A3	always snores	10 (4.5)	203 (92.3)	7 (3.2)
3	A4	snores loudly	21 (9.5)	195 (88.6)	4 (1.8)
4	A5	heavy breathing	42 (19.1)	168 (76.4)	10 (4.5)
5	A6	trouble breathing	10 (4.5)	193 (87.7)	17 (7.7)
6	A7	observed apneas	11 (5.0)	193 (87.7)	16 (7.3)
7	A24	mouth open during the day	44 (20.0)	162 (73.6)	14 (6.4)
8	A25	dry mouth on awakening	49 (22.3)	148 (67.3)	23 (10.5)
9	A32	nocturnal enuresis	15 (6.8)	205 (93.2)	0 (0.0)
10	B1	unrefreshed in the morning	33 (15.0)	181 (82.3)	6 (2.7)
11	B2	problem with sleepiness during the day	12 (5.5)	203 (92.3)	5 (2.3)
12	B4	sleepy per teacher	6 (2.7)	208 (94.5)	6 (2.7)
13	B6	hard to wake up	36 (16.4)	182 (82.7)	2 (0.9)
14	B7	morning headache	7 (3.2)	209 (95.0)	4 (1.8)
15	B9	delayed growth	10 (4.5)	207 (94.1)	3 (1.4)
16	B22	Obesity	14 (6.4)	200 (90.9)	6 (2.7)
17	C3	does not listen	48 (21.8)	170 (77.3)	2 (0.9)
18	C5	difficulty organizing	50 (22.7)	164 (74.5)	6 (2.7)
19	C8	easily distracted	87 (39.5)	131 (59.5)	2 (0.9)
20	C10	Fidgets	82 (37.3)	135 (61.4)	3 (1.4)
21	C14	on the go	38 (17.3)	180 (81.8)	2 (0.9)
22	C18	Interrupts	60 (27.3)	154 (70.0)	6 (2.7)

Table 3
The total test scores of the PSQ/SRBD scale and the validated subscales.

PSQ-SRBD (sub) scale scores	N	Mean (sd)	Median	Range
PSQ-SRBD (22 items)	220	0.15 (0.14)	0.11	0.00–0.64
Snoring (4 items)	220	0.11 (0.24)	0.00	0.00–1.00
Sleepiness (4 items)	220	0.11 (0.19)	0.00	0.00–1.00
Behavior (6 items)	220	0.28 (0.33)	0.17	0.00–1.00

3.3. Cross-cultural validity

Both the results of Bartlett's sphericity test ($\chi^2 = 1015.71$, df = 231; $p < 0.001$) and the Kaiser-Meyer-Olkin measure of sampling adequacy were sufficient to perform FA. Before rotation, the principal component FA presented six factors with a eigenvalue ≥1, which accounted for 61.47 % of the cumulative variance. Based on the eigenvalue one test, Cattell's scree test, and the predetermined factors of the original study, the number of factors was reduced to four (Fig. 2). Consequently, a promax rotation was performed with a forced four FA. For the

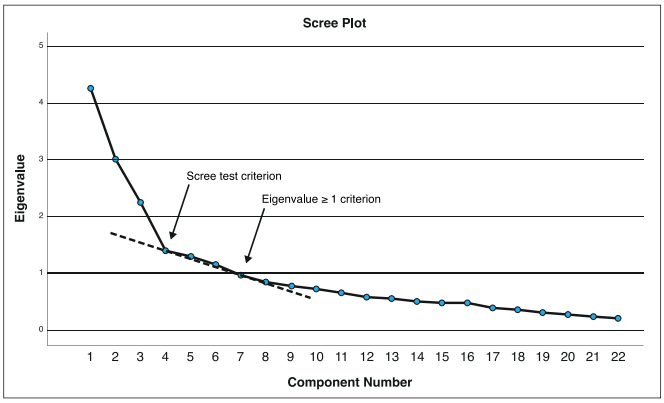

Fig. 2. Fig. 2. A scree plot of the FA, with 22 components on the x-axis and their eigenvalues on the y-axis.

interpretation of the structure matrix, only those loadings with a significance level of 1 % were retained. For our sample of 220 respondents, this meant that only factor loadings with a CV $\geq$ 0.35 were considered [38]. This resulted in 15 question-item loadings consistent with the original study. Except for question-item B6 "hard to wake up," no question-items loaded on two factors at the same time, and all question-items were unipolar (Table 4, Appendix B).

3.4. Reliability

Internal consistency measures using a Cronbach's α for the total SRBD scale and the validated subscales of snoring, sleepiness, and behavior were 0.77, 0.66, 0.49, and 0.83, respectively (Table 5). The test-retest measurement for the total scale showed a Spearman's correlation of 0.93, an ICC of 0.89, and a SEM of 0.05. The Spearman correlations for the subscales of snoring, sleepiness, and behavior were 0.78, 0.63, and 0.89, respectively. The ICCs for the subscales of snoring, sleepiness, and behavior were 0.81, 0.67, and 0.87, respectively. The Bland-Altman analysis showed a systematic mean difference between the two measurements of −0.002 and an LoA between −0.138 and 0.135 (Appendix C).

4. Discussion

Globally, the SRBD scale of the PSQ, has proven to be a valuable alternative to PSG for the screening of PSDB. Consistent with previous translations, our findings revealed that the Dutch version of the SRBD scale is also a valid and reliable tool.

During the translation phase of the SRBD scale, we followed the TRAPD approach recommended by the CCSG guidelines [32]. This approach does not require the frequently performed back-translation after the forward-translation, but focuses on cross-cultural adaptations [32,43,44]. Therefore, a pretest cohort, a team comprised of members with differing expertise and three cognitive interviews supplied the know-how necessary to select the optimal translated version for this study. During this process, specifically the question-items A6 and B9, similarly to the Thai version, and some behavior question-items (C10, C14, and C18), similarly to the French and Malaysian versions, had to be culturally adapted for the Dutch version [21,26,27].

In the second phase, the accuracy of the Dutch SRBD scale was assessed. Cross-cultural validity was confirmed by a similar factor loading pattern as in the original study, with question-items clustering around factors described as "breathing," "sleepiness," "behavior," and "other" (Table 4) [11]. Nearly all the question-items loaded significantly on a single factor and all the items were unipolar within the factors, which means the loadings are in the same direction, thus, enhancing the comprehensibility of the questionnaire. Only B6 "hard to wake up" loaded on two factors in different directions, which renders this single question-item difficult to interpret. The Dutch questions-items A32, B1, B7, and B9, unlike the FA of the original English question-items, grouped at the respective A and B distributions, which were initially allocated to the symptom complexes of snoring/breathing and sleepiness in the original scale development (Table 4) [11]. In addition, question-items A5, A6, and A7 did not load on the factor "breathing" as in the original study but, along with question-items B6 "hard to wake up" and B22 "obesity," clustered around the "other" factor. This difference in clustering might reflect the fact that the parents/caregivers of mostly healthy children in this study population may be less aware of breathing problems during sleep unless they are already familiar with other symptoms such as "obesity" and "hard to wake up," which are often related to pediatric OSA [2]. Hence, the divergence in factor-loading of the breathing question-items may derive from the difference in population, given that the original study reported higher prevalence of 25 % of participants that had PSDB, whereas only 13.6 % of the children in our study setting scored positively for PSDB. The reported scores of our sample are thereby in correspondence with previously reported prevalence of 11 % in general populations [5,45]. In fact, the Danish validation in a similar oral health care setting, with a comparable prevalence of SDB scores of 10.3 %, also reported the highest percentage of "don't know" for the breathing question-items in accordance with our findings [31] (Table 2). This interpretation of the differing results appears to be confirmed by one of the interviewed mothers, who stated that she did not know about her child's breathing problems during sleep as she did not sleep next to her child and therefore would clearly respond with "don't know" [32]. In addition, in contrast to the Chinese and French factor analyses, all the Dutch question-items related to behavior correlated well above 0.68, thereby supporting complete comparability with the English question-items in the inattention/hyperactivity symptom category [11,22,26].

The internal consistency (0.77) of the total Dutch SRBD scale was acceptable in accordance with the results of Chervin et al. and other translations (Table 5) [11,18,20–23,26–28]. The subscales ''snoring'' and ''sleepiness'' showed the lowest values at 0.66 and 0.49, respectively. These results were consistent with the Turkish and French validations, which also considered a reduced number of four validated question-items from these subscales in their analyses, conforming to the original validation [11,20,26,39].

Test-retest reliability between two measurements of the total SRBD scale was good to excellent, with an ICC of 0.89, a CI of 0.82–0.93, and a Spearman's correlation of 0.93, while the subscales ''snoring'' and behavior'' showed good reliability at more than 0.81, in accordance with the Thai and Brazilian versions [27,29]. The ICC of the subscale "sleepiness" was moderate in our study. The results from the Thai and Brazilian versions showed higher ICCs of 0.86 and 0.93, respectively, which might be due the inclusion of more question-items in the sleepiness subscale and a higher variance in the population, since not only the addition of items to the analysis, but also increased heterogeneity support higher questionnaire reliability [39]. To further asses the reliability of the total SRBD scale, we calculated a SEM of 0.05. As the SEM is not intuitive to interpret in the case of questionnaires, we established a BA plot that showed a systematic error of −0.002, which was insignificant consistent with the Thai validation [27]. The LoA between −0.138 and 0.135 indicates that 95 % of the measurement error will fall between these limits. The scores that fall outside these small limits, the SDC, could be useful for the interpretation of intra-individual change scores particularly in future research (Appendix C).

It should be noted that the SRBD scale was originally developed within a heterogeneous population. Our sample consisted of mainly healthy children, representative of patients seeking primary oral health care. In fact, it could be characterized as typical for a general population. For instance, 98.1 % of the children enrolled in normal education and 84.8 % were of normal weight, in close agreement with the nationally reported proportion of 87 % [46]. However, despite the characteristics

Table 4
Oblique rotated component matrix, promax FA. Loadings <0.35 were discarded as not meaningful.

PSQ-SRBD question-items		Factor 1	Factor 2	Factor 3	Factor 4
		Behavior	Breathing	Sleepiness	Other
C3	does not listen	0.701			
C5	difficulty organizing	0.735			
C8	easily distracted	0.766			
C10	fidgets	0.723			
C14	on the go	0.684			
C18	interrupts	0.728			
A2	usually snores		0.595		
A3	always snores		0.743		
A4	snores loudly		0.583		
A24	mouth open during day		0.370		
A25	dry mouth on awakening		0.538		
A32	nocturnal enuresis		*0.353*		*
B1	unrefreshed in morning			0.520	
B2	problem with sleepiness			0.788	
B4	sleepy per teacher			0.819	
B7	morning headache			0.485	
B9	delayed growth			0.386	
B6	hard to wake up		*-0.468*		0.379
B22	obesity				0.726
A5	heavy breathing				0.613
A6	trouble breathing				0.729
A7	observed apneas				0.508

*The shaded boxes indicate the locations of the factor loadings in the original study, where they differed from the FA of the Dutch PSQ/SRBD scale.

Table 5
Internal consistency, ICC, SEM and Spearman's correlation, of the Dutch PSQ/SRBD scale.*p < 0.001.

Dutch PSQ/SRBD, and the 3 subscales, snoring, sleepiness and behavior, number of question-items	Chronbach's Alpha n = 220	ICC* [1,2] n = 60	ICC 95 %, CI	SEM n = 60	Spearman's correlation* n = 60
	consistency	test-retest			
D-PSQ/SRBD [22]	0.77	0.89	0.82–0.93	0.05	0.93
Snoring [4]	0.66	0.81	0.70-0.88	0.04	0.78
Sleepiness [4]	0.49	0.67	0.50-0.79	0.07	0.63
Behavior [6]	0.83	0.87	0.78-0.92	0.05	0.89

of this general population, the complete Dutch SRBD scale, with all 22 question-items included, was sufficiently accurate.

The SRBD scale is already a globally utilized, practical, and non-invasive tool, designed for use in clinical research, facilitating international comparisons of studies on PSDB [11]. The current validation has demonstrated that the measurement properties of the Dutch SRBD scale are sufficiently accurate for use in research in a general population, such as is typically seen in oral health care settings. Moreover, international guidelines recommend the SRBD scale to actuate initial suspicions of pediatric OSA in the clinic [1,4,6]. It would be valuable for oral health care providers to integrate the SRBD scale into their daily practice to screen their patients, especially when orofacial deformities associated with PSDB are noted [6–8,10,47]. Hence, the SRBD scale is a helpful first step to evaluate suspicions of OSA and provide support for a referral decision for further evaluation and definitive diagnosis [48]. A limitation of the validation of the present study, however, is that definitive

diagnosis can only be verified by a PSG. Consequently, we could not asses the criterion validity with regard to sensitivity and sensitivity. Future studies should therefore further explore the criterion validity verified against the PSG, preferably in a more heterogeneous population, to compare the Dutch SRBD scale against the PSG as the reference standard.

5. Conclusions

After translation and cultural adaptation from the original SRBD scale of the PSQ, the Dutch scale was found to be both valid and reliable in a general population setting for the screening of PSDB.

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CRediT authorship contribution statement

Bibi E. Becking: Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization, Writing – review & editing. **Jop P. Verweij:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Ronald E.G. Jonkman:** Conceptualization, Writing – original draft, Writing – review & editing. **J.P. Richard van Merkesteyn:** Conceptualization, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **M. Elske Van den Akker-Van Marle:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2024.04.010.

List of abbreviations

CI	Confidence interval
CCSG	Cross-Cultural Survey Guidelines
COSMIN	COnsensus-based Standards for the selection of health Measurement INstruments
CV	Critical value
ESS	European Social Survey
FA	Factor analysis
ICC	Intraclass correlation coefficient
LoA	Limits of agreement
OSA	Obstructive sleep apnea
SEM	Standard error of measurement
SDB	Sleep-disordered breathing
PSDB	Pediatric sleep-disordered breathing
SDC	Smallest detectable change
SRBD	Pediatric sleep-related breathing disorder
PSG	Polysomnography
PSQ/SRBD scale	Sleep-Related Breathing Disorder scale of the Pediatric Sleep Questionnaire
TRAPD	Translation, Review, Adjudication, Pretesting, and Documentation
TVFF	Translation and Verification Follow-up Form

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