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Original Article

The French Sleep Disturbance Scale for Children

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ABSTRACT

Objective: The psychometric properties of the Sleep Disturbance Scale for Children (SDSC) have been shown to be accurate, even when translated into several languages. The aim of the present study was to translate, adapt, and validate the SDSC for a French-speaking population.
Methods: After forward- and back-translation, the tool was further translated and adapted into the French language. It was then pretested in terms of clarity on 33 French-speaking parents. Pretesting demonstrated that the questionnaire was well understood, indicating good clarity. During the validation phase, a total of 447 French-speaking parents of children aged between 4 and 16 years completed the SDSC. Among these, 66 children were diagnosed with sleep disorders by a pediatric specialist after a sleep consultation and polysomnographic recordings.
Results: The factor analysis revealed five factors: difficulty in initiating and maintaining sleep (DIMS), sleep breathing disorders (SBD), disorders of excessive somnolence (DOES), parasomnias (PARA) and non-restorative sleep (NRS). This psychometric structure is reliable and logical in comparison with the experts' diagnoses. Convergent validity, divergent and internal reliability are very good. Inter-parental concordance in scoring the child's sleep problem does show differences in the ways in which parents report their children's sleep patterns. Cut-off was calculated for the total score (45).
Conclusion: This study validated a 25-item French version of the questionnaire. The French SDSC could therefore be used to aid screening of sleep disorders in the general population.

1. Introduction

Sleep disturbances in children are very common. The prevalence of sleep-related problems is estimated to be between 35 and 46% [1,2]. Sleep disturbances are a major cause for pediatric consultation [3] which unfortunately often results in erratic treatment of young patients [4]. The consequences of sleep disturbances impact various areas of life [5] including learning [6], mood swings [7,8], health [9], and risk of obesity [10–15]. Sleep disorders are associated with inattention, mood variability, and limit-setting and rule-breaking behaviors [16]. Poor sleep is related to maladaptive social skills [17]. Some studies show that, if left untreated, sleep disturbances in childhood can persist with age [18–20]. Some sleep disturbances in children are chronic, others temporary, but even in temporary disturbances, long-term effects on the whole family can be observed [21], such as parental insomnia [22], marital problems [23], and depression [24].

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Despite their high prevalence, sleep disturbances are underdiagnosed in France [25]. While there are more than 57 scales and questionnaires currently being used to assess sleep and associated pathologies in children and adolescents [26,27]. Recently two reviews were published on pediatric sleep questionnaires; ie, questionnaires focusing on sleep problems in adolescents and questionnaires focusing on sleep times in children and adolescents [28,29]. To the best of our knowledge, none have yet been validated for a French-speaking population.

The Sleep Disturbance Scale for Children (SDSC) [30] has been reported to have good psychometric properties in studies undertaken worldwide (high internal consistency of 0.79 in controls and 0.71 in clinical groups, adequate test/retest reliability of $r = 0.71$ for total and single-item scores, and this across countries and hence languages) [31–34]. The 26 sleep complaints are scored by the caregiver on a five-point Likert scale investigating the complaint during the previous six months. The tool is provided at no cost and the average time taken to complete it is approximately 10 min. The items describe typical symptoms and behaviors relating to each of the most common sleep disorders among children. Indeed, Bruni's study, using non-clinical and clinical participants, demonstrates six significant factors, which represent the most common sleep disturbances in children and adolescents: disorders of initiating and maintaining sleep (DIMS), sleep-disordered breathing disorders (SDB), disorders of arousal (DA), sleep–wake transition disorders (SWTD), disorders of excessive somnolence (DOES), and sleep hyperhydrosis (SHY). The factors more closely resemble those of the Association of Sleep Disorders Centers classification (ASDC) [35] than the International Classification of Sleep Disorders categories (ICDS) [36], as these are better adapted to childhood disorders and more clinical in nature. The SDSC was developed for 6.5- to 15.3-year-old children, and recently also a version for 3- to 6-year-olds has been made available [37]. The SDSC for preschoolers assesses six types of sleep disorder: parasomnias (PARA), DIMS, SBD, DES, SH, and non-restorative sleep (NRS). Considering factor analysis differences, we decided to compare the French version of the SDSC to the newer categories of the ICSD-3 [38] which have six major categories: insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep–wake disorders, parasomnias and sleep-related movement disorders. This article describes the translation, adaptation and validation of the French version of the original SDSC for children aged 4–16 years old.

2. Method

The present study was carried out in three main phases (Table 1): (1) English–French forward- and back-translation of the SDSC and accompanying translation for better adaptation in French culture, (2) pretesting the comprehension of items in a sample of 33 parents, (3) psychometric validation of the French SDSC in 447 French children aged between 4 and 16 years, 381 children whose parents have never asked for a sleep consultation (control group), and 66 children diagnosed with a sleep disorder by a pediatrician specialized in sleep disturbances (clinical group). All parents signed a parental consent form. The study was previously approved by the Lyon Bérard Committee for the Protection of People (CPP).

2.1. Participants

2.1.1. Second phase: pretesting of the French SDSC

In pretesting, participants were 33 French-speaking parents (11 fathers and 22 mothers), students in Psychology.

Table 1
Distribution of all children who participated in the three phases of the study.

	$N = 480$ French-speaking children		
	Pretesting group ($N = 33$)	**Clinical group** Children in sleep consultation ($N = 66$)	**Control group** Children in school ($N = 381$)
Phase 1: translation and back-translation	Panel of sleep experts discussed the translated version		
Phase 2: pilot testing the comprehension	33		
Phase 3: psychometric analysis			
Validity			
Construct validity		66	381
Concurrent and divergent validity with diagnostics		66	
Concurrent and divergent validity with rhythm factors			381
Convergent validity		66	381
Reliability			
Internal reliability		66	381
Concordance between father and mother		36	
Diagnostic validity			
Distribution		66	381
Cut-off		66	381

2.1.2. Third phase: psychometric validation of the French SDSC

The French SDSC questionnaire was sent to 540 parents, either parents whose children attended schools which were partners in the study (control group), or parents having requested a pediatric sleep consultation in the pediatrics unit of the Mother–Child Hospital in Bron (Hopital Femme Mère Enfant, HFME) (clinical group). The SDSC was accompanied by an explanatory covering letter, a parental consent form, and sleep schedule questions. The child's sleep patterns were recorded: bedtime, wake-up time, nap time, and any changes in pattern between schooldays and weekends were obtained from parents. When returned, the questionnaires were checked to ensure that they were fully completed. Of the 540 questionnaires sent out, 93 questionnaires were not fully completed, and were thus excluded from the study. The remaining 447 questionnaires completed by parents of French-speaking children were used to test the psychometric properties of the French SDSC. These included 381 questionnaires of children whose parents have never requested a sleep consultation for their child (control group) and 66 questionnaires of children who were later seen in sleep consultation and subsequently diagnosed with sleep disorders by specialized sleep pediatricians (clinical group).

In the control group, all children were assessed by one parent. In the clinical group, 30 children were assessed by one parent and 36 were assessed by both parents. Parents of children of the clinical group completed the SDSC prior to the sleep consultation.

Control group: the control group sample came from children participating in a study on 'Acquisition of normative behavioral data' in a population of healthy children in schools in the Academy of Rhone (France).

Clinical group: the patients had an initial consultation with four certified sleep specialists (PF, AGP, AR, DW) who were also responsible for their treatment. Diagnostic procedures were based on sleep disorders according to the third edition of the International Classification of Sleep Disorders [39]. For insomnia, parasomnias, and circadian rhythm sleep–wake disorders,

diagnoses were made based on interviews with both the parents and patients, a complete clinical examination of the patients and analyses of sleep logs completed for the 15 days preceding the sleep consultation. In addition, for sleep-related breathing disorders, central disorders of hypersomnolence, and sleep-related movement disorders diagnoses, polysomnographic recordings (PSGs) were made in the Pediatric Sleep Laboratory (HFME), including an electroencephalography (Fp1-A2, C3-A2, O1-A2), left and right electro-oculograms, levatormenti surface electromyography, nasal pressure trough cannulae, respiratory efforts using thoracic and abdominal belts, position, electrocardiography (ECG), transcutaneous oximetry and end tidal CO_2 values during the night. Sleep stages, arousals and respiratory events were scored visually according to standard pediatric criteria [40]. Total sleep time (TST), total sleep period, sleep and REM sleep latencies, durations and percentages of non-REM sleep stage (N1, N2, N3), and REM sleep (R) were determined during night recordings as well as indexes of sleep fragmentation (ie, arousal index, respiratory arousal index (RAI)), apnea–hypopnea index, minimal and mean oxygen saturation during sleep, maximum end tidal CO_2 values in NREM and REM sleep and percent of CO_2 values greater than 50 mmHg during TST. Obstructive sleep apnea syndrome was defined by the presence of clinical criteria plus an obstructive apnea–hypopnea index greater than 1/h [39]. Obstructive hypoventilation was defined as being more than 25% of TST with CO_2 higher than 50 mmHg. For periodic limb movement syndrome, clinical signs and an index of periodic movement of more than 5/h were required [39]. All patients who met the criteria for narcolepsy [39] had: (i) complaints of excessive daytime sleepiness for at least three months, (ii) presence of clear-cut cataplexy and/or mean sleep latency during multiple sleep latency tests (MSLTs) less than eight minutes plus two or more sleep-onset REM periods on MSLT or night PSG. Indeed, for narcolepsy diagnosis, standard MSLTs were conducted after night PSG at 09:00, 11:00, 13:00, 15:00, and 17:00 h, which were terminated after 20 min if no sleep occurred, and after 15 min asleep if sleep occurred.

2.2. Procedure and statistical analysis

Results are presented as mean ± SD for quantitative variables and as the absolute frequency *N* followed by the observed percentage (%) for qualitative variables. Data normality was assessed graphically using aggPlot curve, and statistically using the Shapiro test. Where distributions were overly skewed, we undertook a natural log-transformation to normalize data. Single comparisons between the two groups were performed with the Student's *t*-test or the Wilcoxon test according to the distribution of quantitative variables and with the Fisher exact test for any qualitative data. Polychoric correlations were performed when ordinal variables showed less than 10 levels instead of the Pearson correlation in the case of normal distribution, or Spearman correlation where data distribution could not be considered normal. All statistical analyses were performed using questionnaires completed by the mothers, except for those analyses which tested understanding (mother or father) and concordance between parents (mother and father).

Statistical analyses were performed using R language R version 3.1.1 available at https://cran.r-project.org/and Mplus version 7.1. available at https://www.statmodel.com/. For all single tests, a significance level of 0.05 was chosen.

2.2.1. First phase: creation of the French version

The English version of the SDSC was translated into French by two bilingual and experienced translators, who worked independently without consulting each other, and who were both fluent in French (following Vallerand's procedure [41]). Translations were then submitted to all participating researchers (including four sleep specialists) in the course of a group meeting, and then combined. The agreed best elements from each were selected and further amendments were approved by all participants to create the first translation. An item relating to cataplexy was added in order to increase the chances of screening for narcolepsy-cataplexy [42].

In order to test the reliability of the translation, the French text was then back-translated into English by two other bilingual translators who had not taken part in the initial forward translation. The result of the back-translation was reviewed by the above-mentioned committee of experts. All differences were discussed and, where necessary, the French phrases were reconstructed until a consensus was obtained and the final version of the French SDSC was produced (Appendix A).

2.2.2. Second phase: pretesting of the French SDSC

In pretesting, understanding of the questions was analyzed according to the Vallerand cross-cultural adaptation procedure [41]. Participants were asked to assess their understanding for each item rated using a seven-point Likert-type scale of the retained French version. We then calculated averages and the first quartile of understanding scores for each item. Items which obtained average or upper quartile marks of less than four were modified to render them clearer.

2.2.3. Third phase: psychometric validation of the French SDSC

Validity of the scale. The construct validity of the SDSC scale was studied using exploratory factorial analysis with the principal component method of extraction and the Varimax method for rotation. We selected items with absolute factor loadings higher than 0.3, which did not cross-load on two different factors. We checked the validity of the model obtained with the remaining items using confirmatory factor analysis. The cut-off chosen for an acceptable model was: inferior to 0.06 for the mean square error of approximation (RMSEA) [43] and superior to 0.9 for the Comparative Fit Index (CFI) [44]. Concurrent and divergent validity was determined in two ways: (1) for the clinical group, polychoric correlations [45] between pediatricians' diagnoses [38] and the subscores corresponding to the retained factors were computed, (2) for the control group, Spearman correlations on the SDSC total and subscores according to factors relating to children's rhythms were computed. Finally, convergent validity was assessed on both control and clinical groups using Spearman correlation between the total and subscores taken pair-wise.

Reliability analysis. Internal consistency reliability of the retained scale was conducted using item-total correlation coefficients and Cronbach's alpha, which gives a measure of the internal consistency of the scale. Paired Wilcoxon test and Spearman rank order correlations were used to assess concordance between the two parents having completed the SDSC independently for the clinical group (ie, inter-rater reliability).

Diagnostic validity. First, an receiver operating characteristic (ROC) analysis was performed to identify optimal cut-off value using Youden criteria with binary classifier control group (children in school) and clinical group (children in sleep consultation).

We calculated the values of sensitivity, specificity, area under the curve (AUC), and cut-off for total score. Secondly, we derived scores with the formula used in other SDSC studies (T-score = 50 (value − mean)/standard deviation × 10) and applied the pathological threshold habitually adopted (T-score > 70 indicates a pathological score).

3. Results

3.1. Second phase: pretesting

The mean age of the pretesting group children was 7.4 years old (SD = 5.2, n = 33). None of the items received a score lower than four out of five. Three items were rated in the first quartile with a score of less than four out of five; these were phrases 'vivid dream-like', 'gasps for breath,' and 'unusually difficult.' As at least one parent in four assessed these terms as being unclear, the translation of these items was further reviewed by the study's committee of experts. Therefore, all items of the French version of the SDSC are concluded to be well understood.

3.2. Third phase: psychometric validation of the French SDSC

3.2.1. Validity of the scale

Mean age for the control group was 10.7 years old (SD = 2.7, $N = 381$) and for the clinical group 9.5 years old (SD = 3.4, $N = 66$). A significantly higher proportion ($p = 0.045$) of girls were present in the clinical group (53.3%) compared with the control group (39.4%). In the clinical group, 40 children were diagnosed with insomnia, 19 children with parasomnias (more precisely NREM-related parasomnias), 28 children with sleep-related breathing disorders (more precisely obstructive sleep apnea syndrome), 10 children with central disorders of hypersomnolence (more precisely narcolepsy, of which five with cataplexy), six children with circadian rhythm sleep–wake disorders, and six children with sleep-related movement disorders (more precisely restless leg syndrome). Thirty-eight children presented comorbidity of two disorders.

a. *Construct validity*

To analyze construct validity, an exploratory factor analysis was performed on the total sample ($N = 447$), according to the 26 items of the original SDSC. The first six factors obtained over 54% of the total variance but the distribution of items in the factors obtained do not follow any clinical logic, in comparison with Bruni's results [30] (six factors and 46% variance). Moreover, of items having a factor loading above 0.30, six items cross-loaded on two extracted factors. However, retaining only five factors, which accounted for 50.7% of variance (Table 2), organizes all items into sleep disorder categories that are clinically similar. For example, sleep hyperhydrosis and sleep breathing disturbances load onto the same factor in the French version, which reflects clinical reality. Items six and seven of the Bruni version regarding hypnic jerks and rhythmic movement disorders present the lowest factor loadings with extracted factors (above 0.30). These do not seem to be specific to any single disorder. In order to increase internal reliability of the scale and make subscores more discriminating, we decided to remove these two items. None of the other items cross-load onto more than one factor with a value greater than 0.3.

Remaining analyses were carried out on the 25-items version. These were obtained from a satisfactory adjustment (RSMEA of 0.06 and a CFI of 0.91) with a confirmatory factor analysis model of the French data according to their loading on five factors. The factor solution is presented in Table 3 including 25 items.

Table 2
Eigenvalues extraction with principal components analysis.

Factor	Value	% Total variance	Total value	Total %
1	5.65	22.60	5.65	22.60
2	2.34	9.35	7.99	31.94
3	1.86	7.43	9.84	39.38
4	1.47	5.88	11.31	45.26
5	1.37	5.49	12.69	50.74

Factor 1 is composed of items concerning DIMS. Factor 2 represents arousal disorders (sleepwalking, sleep terrors) and other parasomnias (PARA). Factor 3 comprises items focused on the factor of excessive somnolence (DOES). Factor 4 is composed of two factors of the original version: sleep breathing disorder and sleep hyperhydrosis (SBD). Factor 5 may refer to difficulties in waking up in the morning, therefore concerning NRS.

b. *Concurrent and divergent validity with diagnostics*

Factor scores were obtained by calculating the score of items that loaded onto each single factor. The total score is the sum of the 25 items retained, with a potential range from 25 to 125.

To validate the factor structure, polychoric correlations were performed for the clinical group ($N = 66$). Calculated subscores corresponding to the five factors (DIMS, PARA, DOES, SBD, NRS) and major diagnostic categories [38], the six following the sleep consultations (insomnia, parasomnias, circadian disorders), or the polysomnographic recordings (for sleep breathing disorder, central disorders of hypersomnolence and sleep-related movement disorders) of the clinical group were used. Results of the polychoric analysis are presented in Table 4.

According to the results, DIMS correlates positively and significantly with diagnoses of insomnia ($r_{po} = 0.74$, polychoric (po) correlation (r)) and, to a lesser extent, with diagnoses of circadian disorders ($r_{po} = 0.55$) and correlates negatively with diagnoses of parasomnias ($r_{po} = -0.32$), and central disorders of hypersomnolence ($r_{po} = -0.67$). PARA correlates with diagnoses of parasomnias ($r_{po} = 0.3$) and sleep-related movement disorders ($r_{po} = 0.39$). To a lesser extent, and non-significantly, PARA also correlates ($r_{po} = 0.20$) with diagnoses of sleep breathing disorder. PARA factor does indeed represent parasomnias including disorders of arousal. DOES factor correlates positively with central disorders of hypersomnolence diagnostic ($r_{po} = 0.66$) and therefore represents hypersomnolence. SBD correlates significantly with obstructive sleep apnea syndrome ($r_{po} = 0.47$) and restless leg syndrome ($r_{po} = 0.87$), which are often comorbid in children. SBD therefore represents a suspicion of sleep breathing disorders and/or of sleep-related movement disorders. NRS correlates significantly with diagnoses of circadian rhythm disorder ($r_{po} = 0.48$), within which difficulty waking up in the morning is very prevalent. NRS does not correlate with diagnoses of insomnia. NRS, like DIMS, correlates significantly with several factors relating to the child's rhythm (see the next section). It also correlates positively with DIMS ($r = 0.44$). This suggests that NRS represents non-restorative sleep or sleep deprivation.

c. *Concurrent and divergent validity with rhythm factors*

To compute the concurrent validity in the control group, we carried out Spearman correlations on the SDSC total and subscores according to factors relating to children's rhythms (Table 5).

Table 3
Factor analysis with Varimax normalized factors.

Items	Variance explained (%)	Factor loading	Item-total correlation	Alpha if deleted
Factor 1: Disorders of initiating and maintaining sleep (DIMS)	22.60			
1. Sleep duration		0.61	0.37	0.85
2. Sleep latency		0.71	0.39	0.85
3. Going to bed reluctantly		0.53	0.43	0.84
4. Difficulty in falling asleep		0.84	0.54	0.84
5. Falling asleep anxiety		0.56	0.46	0.84
8. Night awakenings		0.56	0.56	0.84
9. Difficulty in falling asleep after awakenings		0.62	0.53	0.84
Factor 2: Parasomnias (PARA)	9.35			
6. Hypnagogic hallucinations		0.37	0.38	0.85
10. Nocturnal hyperkinesia		0.50	0.49	0.84
15. Sleep walking		0.58	0.24	0.85
16. Sleep talking		0.61	0.41	0.85
17. Bruxism		0.45	0.22	0.85
18. Sleep terrors		0.71	0.40	0.85
19. Nightmares		0.55	0.44	0.84
Factor 3: Disorders of excessive somnolence (DOES)	7.43			
23. Daytime somnolence		0.73	0.41	0.85
24. Sleep attacks		0.79	0.25	0.85
25. Cataplexy		0.71	0.22	0.85
Factor 4: Sleep breathing disorders (SBD)	5.88			
7. Falling asleep sweating		0.46	0.44	0.84
11. Breathing problems		0.77	0.27	0.85
12. Sleep apnea		0.77	0.26	0.85
13. Snoring		0.54	0.22	0.85
14. Night sweating		0.51	0.44	0.84
Factor 5: Non-restorative sleep (NRS)	5.49			
20. Unusually difficult to awaken in the morning		0,72	0.46	0.84
21. Feeling tired with non-restorative sleep		0.67	0.57	0.84
22. Sleep paralysis		0.73	0.43	0.84
Total variance explained	50.74			

Table 4
Polychoric correlations between the five factors and the pediatrician's diagnoses for the clinical group following a consultation or a PSG ($N = 66$).

Diagnoses	DIMS	PARA	DOES	SBD	NRS
Insomnia (n = 40)	**0.74***	0.08	−0.26*	0.11	0.14
Parasomnias (n = 19)	−0.32*	**0.30***	−0.12	−0.06	−0.27*
Central disorders of hypersomnolence (n = 10)	**−0.67***	−0.04	**0.66***	−0.38*	−0.23
Sleep-related breathing disorders (n = 28)	0.10	0.21	−0.26*	**0.47***	−0.10
Circadian rhythm sleep–wake disorder (n = 6)	**0.55***	−0.11	−0.01	−0.12	**0.48***
Sleep-related movement disorders (n = 6)	0.05	**0.39***	−0.01	**0.87***	−0.09

DIMS, difficulties in initiating and maintaining sleep; DOES, disorders of excessive somnolence; NRS, non-restorative sleep; PARA, disorders of arousal and parasomnias; SBD, sleep breathing disorder and sleep hyperhydrosis.
*in bold scores $p < 0.05$.

Table 5
Spearman correlation between rhythm factors and logarithmically converted Sleep Disturbance Scale for Children (SDSC) total and subscores.

	SDSC	DIMS	PARA	DOES	SBD	NRS
Bed time on weekdays	0.23	**0.36**	ns	0.15	−0.11	0.20
Bed time on weekends	0.20	**0.38**	ns	ns	ns	0.16
Wake up time on weekdays	ns	ns	ns	ns	ns	ns
Wake up time on weekends (lie-ins)	0.22	**0.31**	ns	ns	−0.13	**0.29**
Duration of naps on weekdays	0.12	0.11	ns	0.19	ns	0.15
Duration of naps on weekends	0.13	ns	ns	0.14	ns	0.14
Duration of night time awakenings	**0.34**	**0.38**	0.20	0.15	ns	0.21
Duration of sleep on weekdays	**−0.25**	**−0.39**	ns	−0.15	ns	−0.17
Duration of nighttime sleep at the weekend	ns	ns	ns	ns	ns	0.07
Duration of nighttime sleep difference between weekday and weekend	0.16	0.21	ns	0.10	−0.14	**0.27**
Bedtime difference between week and weekend	ns	0.18	ns	ns	ns	ns
Wake-up difference between week and weekend	0.18	**0.30**	ns	ns	−0.15	**0.24**

DIMS, difficulties in initiating and maintaining sleep; DOES, disorders of excessive somnolence; NRS, non-restorative sleep; PARA, disorders of arousal and parasomnias; SBD, sleep breathing disorder and sleep hyperhydrosis; ns, not significant. ns: $p > 0.05$; bold: $r > 0.25$ and $p < 0.05$.

Late bedtimes during the week and weekend are most correlated with DIMS ($r = 0.36$). Lie-ins (only on the weekend) mainly correlate with DIMS and NRS scores. The duration of nighttime awakenings and shortened sleep during the week correlate with the DIMS score ($r = 0.36$ and $r = -0.39$, respectively). The difference in sleep duration between weekdays and the weekend correlate with DIMS ($r = 0.21$) and slightly more with NRS ($r = 0.27$). The difference in waking-up times between weekdays and the weekend correlated with DIMS ($r = 0.30$) and NRS ($r = 0.24$). Variations in rhythm are therefore mainly associated with DIMS and NRS. To a lesser extent, the duration of naps during the week corroborates the DOES score. SBD score is only weakly related to factors concerning rhythms. PARA is only associated with the duration of nighttime awakenings ($r = 0.20$). These correlations between scores on the scale and children's rhythms are perfectly logical in clinical terms.

d. *Convergent validity*

To test the convergent validity of the French SDSC, Spearman correlation was performed between the total score and subscores.

Table 6
Factor-total correlation matrix ($N = 447$).

	SDSC total	DIMS	PARA	DOES	SBD	NRS
DIMS	0.77*					
PARA	0.74*	0.34*				
DOES	0.48*	0.31*	0.32*			
SBD	0.51*	0.11	0.36*	0.14*		
NRS	0.70*	0.44*	0.39*	0.35*	0.18*	

DIMS, difficulties in initiating and maintaining sleep; DOES, disorders of excessive somnolence; NRS, non-restorative sleep; PARA, disorders of arousal and parasomnias; SBD, sleep breathing disorder and sleep hyperhydrosis; SDSC, Sleep Disturbance Scale for Children.
*$p < 0.01$.

Results are shown in Table 6. All subscales correlate positively and significantly with the total score. The DIMS factor correlates positively and significantly with PARA, DOES and NRS factors. We note that it does not seem to correlate with SBD, which makes clinical sense. SBD correlates positively with PARA, NRS, and DOES correlate logically. PARA correlates positively with the other four factors.

3.2.2. Reliability analysis

a. *Internal reliability*

Reliability analysis was performed on item scores using Cronbach's alpha, which was very high (standardized alpha = 0.85). The level of internal consistency is very good. The majority of items correlate with the total score (Table 3). We note, however, that seven items have a low item-total correlation (items: 11, 12, 13, 15, 17, 24, 25).

b. *Concordance between father and mother*

Among the 36 pairs of parents of the clinical group ($N = 66$) who both independently completed the SDSC, mothers' scores are substantially higher (mean total SDSC = 56.2, SD = 12.2) than fathers' scores (mean total SDSC = 50.2, SD = 13.2) for both the total score and subscores (except in the case of DIMS). In other words, fathers are less likely to report signs and symptoms of their children's sleep than mothers ($p_{Wilcoxon} = 0.0007$, $p < 0.001$). The Spearman correlation between parental responses for all variables ranged from 0.66 to 0.93 across all variables with a p value of less than 10^{-3} in all cases.

3.2.3. Diagnostic validity

a. *Distribution*

For the control group, the total score (ranging from 25 to 75) gave a skewed distribution (Shapiro Wilk W = 0.92, $p < 0.0001$) and for the clinical group, the SDSC total score (ranging from 32 to 83) gave a normal distribution (Shapiro Wilk W = 0.98, $p = 0.45$). Results are presented in Fig. 1. As a skewed distribution was obtained for the clinical group, the score was transformed to natural logarithm for statistical analysis. The total T-score and subscores differ significantly between the two groups, control and clinical, on all five factors ($p < 0.0001$).

b. *Cut-off*

The ROC analysis, taking the control and clinical groups as a binary classifier, showed that the French SDSC had good diagnostic accuracy (AUC = 0.884). The cut-off of the total score is determined by the best compromise between sensitivity (0.81) and specificity (0.82) and is set at 45. With the cut-off, the French version correctly detects 82% (316/381) of the control group and 79% (52/66) of the clinical group. By applying standard deviation formula for pathological threshold (T-score > 70), a recording sheet based on the T-score was computed which enabled the comparison between the child's total and factor scores with normal values (Appendix B). The pathological threshold (T-score > 70) for subscores were: 21 for DIMS, 17 for PARA, 5 for DOES, 12 for SBD and 11 for NRS.

4. Discussion

This study validated a modified version of the SDSC for French-speaking children (aged 4–16 years old). The French version consists of 25 items divided into five factors: PARA, DIMS, SBD, DOES, and NRS.

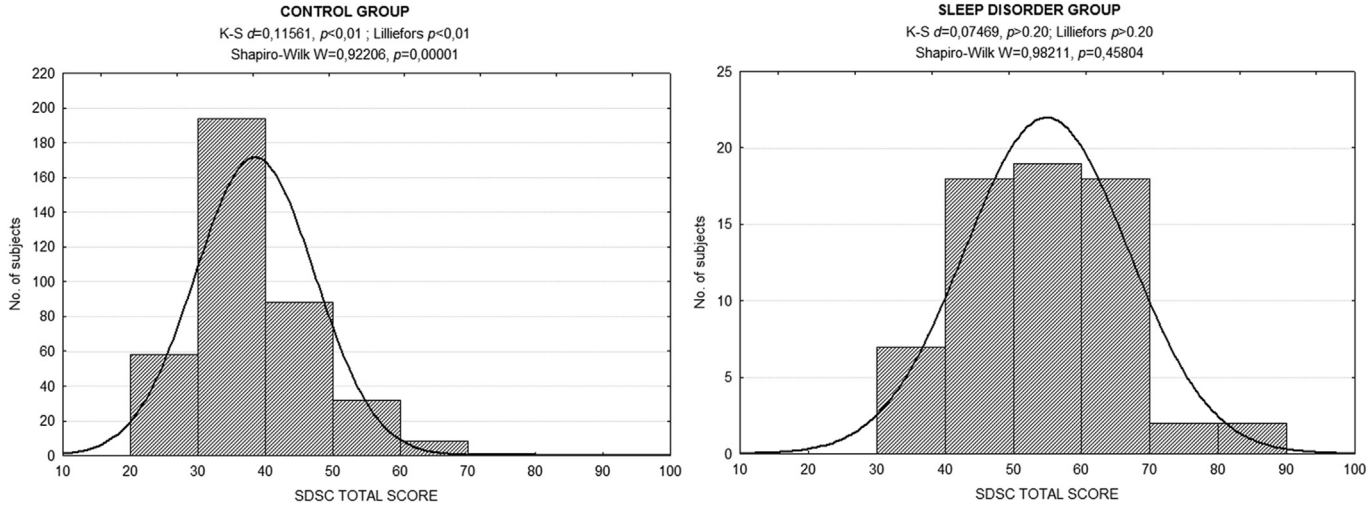

Fig. 1. Distribution of the Sleep Disturbance Scale for Children (SDSC) total score for control and clinical group.

4.1. Participants

The control group sample is large and representative of the general population of school children, as it comprises children from various schools and with different socio-economic backgrounds. The clinical sample nevertheless presents some limits. The number of children with some diagnoses was low (for instance: only six circadian rhythm sleep disorders and six sleep-related movement disorders). Likewise, the control group cannot be considered to represent a healthy group, as it is known that prevalence of child sleep disorders is high in the general child population [39] and, therefore, that the control group will invariably comprise a substantial number of children suffering from at least one disorder. As such, comparison of the two groups can be criticized. Nevertheless, children arriving in the reference center (often having waited over a year for their consultation) present a significant childhood sleep disorder. This limit is not specific to the present study as it is common to all SDSC validation studies carried out thus far. Finally, it would be interesting to validate this scale for preschool-aged children (one to four years old).

4.2. Validity

Construct validity is good. The French version presents some specificity in comparison to other cultural versions. The French version presents three unique features: (1) Compared to other linguistic adaptations, the French version comprises an additional item assessing cataplexy in order to facilitate screening of narcolepsy-cataplexy. (2) Two items which are non-specific to sleep disorders, hypnic jerks and rhythmic movement disorders, were removed for three reasons—these two items did not add any value to the construct validity, given that these symptoms are not specific to any sleep disorder in particular. Moreover, from our clinical experience, these items are often interpreted by parents as the child being agitated while unable to fall asleep, such as tossing and turning, or turning several times in their bed when falling asleep. (3) The SBD and SHY factor of the original version are combined in a single factor.

Factor analysis applied with six factors according to Bruni's original items (with or without cataplexy items) ranked items in chaotic subscores without any clinical reality. The factor structure of this French version is not comparable to the original version; international comparison of the SDSC with the French version should be limited. Nevertheless, we can observe that the factor structure is similar to the factors found by Romeo et al. [37] in a preschool sample, especially for PARA and NRS. Similarly, despite differences between the factor structure of the French version and other cultural versions, concurrent validity is very good, subscores are highly relevant and logical with regards the diagnoses made by the experts. The relationship between subscores is also entirely logical, while convergent and divergent validity are also reasonable.

The factor analysis corresponds approximately to the ICSD-3: DIMS factor is related to insomnia, PARA factor is related to parasomnias, DOES factor is related to central disorders of hypersomnolence, SDB factor is related to sleep-related breathing disorders and NRS is related to Circadian rhythm sleep–wake disorders. However, there is no specific factor for sleep-related movement disorders, perhaps due to the fact that the SDSC is a hetero evaluation, and observing the night movements of their children is difficult for parents.

4.3. Reliability analysis

Internal reliability is good. Mothers and fathers do not score the behaviors associated with their children's sleep in the same way. As already mentioned, the majority of the scales for the control group were completed by the mothers. In light of the authors' clinical experience, it is suggested that this version of the SDSC be completed by the mother, or the parent who is most often with their child at night.

4.4. Distribution

Distributions of the global score for the control group and clinical group are significantly different, even when considering that some children in the control group will have had sleep disorders. It is interesting to note that the distributions in this study are comparable to those observed by Bruni et al. [30,37].

4.5. Cut-off

Regarding the AUC, we can conclude that the diagnosis validity is satisfactory.

5. Conclusion

The French SDSC presents psychometric qualities which are as good as versions validated in other languages [30–34]. It comprises a total of 25 items. It is an excellent screening tool, both for alerting and reassuring parents regarding how normal their child's sleep is, and for supporting pediatric professionals in making a sleep diagnosis and advising on any treatment. Interpreting this questionnaire for diagnostic purposes should be combined with the analysis of a sleep diary completed over a period of at least two weeks. The total score should be interpreted as a global indication and serve rather as a measure for monitoring the child's sleep patterns over time. The clinician will focus especially on the SBD factor, which requires a more extensive clinical exam, especially looking at the child's body mass index (BMI) and the size of their tonsils and adenoids. Scores which are higher than the threshold for DOES and SBD should result in the child being referred for a consultation with a pediatrician specialized in childhood sleep (lung specialist, ear, nose and throat specialist, or a specialist sleep center). A high DIMS score invites the clinician to provide behavioral recommendations adapted to the child's insomnia [46]. A high NRS score suggests that future research should further clinically explore circadian rhythm sleep–wake disorders [47].

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Appendix A. The French version of the Sleep Disturbance Scale for Children (SDSC)

The French version of this scale is available at: http://echelle.sommeilenfant.org.

Echelle des troubles du sommeil de l'enfant de 4 à 16 ans

Prénom de l'enfant : ..... Date de naissance: ..... Taille :.....
Nom de l'enfant :..... Sexe : □ Garçon □ Fille Poids :.....

Pour répondre à ce questionnaire, basez-vous sur les observations que vous avez pu faire durant les 6 derniers mois et cochez les cases correspondant le mieux à ce que vous avez observé de votre enfant. Merci de répondre à toutes les questions.

	Plus de 9h	8h à 9h	7h à 8h	5h à 7h	Moins de 5h
1. Combien d'heures l'enfant dort-il la plupart des nuits ?	(1)	(2)	(3)	(4)	(5)

	Moins de 15 min	15-30 min	30-45 min	45-60 min	Plus de 60 min
2. Combien de temps après sa mise au lit l'enfant met-il habituellement pour s'endormir?	(1)	(2)	(3)	(4)	(5)

	Jamais	Rarement *1 à 3 fois / mois*	Parfois *1 à 2 fois / semaine*	Souvent *3 à 5 fois / semaine*	Toujours *Tous les jours*
3. L'enfant va au lit avec réticence	(1)	(2)	(3)	(4)	(5)
4. L'enfant a des difficultés à s'endormir	(1)	(2)	(3)	(4)	(5)
5. L'enfant ressent de l'anxiété ou des peurs au moment de s'endormir	(1)	(2)	(3)	(4)	(5)
6. Lorsque l'enfant s'endort, il semble vivre ses rêves	(1)	(2)	(3)	(4)	(5)
7. L'enfant transpire excessivement à l'endormissement	(1)	(2)	(3)	(4)	(5)
8. L'enfant se réveille plus de 2 fois par nuit	(1)	(2)	(3)	(4)	(5)
9. L'enfant a des difficultés à s'endormir à nouveau après s'être réveillé dans la nuit	(1)	(2)	(3)	(4)	(5)
10. Dans son sommeil, l'enfant a des mouvements brusques ou des secousses des jambes ou il change souvent de position durant la nuit ou encore il jette les couvertures au pied de son lit	(1)	(2)	(3)	(4)	(5)
11. L'enfant a des difficultés à respirer durant la nuit	(1)	(2)	(3)	(4)	(5)
12. L'enfant fait des pauses respiratoires ou cherche sa respiration pendant son sommeil	(1)	(2)	(3)	(4)	(5)
13. L'enfant ronfle	(1)	(2)	(3)	(4)	(5)
14. L'enfant transpire excessivement pendant la nuit	(1)	(2)	(3)	(4)	(5)
15. Vous avez assisté à un épisode de somnambulisme de l'enfant (il se lève et déambule pendant son sommeil)	(1)	(2)	(3)	(4)	(5)
16. Vous avez déjà entendu l'enfant parler dans son sommeil	(1)	(2)	(3)	(4)	(5)
17. L'enfant grince des dents pendant son sommeil	(1)	(2)	(3)	(4)	(5)
18. L'enfant se réveille en hurlant ou est confus au point qu'il est impossible de l'approcher, mais il n'a aucun souvenir de ces événements le matin suivant	(1)	(2)	(3)	(4)	(5)
19. L'enfant fait des cauchemars dont il ne se rappelle pas le matin venu	(1)	(2)	(3)	(4)	(5)
20. L'enfant est difficile à réveiller le matin	(1)	(2)	(3)	(4)	(5)
21. L'enfant se réveille le matin en se sentant fatigué	(1)	(2)	(3)	(4)	(5)
22. L'enfant se sent incapable de bouger quand il se réveille le matin	(1)	(2)	(3)	(4)	(5)
23. L'enfant est somnolent durant la journée	(1)	(2)	(3)	(4)	(5)
24. L'enfant s'endort brutalement, de façon inattendue, à l'école ou lors de ses activités	(1)	(2)	(3)	(4)	(5)
25. Lorsque l'enfant rit, il a une perte de tonus musculaire qui peut entraîner un affaissement du corps ou une chute	(1)	(2)	(3)	(4)	(5)
Trouble de l'initiation ou du maintien du sommeil (somme des items 1, 2, 3, 4, 5, 8, 9)					
Parasomnie (somme des items 6, 10, 15, 16, 17, 18, 19)					
Somnolence dirune excessive (somme des items 23, 24, 25)					
Trouble respiratoire du sommeil (somme des items 7, 11, 12, 13, 14)					
Sommeil non réparateur (somme des items 20, 21, 22)					
Score total (somme des 5 facteurs)					

Appendix B. Sleep Disturbance Scale for Children (SDSC) scoring sheet

Name: ..... Age:.....

	TOTAL	DIMS	PARA	DOES	SBD	NRS	
T-score							T-score
100	83						100
99	82	33					99
98	81		25				98
97	80	32		7	18		97
96	79						96
95	78						95
94		31	24				94
93	77				17		93
92	76	30					92
91	75		23				91
90	74	29					90
89	73						89
88	72		22		16		88
87	71	28				15	87
86	70						86
85		27					85
84	69		21	6	15		84
83	68	26				14	83
82	67						82
81	66		20				81
80	65	25			14		80
79	64					13	79
78	63	24	19				78
77	62						77
76		23			13		76
75	61					12	75
74	60		18				74
73	59	22					73
72	58				12		72
71	57	21	17	5		11	71
70	56						70
69	55	20					69
68			16		11		68
67	54					10	67
66	53	19					66
65	52		15				65
64	51	18			10		64
63	50					9	63
62	49						62
61	48	17	14				61
60	47						60
59		16			9	8	59
58	46		13				58
57	45	15					57
56	44						56
55	43		12		8	7	55
54	42	14					54
53	41						53
52	40	13					52
51	39		11		7	6	51
50		12					50
49	38						49
48	37		10				48
47	36	11			6	5	47
46	35						46
45	34	10	9				45
44	33						44
43	32	9			5		43
42	31						42
41			8				41
40	30	8					40
39	29						39
38	28	7	7				38
37	27						37
36	26	6					36
35	25		6				35
34	24						34
33	23	5					33
32							32
31	22		5				31

Conflict of interest

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