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Original Article

French validation of the sleep disturbance scale for children (SDSC) in young children (aged 6 months to 4 years)

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ABSTRACT

The sleep disturbance scale for children (SDSC) has been translated and adapted into several languages and its psychometric properties are good. Notably, a French version has been validated for 4- to 16-year olds. The objective of the current study was therefore to adapt and validate the SDSC for French young children (aged 6 months to 4 years).

Method: 421 French-speaking mothers of children aged between 6 months and 4 years completed the SDSC and the Brief Infant Sleep Questionnaire (BISQ) which is specifically for young children. Of these, 105 children were diagnosed with sleep disorders (clinical group) during a sleep consultation, and 316 completed the SDSC and BISQ in a network of nurseries (control group). Several factor analyses were conducted to identify the most consistent factor structure for this sample.

Results: Three items from the previous version were deleted due to lack of clinical relevance for this age group. The best factor analysis revealed six factors, comparable to the Italian version of the SDSC for children: Disorders of Initiating Sleep, Disorders of Maintaining Sleep, Sleep Hyperhidrosis, Sleep Breathing Disorders, Parasomnias, and Non-Restorative Sleep and Excessive Somnolence. This psychometric structure is reliable and aligned with expert diagnoses. The convergent validity, and divergent and internal reliability were acceptable.

Conclusion: This study validates a 22-item SDSC for French young children. Coupled with some questions from the BISQ, the SDSC could therefore be used to facilitate the detection of sleep disturbances in children aged between 6 months and 4 years old.

1. Introduction

Sleep disturbances are a major cause for pediatric consultation. These are most common during the first five years of life [1]. Indeed, the prevalence of sleep-related disturbances is estimated to be between 35% and 46% [2]. In young children, child sleep disturbances perturb the whole family, increasing marital conflicts and the risk of depression in parents [3]. Sleep disorders which are not treated early will tend to persist over time [4]. Treatment is complex, as there are many kinds of sleep disorders and etiologies [5]. Diagnosis requires consideration of a combination of medical and psychological information about the child, concerning organic, developmental, psychological, behavioral and dietary aspects. As such, questionnaires are a highly useful tool for clinical practice.

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The Sleep Disturbance Scale for Children (SDSC) was initially developed for children between the ages of 6 and 15 years old [6]. It comprises questions concerning their sleep over the previous six months and is hetero-assessed by their parents on a 5-point Likert scale. It is free and the time required for completion is approximately 10 min. The SDSC has the best psychometric properties (high internal consistency of 0.79 among control subjects and 0.71 among clinical subjects) [7]. It has been validated in several languages: Portuguese [8], Chinese [9], Flemish [10], French [11] and Australian [12]. It was also validated among an Italian population of 3–6 year olds [13]. The French version was only validated among 4 to 16-year olds. To enable diagnosis and therapy for sleep disturbances at an earlier age, the French questionnaire thus needed to be adapted to a population of children (6 months–4 years old). Characteristics of sleep (nocturnal sleep duration, number of night awakenings, etc.) that are modified in case of sleep disorders have been shown to be correlated with several factors together called “Sleep Hygiene” [14] which are relevant for younger children: nighttime feeding [15], television, computer or mobile device use [16,17], sleep rituals [18], and parental behaviors [19]. International recommendations stipulate the appropriate behaviors to adopt regarding nighttime awakenings [20]. The risk of sudden infant death should also be systematically assessed, particularly regarding the child's position when they sleep and the practice of co-sleeping [21]. Some aspects of this sleep hygiene can be collected using part of the Brief Infant Sleep Questionnaire (BISQ) [22,23] and questions about the child's exposure to screens [17].

The main objective of the present study was to validate a French version of the SDSC adapted for preschool (6 month-to-4-year-old) Children (SDSC-Y) by starting from the previous 25-item French version of the SDSC [11]. The construct validity of the SDSC-Y was assessed using exploratory (EFA) and confirmatory (CFA) factorial analyses, its reliability using standard Cronbach's alpha. The concurrent criterion validity was studied using validated aspects of sleep hygiene, assessed using the BISQ in the framework of a structural equation modeling (SEM). Discriminant validity between control and clinical groups was studied and a ROC analysis was performed to assess the diagnostic validity of the SDSC-Y.

2. Method

The present study is the second psychometric validation of the French SDSC and follows the study of 4–16 years old by Putois et al., [11]. Both studies were approved by the Léon Bérard Committee for the Protection of Persons in Lyon (CPP). All the mothers who participated in the study signed a consent form. They completed both the SDSC and extended BISQ.

2.1. Participants

This study comprised two samples: a clinical group of children having sought consultations with the last-cited author of the present paper, and a control group of children attending partner nurseries. According to information provided by parents, all children with reported signs of mental, developmental or physical disabilities or receiving on-going prescription medication (antiepileptic drugs, antihistaminic drugs, benzodiazepine, melatonin) were excluded.

The clinical group comprised 105 children. The French versions of the SDSC [11] and BISQ were completed by the child's mother prior to the consultation. Diagnoses were made during a one-hour consultation with a qualified sleep specialist (the last-cited author) and established according to the criteria set out in the third edition of the International Classification of Sleep Disorders [20]. The consultation involved a clinical examination of the child, an interview with the mother and analysis of the sleep diary recorded over at least the 15 days preceding the consultation.

For the control group, the French version of the SDSC and BISQ questionnaires were sent to 780 parents of children attending the partner nurseries involved in this study and were completed by the children's mother, as for the control group. These parents had never sought a consultation about their children's sleep. Of the 780 questionnaires sent, 321 were returned, ie a 41% response-rate. 5 were not correctly completed (missing age or gender) and were therefore excluded from the analyses. In total, 316 children were included in the control group.

2.2. Elaboration of the SDSC-Y based on the SDSC

A committee of experts (Benjamin Putois, Patricia Franco and Marie-Josèphe Challamel) conferred and decided to remove the items regarding sleepwalking [24], bruxism [25,26] and narcolepsy-cataplexy [27] (items 15, 17, and 25 according to Putois and colleagues [11]), given their low prevalence for young children. This adaptation thus yielded a 22-item questionnaire (the age-adapted SDSC) (See Appendix A).

2.3. Elaboration of the Sleep Hygiene Scale for Children based on the BISQ

The BISQ assesses aspects of a young child's day and night: sleep habits, sleeping position, co-sleeping, information relating to sudden infant death, breastfeeding, any sleeping rituals, sleep routines such as bedtime and parental behavior when their child goes to sleep or with nighttime awakenings. The translation was examined by the study's committee of experts. All BISQ items of the French version are deemed to be well understood. The BISQ contains no numerical scale, it is merely a descriptive questionnaire with yes-no questions. Two items about screen exposure were added [17]. In order to control the influencing factors of early childhood sleep disorders, only items correlated with the SDSC total score and respected international recommendations about appropriate behaviors to adopt regarding sleep hygiene [14] were selected for the statistical analysis. The derived version was named the Sleep Hygiene Scale for Children.

2.4. Procedure and statistical analysis

The results are presented in the form of mean ± standard deviation for quantitative variables, and in the form of absolute frequency N, followed by the percentage observed (%) for qualitative variables. Normality of data was graphically assessed using the curve, and statistically using the Shapiro test. Simple comparisons between the two groups were carried out using the Student t-test or Wilcoxon rank-sum test, depending on the distribution. Pearson or Spearman correlations were carried out depending on the distribution of the sample.

2.4.1. Item characteristics

The mean and SD of item scores were reported with skewness and kurtosis to assess the non-normality of the item distribution.

2.4.2. Construct validity

An exploratory factor analysis was conducted by taking into account the ordinal nature of the item scores and using geomin rotation because subdimensions of the SDSC-Y were expected to be

correlated as the whole scale measured global latent sleep disorders. Successive models with an increasing number of factors were fitted. A root mean square error of approximation (RMSEA) < 0.06 and comparative fit index (CFI) value >0.95 were considered representative of a factor analysis well-fitting for all [28]. Extra criteria could be considered in order to fine tune the model selection. The selected model must have all factors with eigenvalues above one. An increase of 1% of the CFI between two successive models was considered as an improvement of the fit. When a model with a specified number of factors enables a plausible description of the data, the chi-square statistics would be expected to have the magnitude of associated degrees of freedom. After EFA, items were then affected to one factor according to their correlation (>0.30) and their clinical meaning. Then, a confirmatory factor analysis was performed to validate the retained factor structure using robust weighed least squares [29].

2.4.3. Items and scale reliability

Reliability of internal consistency of the scale and its subscales was assessed using Cronbach's alpha [30] which estimates the percentage of the total sum of scores variability explained by the underlying sleep propensity. This coefficient indicates an acceptable reliability when over 0.70 [31]. The contribution of each item to the reliability of the whole scale was studied (i) by re-estimating the Cronbach's alpha after the deletion of each item in turn and (ii) by examining relationships between scores of each item and the total score of the SDSC-Y. For the last point the corrected item-total score correlations were calculated (by excluding the corresponding item from the total SDSC-Y score).

2.4.4. Concurrent criterion validity

The concurrent criterion validity was assessed using the 12-item Sleep Hygiene Scale for Children, the factor analysis of which was investigated as explained above for the SDSC-Y. The correlation between the latent dimension or subdimensions of the SDSC-Y and the latent sleep hygiene dimensions were estimated using structural equation modeling. Standardized coefficients were reported with their 95% confidence interval.

2.4.5. Discriminant and diagnostic validity

Discriminant validity was calculated using the difference in mean between the control and clinical groups. First, scores were obtained for the control group (group of nursery children) using the formula used in other studies [13] $\left(T-score = 50+10\times\left(\frac{Value-mean}{Standard\ Deviation}\right)\right)$ and the usual pathological threshold was employed (T-score > 70 indicates a pathological score). Secondly, an analysis of the performance characteristics of the test (ROC) was carried out to identify the optimal threshold value using Youden criteria with the control group (nursery children) and the clinical group (children in sleep consultations). The values of sensitivity, specificity, area under the curve (AUC) and threshold for the total score were calculated. This ROC analysis was carried out for the whole total score of the SDSC-Y.

Standard statistical analyses were performed using R language "R version 3.5.2" available at http://cran.r-project.org/ and Mplus 7.11 version 7.1 software available on the website https://www.statmodel.com/ for factor analysis and SEM using robust weighed least squares due to the potential non-normality of item scores [32]. The R packages used were MplusAutomation [33], psy for Cronbach coefficient and pROC for ROC analysis. A significance threshold of 0.05 was chosen unless otherwise indicated.

3. Results

3.1. Participants

The mean age for the control group was 22 months with 60% boys (standard deviation = 11 months, N = 316) and for the clinical group, the mean age was 24 months with 47% boys (standard deviation = 12 months, N = 105). In the clinical group, all 105 children received a diagnosis of insomnia, with 10 presenting several comorbidities: three with an ear-nose-throat disorder, three with gastro-esophageal reflux, three with asthma and nine with sleep breathing disorders, and eight children presented two disorders simultaneously. In this same group, 10 children no longer suffered from insomnia (in remission), but the parents still reported issues concerning their children's sleep.

3.2. Item descriptions

All items had left-tailed distribution with positive skewness coefficient (Supplementary Table 1, and Supplementary Fig. 1, pages 2–6). Height items (1, 11, 12, 16, 17, 20, 21, and 22) had extreme skewness and kurtosis denoting a long-right tail and a fat left tail. No children slept less than 5 h per night or had sleep attacks at least three times per week. More than 90% of the subjects scored the first response category for three items (12. Sleep apnea, 20. Sleep paralysis and 22. Sleep attacks) as if these items were little relevant to this population (fat left tail - high kurtosis). All items correlated significantly with the total score. We can note, however, that seven items had a low item-total correlation <0.30 (items: 11, 12, 13, 15, 18, 20, 22). These items, except for item 18, seemed to behave more like dichotomous or trichotomous items.

3.3. Construct validity of the SDSC-Y

The results of the EFA for the SDSC-Y are summarized in Table 1. Two models with all eigenvalues above one demonstrated acceptable fit: the 5-factor and 6-factor models explained 64% and 69% of the total variance respectively. CFI decreased more than 1% between both models and the ratio of Chi-square statistics on the degree of freedom was closer to one for the 6-factor model. With the 5-factor solution, nine items (1, 7, 9–12, 14, 21–22) cross-loaded, while only two items (1, 6) cross-loaded with the 6-factor solution (Table 2). The 6-factor model was therefore retained: factor 1 is Disorders of Initiating Sleep (DIS), factor 2 is Disorders of Maintaining Sleep (DMS), factor 3 is Sleep Hyperhidrosis (SHY), factor 4 is Sleep Breathing Disorders (SBD), factor 5 is Parasomnia (PARA), and factor 6 is Non-Restorative Sleep and Excessive Somnolence (NRSES). The first-order confirmatory factorial analysis model with 6 factors showed an acceptable fit (RMSEA = 0.053 < 0.060; CFI = 0.958 > 0.90). As the two latent variables DIS and DMS were highly correlated with items having close meanings, it was supposed that these two latent variables DIS and DMS were explained by a latent variable DIMS. In addition, the overall sleep disorders were supposed to be explained by five latent variables (F12, F3, F4, F5, and F6) leading to a third-order confirmatory factorial model (RMSEA = 0.053 < 0.060; CFI = 0.958 > 0.90) presented in Fig. 1.

3.4. Scale reliability of the SDSC-Y

The scale reliability was acceptable with a global Cronbach's alpha of 0.86.

Table 1
Indices of fit for the models obtained by exploratory factor analysis of the 22-items Sleep Disorder Scale for Young Children (SDSC-Y).

Model	Eigenvalue	% Variance per factor	% Cumulative Variance	RMSEA	CFI	Increase in CFI (%)	Chi-Square	Degree of freedom (df)	Chi-Square/df
1-factor	7.38	33.5	34	0.099	0.847		1079.4	209	5.16
2-factor	2.26	10.3	44	0.081	0.910	6.3	704.0	188	3.74
3-factor	1.66	7.5	51	0.069	0.940	3.0	508.2	168	3.03
4-factor	1.57	7.1	58	0.061	0.960	2.0	379.1	149	2.54
5-factor	1.27	5.8	64	0.052	0.974	1.4	277.6	131	2.12
6-factor	**1.11**	**5.0**	**69**	**0.036**	**0.989**	**1.5**	**176.2**	**114**	**1.55**
7-factor	0.96	4.4	74	0.033	0.992	0.3	143.4	98	1.46

The line in bold indicates the factorial structure retained for the SDSC-Y.

Table 2
Geomin rotated factor loadings estimated in the 6-factor model using exploratory factor analysis of the SDSC-Y.

Factor	Item short label	Variance explained	Factor loading
Factor 1: Disorders of Initiating Sleep (DIS)		33.5%	
	1. Sleep duration		0.39
	2. Sleep latency		0.81
	3. Going to bed reluctantly		0.72
	4. Difficulty in falling asleep		0.97
	5. Anxiety when falling asleep anxiety		0.69
Factor 2: Disorders of Maintaining Sleep (DMS)		10.3%	
	8. Night awakenings		0.91
	9. Difficulty in falling asleep after awakenings		0.62
	10. Noctural hyperkinesia		0.37
Factor 3: Sleep Hyperhidrosis (SHY)		7.5%	
	7. Sweating when falling asleep		0.80
	14. Night sweating		0.85
Factor 4: Sleep Breathing Disorders (SBD)		7.1%	
	11. Breathing problems		0.75
	12. Sleep apnea		0.89
	13. Snoring		0.49
Factor 5: Parasomnias (PARA)		5.8%	
	6. Hypnagogic hallucinations		0.26
	15. Sleeptalking		0.61
	16. Sleep terrors		0.53
	17. Nightmares		0.83
Factor 6: Non-Restorative Sleep and Excessive Somnolence (NRSES)		5.%	
	18. Unusually difficult to awaken in the morning		0.62
	19. Feeling tired with non-restorative sleep		0.60
	20. Sleep paralysis		0.68
	21. Daytime somnolence		0.46
	22. Sleep attacks		0.39

3.5. Concurrent criterion validity of the SDSC-Y using the Sleep Hygiene Scale for Children

Ten items of the BISQ and two items about screen exposure were correlated with the total SDSC score. This produced a 12-item questionnaire (the Sleep Hygiene Scale for Children, SHSC) (see Appendix B). The exploratory and confirmatory factorial analysis of the SHSC was reported in the Supplementary Data on pages 8–9. The 3-factor model was retained because it was the smallest model with acceptable fit (RMSEA = 0.055 < 0.06; CFI = 0.939 > 0.90) and it explained 66% of the total variance of the SHSC (Supplementary Tables 2 and 3, page 8). The 3 cross-loading items (6, 10, and 12) were assigned to the factor with which they had the highest factor loading. The three factors were “Attachment parenting” (items 1 to 6, 8 and 10), “Transitional coping” (items 7 and 9) and “Screen exposure” (items 11 and 12). The confirmatory 3-factor model demonstrated a good fit (RMSEA = 0.048, CFI = 0.922) (Supplementary Fig. 2, page 9).

Two structural equation models including the 22 items of the SDSC-Y and the 12 items of the SHSC demonstrated acceptable fit. These estimated the pairwise correlations between the SHSC latent sub-dimensions and the latent global Sleep Disorders and its latent sub-dimensions (Supplementary Table 4, page 10). The highest correlations were obtained for “Attachment parenting” with global DIMS (0.66) and SDSC-Y (0.55) and between “Screen Exposure” and NRSES (0.38), global SDSC-Y (0.36) and DIMS (0.32) (Fig. 3). “Transitional coping” did not correlated significantly with the global SDSC-Y nor the subscore SDSC-Y.

3.6. Diagnostic validity of the SDSC

3.6.1. Distribution

Distribution of the total score in the control group (ranging between 22 and 78) was asymmetric (Shapiro Wilk W = 0.91, $p < 10^{-12}$) and that of the clinical group (ranging between 22 and 75) was normal (Shapiro Wilk W = 0.99, $p = 0.85$). The control and clinical distributions are presented in Fig. 2 for the total SDSC-Y score. The total T-score and sub-scores differed significantly between the clinical and control groups, across the five main

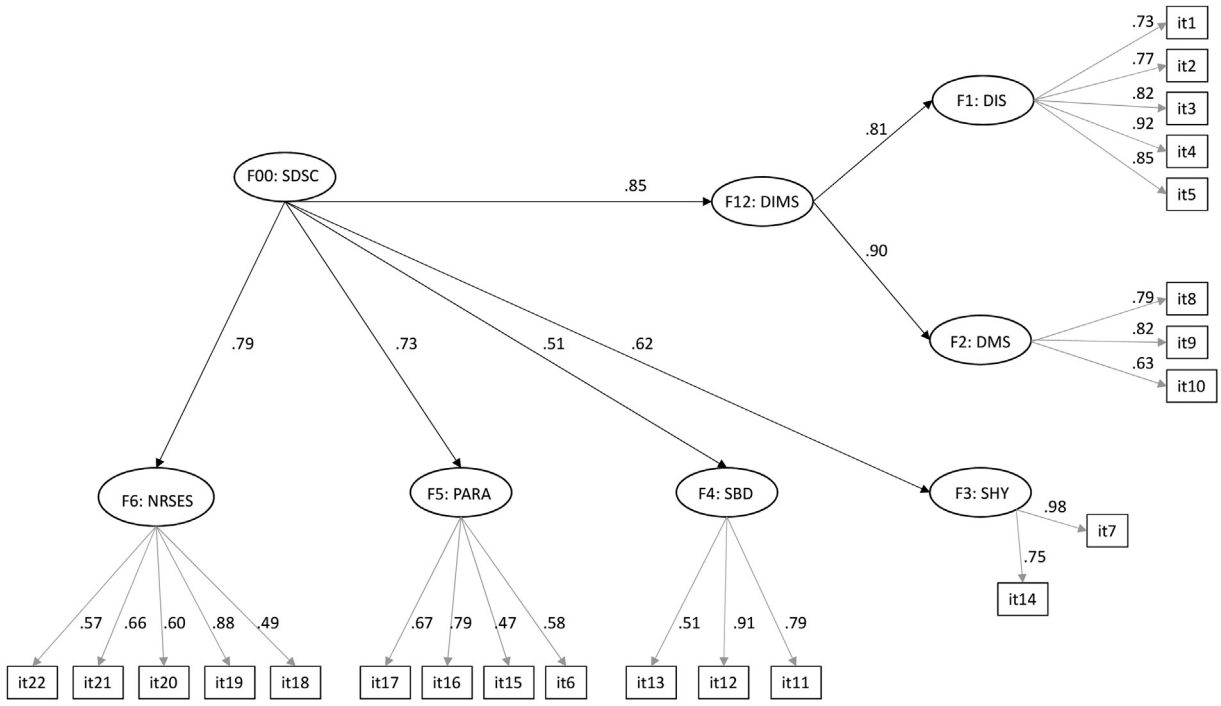

Fig. 1. Third-order model of factorial structure for the Sleep Disorders Scale for Young Children (SDSC-Y). Item indicators are presented in square, latent variables in ellipse. Numbers in gray are the standardized coefficients for the first-order measurement model. Both latent variables F1 and F2 were supposed to be explained by a latent F12 variable. The latent variable F00 reflecting global sleep disorders was supposed to be explained by five latent variable F12, F3, F4, F5 and F6. Disorders of Initiating and Maintaining Sleep (DIMS), Disorders of Initiating Sleep (DIS), Disorders of Maintaining Sleep (DMS), Sleep Hyperhidrosis (SHY), Sleep Breathing Disorders (SBD), Parasomnias (PARA) and Non-Restorative Sleep and Excessive Somnolence (NRES).

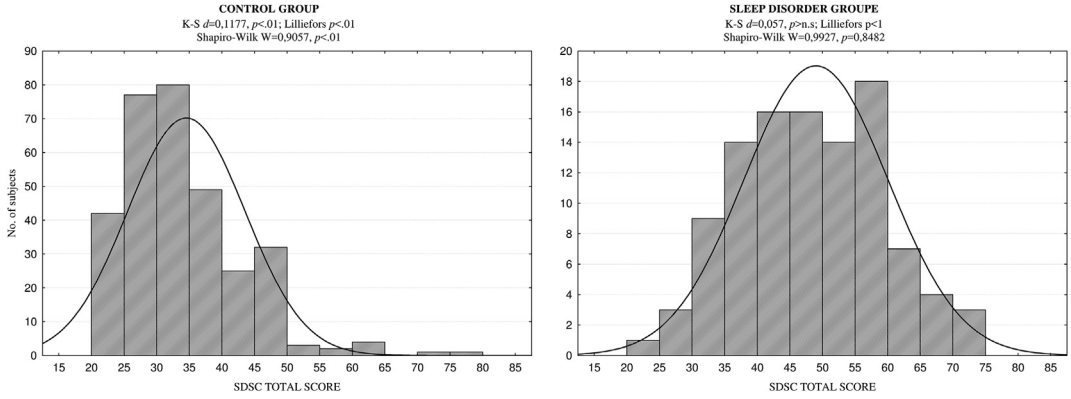

Fig. 2. Distribution of the Sleep Disturbance Scale for Young Children (SDSC-Y) total score for the control and clinical groups.

subscales (F12, F1–F6) except for SHY and SBD (see Supplementary Table 5, page 11 for details).

3.6.2. *Cut-off for the SDSC*

By applying the standard deviation formula on the control group for the pathological threshold (T score >70), the sub-scores obtained the following detection thresholds (See Appendix C): 16 for the DIMS factor (F12), 4 for SHY and 4 for SBD, 7 for PARA and 7 for NRSES.

The ROC analysis of data, taking the control and clinical groups as binary classifiers, demonstrated that the French SDSC for young children produces good diagnostic precision (AUC = 0.849). The detection threshold for the total score is determined by the best compromise between sensitivity (0.84) and specificity (0.74) and is set at 38. The detection threshold of 37 set by the pathological threshold (T score>70) obtains a good compromise between sensitivity (0.86) and specificity (0.72). With this cut-off, the French version correctly detects 72% (227/316) for the control group and 86% (90/105) for the clinical group. The two cut-offs obtained are very close, so the cut-off of 37 seems appropriate for the age-adapted SDSC total score.

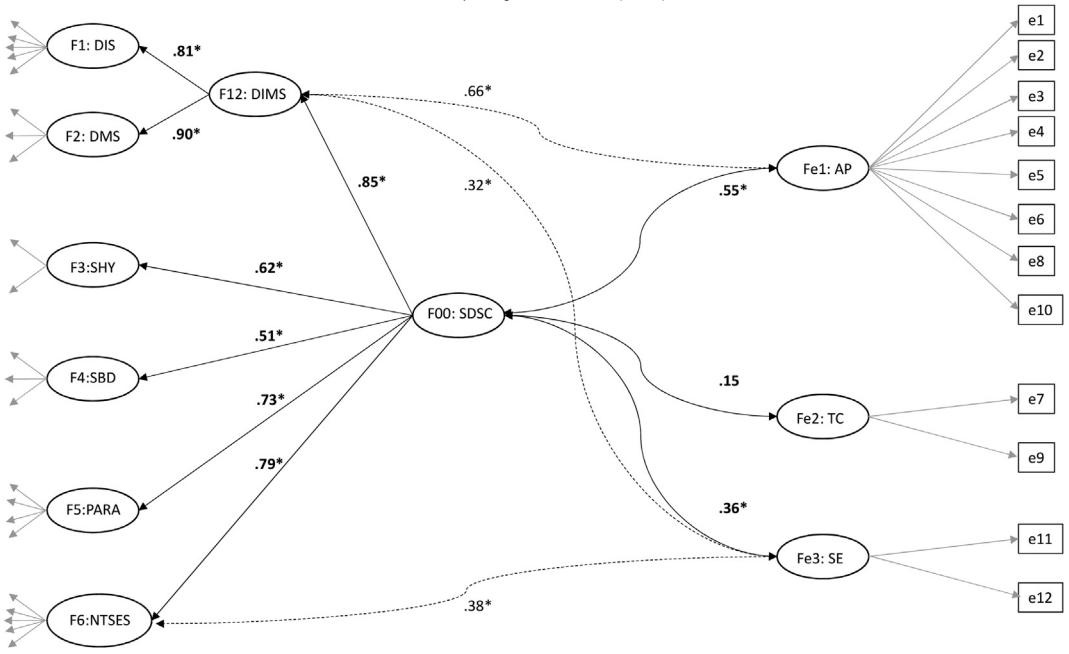

Fig. 3. Structural equation model used to estimate the pairwise correlations between the Sleep Disorder Scale for Young Children and the Sleep Hygiene Scale for Children. Solid line: Structural equation model used to estimate the pairwise correlations between the global latency of SDSC and the latent subscale of the SHSC; the model had an acceptable fit (RMSEA = 0.049, CFI = 0.911). Dotted line: Structural equation model to estimate the pairwise correlations between the latent sub-dimensions of the SDSYC and the latent subscale of the SHSC; the model had an acceptable fit (RMSEA = 0.046, CFI = 0.923). The three SHSC sub-dimensions are: Attachment Parenting (AP); Translational Coping (TC); Screen Exposure (SE). The five SDSYC sub-dimensions are: Disorders of Initiating and Maintaining Sleep (DIMS), Sleep Hyperhidrosis (SHY), Sleep Breathing Disorders (SBD), Parasomnias (PARA) and Non-Restorative Sleep and Excessive Somnolence (NRES). * indicates correlation significantly different from 0 at 5% and superior to 0.3.

4. Discussion

4.1. Statements of principal findings

The aim of the present study was to apply the SDSC to a population of children aged between 6 months and 4 years old. This study validated a modified version of the SDSC for young French children. This SDSC-Y consists of 22 items divided into five factors: DIMS, SHY, SBD, PARA and NRSES and is a good diagnostic tool to detect sleep disorders in the general population.

4.2. Strengths and weaknesses of the study

This study is the first to test the SDSC with children aged under four years old. The control group sample is large and representative of the general population of young children, as it includes children from different nurseries and diverse socio-economic contexts.

The psychometric properties of the SDSC are very satisfactory: Construct validity and scale reliability are good. The distribution of global scores for the control group and the clinical group is significantly different, even considering that certain children in the control group will have experienced sleep disturbances. It is interesting to note that the distributions of this study are comparable to those observed by Bruni et al.; Romeo et al., and Putois et al., [6,11,13]. The cut-off for the SDSC adapted for children aged 6 months - 4 years old is 37 for the total score. Regarding the area under the curve (AUC = 0.849), the level of sensitivity (0.72) and of specificity (0.86) were obtained. The SDSC correctly detected 90 of 105 pathological sleep diagnoses in the clinical group. Given that 10 of the children had insomnia in remission, the SDSC demonstrated good diagnostic precision. We can therefore conclude that the diagnostic validity is satisfactory especially for insomnia. Indeed, the major weakness of this study is the homogeneity of the clinical group (insomnia only) due to a selection bias (only consultation data provided by the last author, an insomnia specialist, were used). This could explain the reason for no difference for SHY and SBD between the two groups.

The factor analysis of the SDSC is satisfactory and corresponds approximately to the ICSD-3 criteria: the DIMS factor relates to insomnia, the SHY factor is associated with nighttime or sleep hyperhidrosis, the SBD factor is associated with sleep breathing disorders, the PARA factor relates to parasomnias and the NRSES factor is associated with circadian sleep cycle disorders and the main disorders of hypersomnolence. However, precaution is advised when defining the cutoff for all factors other than insomnia. Indeed, if we applied these strictly, we would obtain for the control group: 28% sleep disorder, 26% insomnia, 21% hyperhidrosis, 28% sleep breathing disturbance, 12% parasomnia and 24% non-restorative sleep of excessive somnolence. The prevalence of breathing disturbance during sleep and excessive somnolence are very high in comparison to other studies [34]. These cut-offs should be recalculated in further studies including more heterogenous sleep pathologies. The statistical validation presented in this article also have three limits: (a) absence of test-retest fidelity, (b) absence of comparison of different age groups (for instance sleep/wake rhythms are very different in children under 12 months compared to 3 year olds) (c) the control group cannot be said to be representative of a purely non-clinical group,

given that we know that the prevalence of sleep disturbances in children is high generally [20].

4.3. Strengths and weaknesses in relation to other studies

This is the first study on the SDSC which computes a third-order model of factorial structure. DIMS is composed of two subfactors: DIS and DMS. This difference is clinically very relevant because DMS rarely begins before 18–24 months old and is mostly associated with bedtime problems and limit-setting insomnia. Moreover, these two subtypes are congruent with different aetiologies [35] of insomnia.

The factor structure of the SDSC for children under four years old differs to other studies on older children. This seems logical because sleep characteristics develop particularly during the first four years of life [2]. The psychometric validation presented in this article, based on existing tools, the SDSC and the BISQ, must nevertheless be used with caution as certain variables specifics to young children have not been controlled: for example, the total duration of sleep is significantly greater at this age [36] (this could explain the floor effect of item 1); daytime sleep, which is physiological under 4 years-old, is not taken into consideration (this could explain the difficulties seen for items 20 and 22). The specificity of this age can also explain why seven items engender dichotomous responses.

Computation of the SDSC concurrent criterion validity selected 10 items of the BISQ. Two further items were added (about screen exposure). The EFA and the CFA undertaken offered a preliminary factorial structure of an adapted version of the BISQ, named the Sleep Hygiene Scale for Children, comprising three factors. On the one hand, correlation between “Parent Attachment” and “Screen Exposure” with SDSC total score, in particular DIMS and NRSES and, on the other hand, no correlation between “Transitional coping” and SDSC total score or subscores are congruent with the literature [17,37,38]. A future study on the psychometric validation of the BISQ would be of great interest.

4.4. Meaning of the study: possible implications for clinicians

The SDSC can be used to detect or measure sleep disorders in young children. The correlations highlighted between certain BISQ items and the SDSC encourage the use of the SDSC in conjunction with the BISQ or its adaptation (SHSC). We note that some items of the BISQ have not been correlated with sleep disorders in this study. However, they are essential for clinical use: the position of the child's body is a crucial variable to be questioned for the prevention of sudden infant death syndrome [39], although it does not seem correlated in the present sample with sleep disorders. Similarly, the sample showed no correlation between the presence of positive rituals and sleep disorders, unlike other studies [18].

Regarding the analysis of the different scores obtained, a score which surpasses the threshold for the DIMS factor suggests that the clinician should provide behavioral recommendations relating to child insomnia [40] on the strength of the sleep diary. The clinician will be vigilant about screen use, nighttime feeding, nighttime and daytime wake-sleep rhythms, sleep position, co-sleeping and bedtime rituals.

The clinician should use caution with the SBD and NRSES factors, completing the information with a thorough clinical examination (Body Mass Index, the size of their tonsils and adenoids, quality of siestas, etc.).

4.5. Unanswered questions and future work

Future studies can explore additional analyses beyond the scope of this study, such as measurement invariance. To detect if some items measured different constructs for subjects belonging to different subgroups, the uniform differential functioning of each SDSC-Y item could be studied according to age and gender using a multiple indicator multiple cause (MIMIC) model. The invariance of the measurement model used for the SDSC-Y could be investigated across age group and gender using multi-group modeling.

The characteristic and information curves of each item were not reported. These curves can nevertheless help us to appreciate the relevance of the item response categories and the item precision in the latent factor estimation on the latent factor scale. This could be potentially interesting if the sleep disorder scale were to be reconsidered by adding or modifying items according to experts.

In order to develop a Sleep Disorder Scale common to different countries, the study of the invariance of the SDSC (or SDSC-Y) measurement model across different cultural contexts would be of great interest. This supposes all participants will complete all the items of the different versions of the questionnaire. The wording of the items may need to be adapted to measure the same construct across the different cultural contexts. Given a measurement invariance across countries, the structural invariance of the questionnaire would provide useful information about the differences in the theoretical constructs across different countries.

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Conflict of interest

This research received no specific funding from public sector, commercial or not-for-profit funding organizations. The authors declare no conflict of interests.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2019.09.014.

Appendix A. French version of the Sleep Disturbance Scale for Children (SDSC) [11] used for adaptation to a young French children population (6 months to 4 years old).

Echelle de dépistage des troubles du sommeil de l'enfant de 6 mois à 4 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 six dernières mois et cochez les cases qui correspondent le mieux à ce que vous avez observé de votre enfant. Merci de répondre à toutes les questions en remplissant les lignes ou en entourant les nombres

	En semaine	En week-end
Heure approximative de coucher habituelle :	.....h.....min	.....h.....min
Heure approximative de lever matinal habituelle :	.....h.....min	.....h.....min
Combien de temps votre enfant dort-il approximativement pendant la JOURNEE (siestes) ?	.....h.....min	.....h.....min
Combien de temps votre enfant passe-t-il appromativement éveillé la NUIT ?	.....h.....min	.....h.....min
Combien de fois l'enfant se réveille-t-il la nuit ? ..... Que faites-vous ?		

	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 déjà entendu l'enfant parler dans son sommeil	(1)	(2)	(3)	(4)	(5)
16 - 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)
17 - L'enfant fait des cauchemars dont il ne se rappelle pas le matin venu	(1)	(2)	(3)	(4)	(5)
18 - L'enfant est difficile à réveiller le matin	(1)	(2)	(3)	(4)	(5)
19 - L'enfant se réveille le matin en se sentant fatigué	(1)	(2)	(3)	(4)	(5)
20 - L'enfant se sent incapable de bouger quand il se réveille le matin	(1)	(2)	(3)	(4)	(5)
21 - L'enfant est somnolent durant la journée	(1)	(2)	(3)	(4)	(5)
22 - L'enfant s'endort brutalement, de façon inattendue, à l'école ou lors de ses activités	(1)	(2)	(3)	(4)	(5)

				Normes		
Facteurs	Sommes	Scores	Seuils	Moyenne	Ecart-type	Q1 et Q3
Troubles du sommeil	Somme des 5 facteurs (sur 110)	.....	>37	34,4	9,0	28-39
A. Insomnies	1, 2, 3, 4, 5, 8, 9, 10 (sur 40)	.....	>16	14,2	5,0	11-17
B. Hyperhydrose	7, 14 (sur 10)	.....	>4	3,5	2,0	2-4
C. Problèmes respiratoires	11, 12, 13 (sur 15)	.....	>4	4,2	1,6	3-5
D. Parasomnies	6, 15, 16, 17 (sur 20)	.....	>7	6,0	2,2	4-7
E. Sommeil non réparateur et Somnolence diurne excessive	18, 19, 20, 21, 22 (sur 25)	.....	>7	6,5	1,9	5-7

Ces scores ne peuvent en aucun cas remplacer le diagnostic d'un spécialiste du sommeil. Si les scores A, C ou E > seuils, consultez un spécialiste.

The digital version is available at http://sommeilenfant.fr.

Appendix B. French version of the binary items used for estimating “sleep hygiene”.

In the literature, all items are associated with sleep characteristics. All items scoring "Yes" reflected bad "sleep hygiene" (except item 3).

Items	Questions and Items' labels	Short label	References
	Comment votre enfant s'endort-il en début de siestes ou en début de nuit ?	Bedtime conditions	[39]
1	L'enfant s'endort pendant l'allaitement	Breastfeeding at bedtime	[15]
2	L'enfant s'endort en étant bercé	Rocked at bedtime	[39]
3	L'enfant s'endort dans un lit seul*	Alone in a bed at bedtime	[39]
4	L'enfant s'endort en étant porté	Carried at bedtime	[39]
	Au moment de l'endormissement de votre enfant ou s'il se réveille durant la nuit, quel comportement adoptez-vous ?	Parental behavior during night awakenings	
5	Je sors l'enfant du lit et je le porte/le berce jusqu'à ce qu'il s'endorme	Carried at bedtime	[37]
6	J'allaite l'enfant jusqu'à ce qu'il se rendorme	Breasfeeding during the night	[15]
7	Je donne à l'enfant son doudou	Given their blanket	[37]
8	J'amène l'enfant dans mon lit	Co-sleeping	[39]
9	Je réconforte l'enfant verbalement mais je ne le sors pas de son lit	Verbally comforted without being taken out of bed	[37]
10	Je chante une chanson ou berceuse à l'enfant	Sung a lullaby during the night	[37]
	Ecrans : télévision, téléphone portable, dessins-animés, jeux video, ordinateurs	Screen exposure	[41]
11	Regarde-t-il souvent les écrans ?	Often watches screens	[41]
12	Ecran après 16h	Screen exposure after 4pm	[42]
	Questions supplémentaires :		
13	L'enfant dort-il sur le dos la plupart du temps ?	Sleep position	[39]
14	Le même rituel de coucher est réalisé tous les soirs ?	Sleep rituals	[18]

All items had a binary response category: 0 for No and 1 for Yes. Supplementary questions were not correlated with the SDSC-Y (they were not computed in the scoring, nevertheless, according to international recommendations, items 13 and 14 are crucial.

* reverted item: positively correlated with good sleep hygiene.

Appendix C. Sleep Disturbance Scale for Young Children (SDSC-Y).

Results Table

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

	SDSYC	DIMS	DIMS.1	DIMS.2	SHY	SBD	PARA	NRS-DOES	
T-Score									T-Score
100	78+	37+	24	14	10	15	18+	14+	100
99	65	31	21	13		11	13	13	99
98	57	28	19	12		10	12	12	98
97	52	26	17	10	9	8	11	11	97
96	50	24	16		8	7			96
95	49		15	9			10	10	95
94		22							94
93	48		14		7	6			93
92		21	13						92
91	47						9	9	91
90	46	20			6				90
89									89
88				8			8		88
87		19				5			87
86	45		12		5				86
85									85
84	44							8	84
83	43	18							83
82	42		11						82
81							7		81
80	41								80
79		17			4				79
78	40								78
77	39		10	7					77
76								7	76
75									75
74	38	16							74
73									73
72									72
71	37		9			4			71
70									70
69									69
68	36						6		68
67									67
66		15		6					66
65									65
64									64
63	35							6	63
62			8		3				62
61									61
60		14							60
59	34								59
58									58
57									57
56									56
55									55
54	33								54
53									53
52		13		5					52
51									51
50									50
49	32		7				5		49
48									48
47									47
46					2				46
45									45
44									44
43	31								43
42		12						5	42
41									41
40				4					40
39									39
38						3			38
37	30								37
36									36
35									35
34									34
33									33
32	29	11	6						32
31									31
30									30

Appendix and supplementary data

Supplementary data and appendix can be found online at https://doi.org/10.1016/j.sleep.2019.09.014.

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