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Original Article

Parent-reported sleep disorders in children with motor disabilities: a comparison with the Sleep Disturbance Scale for Children's new norms

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ABSTRACT

Objective: Children with motor disabilities such as cerebral palsy or neuromuscular diseases present more sleep disorders than their typically developing (TD) peers. However, research on these populations has always been performed using historical normative datasets or controls such as siblings. Therefore, we assessed the sleep quality of children with motor disabilities in comparison with a large, contemporary, general population sample.

Methods: Demographic, medical, and the Sleep Disturbance Scale for Children (SDSC) questionnaires were sent to parents of children aged 4–18 years and followed by our tertiary pediatric neurorehabilitation clinic, and to those of school-aged children in regional primary and secondary schools. TD participant data allowed us to set pathological sleep score thresholds (T score $\geq$70).

Results: We collected 245 responses for children with motor disabilities and 2891 for those from the general population (37% and 26% response rates, respectively). Cerebral palsy was the most frequent diagnosis ($N = 109$, 44.5%). Children with motor disabilities had significantly more frequent pathological sleep reported in their total SDSC score (7% vs 1.9%, odds ratio (OR) 3.98, 95% confidence interval (CI) 2.17–7.27, $p < 0.001$) and in five subscores. Single-parent households and drug-resistant epilepsy showed significant positive associations with pathological sleep among children with motor disabilities. For TD peers, parental unemployment and parental nationality were positively associated with pathological sleep.

Conclusion: This population-based study robustly estimated the prevalence of sleep disorders in children with motor disabilities. Sleep disorders were significantly more frequent in children with motor disabilities, but at a lower frequency than previously reported.

1. Introduction

Children's motor disabilities can arise from a variety of conditions that affect any level of motion control and execution, from their central nervous system (eg, cerebral palsy (CP)) to their muscles (eg, muscular dystrophies). The underlying condition largely determines the nature and severity of motor impairments.

Children with motor disabilities seem to experience more frequent sleep disorders than their typically developing (TD) peers, due either to intrinsic factors related directly to the child's medical problems, such as epilepsy or respiratory complications, or to external contributors associated with specific care needs (eg, feeding, orthoses), or a combination of both [1]. The child's sociocultural environment will also influence his sleep, or at least its perceived quality [2], as reported in several studies based mainly on caregivers' observations [3–6]. A recent review on sleep disorders in children with CP reported a limited number of case–control studies, each comparing CP population samples to either noncontemporary normative data, siblings, or a small convenience sample of TD children, in order to set cut-off levels for sleep disorders [7]. These studies' various methodologies and different clinical settings (leading to potential selection biases) have to date

Abbreviations: DIMS, Difficulty in initiating and maintaining sleep; SBD, Sleep breathing disorders; DA, Disorders of arousal; SWTD, Sleep–wake transition disorders; DOES, Disorders of excessive somnolence; SHY, Sleep hyperhidrosis; TOTAL, Total SDSC score.

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limited the accurate assessment of the prevalence of sleep disorders in the pediatric population with motor disabilities.

Questionnaires are effective methods of investigating sleep quality in large pediatric samples. However, several steps must be considered before using a questionnaire to ensure valid, reliable clinical data collection [8]. The Sleep Disturbance Scale for Children (SDSC), published by Bruni et al., in 1996, is among the few questionnaires to possess a solid methodological construct that can investigate all the domains of sleep disorders in a relatively short completion time [9,10]. Since its original publication, the SDSC has been used in multiple cultural and clinical settings and has been validated in several languages [11–16].

To precisely assess the prevalence of sleep disorders in school-aged children with motor disabilities, we used a three-part questionnaire, including the SDSC, and collected data from a large contemporary sample of children from the general population for comparison, establishing new norms for the SDSC. Secondarily, we explored associations between sleep disorders and demographic and medical characteristics in the motor disorder and general population samples.

2. Methods

A cross-sectional, questionnaire-based survey was carried out after approval by the Human Research Ethics Committee of the Canton Vaud. Part of the dataset was previously reported in a study focusing on co-sleeping among children with motor disabilities [17].

2.1. Participants

In September 2013, we invited a population of 666 children with motor disabilities and their parents to participate in the survey. In December 2013, we sent a reminder. Inclusion criteria were: (1) follow-up in our tertiary Pediatric Neurology and Neurorehabilitation Unit, (2) aged 4–18 years (ie school-aged children) and (3) motor disability connected to the diagnostic categories of CP, genetic syndromes (eg, Rett, Wolf–Hirschhorn), other encephalopathies of various origins (eg, acquired brain injuries), neuromuscular diseases (eg, muscular dystrophies, spinal muscular atrophy), and peripheral or spinal nerve lesions (eg, spinal dysraphism, transverse myelitis). Diagnoses had all been determined by Pediatric Neurology and Neurorehabilitation Unit specialists: the canton Vaud's (743,000 inhabitants in 2013) only reference center for motor disabilities follows up with the vast majority of affected children in this catchment area. We categorized our CP patient sample further by using the CP subtype classification described by Rosenbaum et al., (unilateral spastic, bilateral spastic, dyskinetic, and ataxic) [18].

The regional Department of Education authorized us to contact a list of state primary and secondary schools for our general population sample. The Department itself sampled the schools to provide a representative group of children for the general population. The 11,400 school-aged children listed in these schools were aged from 4 to 18 years. Children whose responding parent reported them as having a chronic medical condition were excluded. Secondary and primary school children were invited to participate in September 2013 and September 2014, respectively.

Potential participants were sent an explanatory invitation letter, the questionnaire described below, an informed consent form, and a self-addressed stamped envelope. Participants in the motor disabilities group were sent these documents by post using our Unit's patient address database. For the general population sample, documents were delivered to the selected primary and secondary schools, and teachers handed them out to the children.

2.2. Questionnaire

The parents of both groups of participants were asked to complete the three-part paper questionnaire which explicitly explored their child's sleep over the last six months. Part one's specifically designed questions examined co-sleeping, and their findings have been reported previously [17]. For the motor disabilities group, added questions on comorbidities covered epilepsy and its treatment, intellectual disability, severe visual impairment, and the child's nighttime care needs, such as tube feeding (nasogastric tube or gastrostomy), mobilization, and orthosis. Only the medical records of the responding children with motor disabilities were examined for information concerning intellectual disability and its severity and their level of mobility according to the Gross Motor Function Classification System (GMFCS) – Expanded and Revised version [19,20]. Patients with GMFCS levels I–III were categorized as walkers and GMFCS levels IV and V as non-walkers: this enabled a comparison between children with CP and those with other motor disabilities.

Part two examined demographic characteristics including the child's age and sex, the parents' nationalities, educational level, and employment status and family housing. Parents' nationalities were classified according to a list of countries and regions used in canton Vaud's 2011 demographic statistics and United Nations' designations. Homes were evaluated for crowding by dividing the number of family members living in the household by its number of bedrooms.

Part three was the translated, validated French version of the SDSC, originally developed and validated by Bruni et al., in 1995 on a sample of 1157 TD children (583 males, 574 females, mean age 9.8 years, range 6.5–15.3 years) [10,12,21]. We used the factor analysis validated in the original study for children $\geq$6 years for our whole study population, because compulsory primary school begins at age four years in Switzerland, with analogous environmental cues for sleep when comparing children aged four and five years to older children. Measured using a Likert-type scale, its 26 items are divided into six categories of sleep disturbances: difficulty in initiating and maintaining sleep (DIMS), sleep breathing disorders (SBDs), disorders of arousal (DA), sleep–wake transition disorders (SWTD), disorders of excessive somnolence (DOES), and sleep hyperhidrosis (SHY). Summing the six subscores (with each item scored from 1 to 5) gave a total sleep score from 26 to 130; higher scores indicated greater difficulties sleeping. The general population sample's SDSC scores became our normative data for the local pediatric population and were used to calculate T scores. A T score $\geq$70 (ie, $\geq$the 97.seventh percentile) indicated a pathological sleep disorder, as per the study by Newman et al. The same process was used for every SDSC subscale [3].

The unique barcode on each questionnaire enabled the automatic extraction of data to a Microsoft Excel® (Microsoft, Redmond, WA, USA) file by scanning responses using the Teleform program (Cardiff Software, Hewlett–Packard, Palo Alto, CA, USA). Scans were manually reviewed for potential errors. The identities of children with motor disabilities were requested to enable necessary data collection from their medical records; following this, motor disability group participants were only identified by barcode. General population sample children were unidentifiable as their data was only available via the questionnaire's barcode.

2.3. Statistics

Wilcoxon rank sum tests were performed on unpaired numerical data for univariable analyses; χ^2 tests were performed on categorical data. Unconditional simple logistic regressions were used for the association analyses of pathological sleep in both samples,

thus providing crude odds ratios (cORs). Every variable with an association value of $p < 0.10$ was tested as an explanatory factor in a single-step multivariable analysis in a multiple logistic regression, providing adjusted odds ratios (aORs). After these steps, univariable and multivariable analyses were also carried out for the six SDSC subscores. The Hosmer–Lemeshow test was used to measure the model's goodness-of-fit (a $p < 0.10$ indicates a lack of fit). Significance values were set at $p < 0.05$. Missing data were not replaced using imputation. All descriptive and explanatory analyses were performed using STATA 13 software (StataCorp, 2013, College Station, TX, USA); tables were generated using STATA 13 and Excel.

3. Results

3.1. Sample characteristics

We collected 245 and 3088 responses from parents of children with motor disabilities and of our general population sample (37% and 26% response rates, respectively); 107 general population group participants were excluded because of a parent-reported chronic medical problem, resulting in a final 2981 general population participants. Both groups' demographic characteristics are described in Table 1; the medical description of the motor disabilities sample is given in Table 2. There were significant differences between sample groups in sex ratio, age, parents' nationality and educational levels, as well as housing crowding. CP was the most frequent diagnosis ($N = 109$, 44.5% of motor disability sample); intellectual disability was the most frequent comorbidity ($N = 113$, 46.1% of motor disability sample).

3.2. SDSC results

The distribution of SDSC scores for the general population is shown in Table 3, with the threshold T score of 70 used to define pathological sleep marked along with the other SDSC subscores (DIMS, SBD, DA, SWTD, DOES, and SHY).

As Table 4 describes, children with motor disabilities exhibited significantly more frequent pathological sleep in the total SDSC score (7% vs 1.9%, odds ratio (OR) 3.98, 95% confidence interval (CI) 2.17–7.27, $p < 0.001$) and in five SDSC categories (DIMS, SBD, SWTD, DOES, and SHY) than general population children did. Furthermore, children with motor disabilities had significantly more pathological sleep subscores than TD children (7% vs 2% had at least two pathological SDSC subscores, $p < 0.001$).

Among general population children, pathological sleep was positively associated with parental unemployment (cOR 3.00, 95% CI 1.49–6.07, $p = 0.002$) and foreign parental nationality (cOR 2.84, 95% CI 1.35–6.14, $p = 0.008$). Pathological sleep was negatively related to higher parental educational levels (cOR 0.90, 95% CI 0.810–0.99, $p = 0.033$). These three factors and housing crowding (cOR 1.16, 95% CI 0.96–2.71, $p = 0.072$), were included in the multivariable analysis, after which only parental unemployment was found to be positively associated with pathological sleep (aOR 2.21, 95% CI 1.06–4.64, $p = 0.035$; Hosmer–Lemeshow χ^2 test = 4.60, $p = 0.800$).

For the motor disability sample, we found that single-parent households (cOR 4.85, 95% CI 1.59–14.71, $p = 0.005$) and drug-resistant epilepsy (cOR 5.20, 95% CI 1.40–19.31, $p = 0.014$) were the two factors significantly associated with pathological sleep, in both univariable and multivariable logistic regressions. Table 5 describes these results, and those for DIMS, SBD, SWTD, and DOES, the four SDSC categories for which we found significant associations. Severe/profound intellectual disability was significantly associated with three SDSC subcategories (DIMS, SBD, and SWTD), as was drug-resistant epilepsy (SBD, SWTD, and DOES). Older age was the only significant protective factor found for the motor disabilities population, with a negative association with SWTD.

4. Discussion

This large questionnaire-based study achieved two things. First, it extracted contemporary SDSC score distribution data from a TD population and was therefore able to define pathological sleep using updated cut-off values. In comparison with the original work by Bruni et al. [10], in which the threshold T score of 70 equated to an average total SDSC score of 50, based on 1157 children, we obtained a threshold T score of 70 at an average total SDSC score of 65 with a sample of 2353 children; all the SDSC subcategory scores were also higher in our study. The rise in SDSC scores in the two decades between studies indicates a worsening quality of sleep in the general population of children and teenagers, possibly as a consequence of the expansion of media and technology use in children's daily habits (ie, screen time and smartphone use) and of changes in their cultural and educational backgrounds [22,23]. The present study's different geographical and demographic context could also have been a contributive factor, as there are wide variations in the parental and societal perceptions of what is considered 'good sleep' [2,24,25]. Indeed, the majority of the families in our general population sample were composed of at least one parent from outside Switzerland, in line with Switzerland's general population 2016 statistics [26].

The second achievement, thanks to its renewed reference data, was to demonstrate that pathological sleep was more frequent among children with motor disabilities than those from the general

Table 1
Demographic characteristics of the study populations.

Characteristics	Motor disability ($N = 245$)	General population ($N = 2891$)	p
Sex ratio (M:F)	1.38	0.99	**0.014**
Age (years), mean ± SD	10 years 6 months ±3 years 10 months	9 years 6 months ±3 years 5 months	**<0.001**
Age group (years)			
4–8	34.3%	42.4%	**0.013**
9–13	39.2%	41.9%	0.41
14–18	26.5%	15.7%	**<0.001**
Single-parent household	18.9%	19.2%	0.901
At least one unemployed parent	3.0%	5.3%	0.133
Parental nationality			
Both Swiss	53.6%	37.5%	**<0.001**
At least one foreign	8%	62.5%	**<0.001**
Parents' educational level (/12, 12 = highest)	7.52 ± 2.83	8.23 ± 3.08	**<0.001**
House crowding (persons/bedrooms)	1.32	1.48	**<0.001**

SD, standard deviation. Values in bold where $p < 0.05$.

Table 2
Medical characteristics of the population with a motor disability (*N* total = 245).

	N (% total)
Cerebral palsy	109 (44.5)
Spastic unilateral	46
Spastic bilateral	35
Dyskinetic	10
Mixed bilateral	18
Syndrome (eg, Rett, Angelman, Wolf–Hirschhorn)	64 (26.1)
Encephalopathy	35 (14.3)
Neuromuscular diseases (eg, spinal muscular atrophy, Duchenne muscular dystrophy)	23 (9.4)
Peripheral and spinal nerve diseases	14 (5.7)
Walkers	184 (75.1)
Non-walkers	61 (24.9)
Intellectual disability	113 (46.1)
Mild	35
Moderate	23
Severe/profound	55
Severe visual impairment	19 (7.8)
Epilepsy	60 (24.7)
Drug-resistant epilepsy	27
Tube feeding	17 (6.9)
Nighttime orthosis	41 (16.7)

Table 3
Distribution of Sleep Disturbance Scale for Children subscores among the general population sample (*N* = 2353).

T score	TOTAL	DIMS	SBD	DA	SWTD	DOES	SHY	T score
80								80
79								79
78								78
77								77
76	≥75	25	≥9	≥9	≥21	≥17	10	76
75								75
74								74
73								73
72	68	24	**8**	8	20	15	9	72
71								71
70	**65**	**23**		**7**	**18**	**14**	**8**	70
69								69
68		22	7		17	13		68
67				6	16	12	7	67
66		21	6			11	6	66
65		20			15			65
64								64
63	54			5	14	10		63
62.5	53	19	5				5	62.5
62	52							62
61	51	18			13			61
60	50					9	4	60
59	49	17						59
58	48			4	12	8		58
57	47	16	4					57
56.5	47							56.5
56	46				11			56
55	45						3	55
54	44	15				7		54
53	43				10			53
52	42						2	52
51								51
50	41	14			9			50
49	40		3	3		6		49
48	39	13						48
47								47
46	38				8			46
45	37							45
44								44
43	36	12						43
42	35				7	5		42
41								41
40	34							40
39								39
38								38
37	33	11			6			37
36								36
35	32	10						35
34								34
33								33
32								32
31	≤31							31
30	≤30	≤9						30

DA, disorders of arousal; DIMS, difficulty in initiating and maintaining sleep; DOES, disorders of excessive somnolence; SBD, sleep breathing disorders; SHY, sleep hyperhidrosis; SWTD, sleep–wake transition disorders; TOTAL, Total SDSC score.
The bold values mark the T score 70, representing the limit between "normal" and "pathological" values.

population. This finding was in line with previous studies, but the present study demonstrated a substantially lower prevalence of pathological sleep (7%) than previous studies on specific motor disabilities using the same scoring system and thresholds. Using the total SDSC score and a threshold T score at 70, pathological sleep was reported for 19–37% of school-aged children with CP [3,6,27] and 13% of pre-schoolers with CP [28] and 25% of school-aged children with Duchenne muscular dystrophy [4]. The main contender for explaining this smaller difference in prevalence in school-aged children is the difference between our reference values and the historical data from Bruni et al. [10], as mentioned above could be related to a decrease in sleep quality among the general population. It is also notable that the studies by Romeo et al. [27,28], using contemporary samples of controls and children with CP yields results that are very similar to those in our study in terms of differences in sleep quality between both populations. However, our hypotheses regarding this evolution, including considerations of home screen usage, could also apply to a significant proportion of children and youths with motor disabilities, along with their families. Furthermore, one cannot completely exclude an effect of age between the sample in this study and the aforementioned comparisons, since the age structure does differ to a moderate extent between certain of them.

For the TD sample, pathological sleep was associated with parental unemployment, which is a significant personal and familial stressor due to its implications on household finances, well-being, and stability. Its potential impact on a child's sleep quality, or at least on parental perceptions of it, is evident. The relationship between pathological sleep and a parent's foreign nationality may reflect cultural backgrounds, which are known to affect parental expectations about children's sleep, possibly confounded by a certain number of related socioeconomic factors. Our questionnaire's design did not allow us to detail these associations or make any definitive conclusions about them; this would have required further details about family background, including a number of social, cultural, educational, and economic factors.

For the motor disabilities population, drug-resistant epilepsy and a single-parent household were the only two factors associated with pathological sleep. Drug-resistant epilepsy involves different sleep disruption mechanisms, sustaining its association with SBD, SWTD, and DOES. Seizures can directly disrupt sleep, can have a tendency to be hypnagogic or hypnopompic, and the often-substantial medication that these children require can induce numerous side-effects, including excessive sleepiness or central/peripheral respiratory impairment. Regarding single-parent households, one could hypothesize that being a single-parent caring for a child or youth with motor disability limits one's capacity for coping with potential sleep disrupters, with fatigue playing a key role when limited respite is available. This could be especially true if the child needs specific nighttime care, such as tube feeding, or is at risk from seizures [29].

Table 4
Description of Sleep Disturbance Scale for Children subscales by study population.

	Motor disability	General population	*p*
Difficulty in initiating and maintaining sleep (DIMS)	236	2744	
Mean (SD)	15.7	14.5 (3.3)	
T score >70, *N*	21	59	
T score >70, %	8.9	2.2	**<0.001**
Sleep breathing disorders (SBD)	242	2848	
Mean (SD)	5 (2.1)	3.9 (1.3)	
T score >70, *N*	24	58	
T score >70, %	9.9	2	**<0.001**
Disorders of arousal (DA)	225	2861	
Mean (SD)	3.8 (1.2)	3.9 (1.2)	
T score >70, *N*	6	56	
T score >70, %	2.6	2	0.54
Sleep–wake transition disorders (SWTD)	229	2678	
Mean (SD)	10.7 (3.9)	10.0 (3.1)	
T score >70, *N*	15	56	
T score >70, %	6.6	2.1	**<0.001**
Disorders of excessive somnolence (DOES)	235	2859	
Mean (SD)	8.2 (3.3)	7.2 (2.2)	
T score >70, *N*	18	58	
T score >70, %	7.7	2	**<0.001**
Sleep hyperhidrosis (SHY)	242	2878	
Mean (SD)	3.5 (2.1)	3.0 (1.6)	
T score >70, *N*	8	33	
T score >70, %	3.3	1.1	**0.003**
Total score	213	2353	
Mean (SD)	46.2 (11.6)	42.3 (8.3)	
T score >70, *N*	15	44	
T score >70, %	7	1.9	**<0.001**

SD, standard deviation. Values bold where $p < 0.05$.

Among the SDSC categories, SBDs were the most frequent in children with motor disabilities. SBDs were associated with drug-resistant epilepsy discussed above, non-walking status, tube-feeding, and severe/profound intellectual disability – medical characteristics that tend to coexist in more-severely affected children. The existence of feeding problems among children with CP or other neurological and neuromuscular conditions is frequent, with increasing prevalence as the neurological impairment grows. The nutritional benefits of tube-feeding and its improvements to overall care management have been well described, especially for CP, but how it modifies sleep has been far less investigated [30,31]. SBD may directly be caused by the neurological impairment of swallowing and maintenance of an open upper airway during sleep, but the gastroesophageal reflux induced by tube-feeding could also play a role. Severe motor impairment leading to an inability to walk can be linked to SBD via respiratory mechanics, for instance, directly via a diaphragmatic weakness in certain neuromuscular conditions or decreased thoracic compliance in severe spastic CP, or indirectly through the consequences of neurological scoliosis. This direct impairment of sleep can lead to DOES during the daytime.

DIMS was the second most frequent category of sleep disorders and was associated with severe/profound intellectual disability. DIMS may be a marker of a more severely affected central nervous system in children with altered sleep–wake patterns, associated with the more extensive behavioral difficulties encountered in this population but also with the disease-specific sleep impairments in certain syndromes (eg, Angelman or Rett syndrome). This was described in a recent review of sleep-related problems among people with intellectual disabilities [32].

The physical factors associated with DOES quite closely mirrored those found for SBD (epilepsy, non-walking, tube-feeding), and the daytime somnolence may therefore largely be considered a consequence of disrupted nighttime sleep with the addition of side-effects from epilepsy medication. Lack of mobility per se, as seen in advanced Duchenne muscular dystrophy, is known to impair sleep, and daytime somnolence can arise as a consequence [4]. Crowded homes also increased the prevalence of DOES, perhaps being a proxy marker of altered nighttime sleep recovery.

SWTD were associated with parental unemployment – and we could formulate hypotheses similar to those for sleep quality in the TD sample – as well as active epilepsy and severe/profound cognitive retardation, both of which are signs of a more severely affected central nervous system.

This study had certain limitations. The use of the factor analysis of the original version of the SDSC by Bruni et al. [10], was justified by the fact that children enter primary school at age four years in Switzerland. However, a number of intrinsic factors may also contribute to changes in sleep quality at these ages, since the validation of the SDSC by Romeo et al. [12], for pre-schoolers aged from three to six years provided a different factor analysis to the original scale. We do believe that the original factor analysis adequately applies throughout our age range, since there were no demonstrated associations between age and sleep disorders in our control or motor disability samples for the total score.

The next limitation involved the survey participation rates in both the general population and motor disability samples. Because a single anonymous questionnaire was distributed to the general population sample and even though a reminder was sent to the families followed by our clinic, both participation rates were below 50%. A degree of participation bias can therefore not be excluded, especially for the general population, since the demographic and diagnostic characteristics of our participant children with motor disorders were representative of our total clinical population. Another limitation involved the multiple significant demographic differences between the samples. Besides parents' nationalities, mentioned above, we did not consider sex to be relevant to sleep disorders, and did not identify a specific role in previous studies. A potential limitation was the choice to combine numerous medical conditions, of varying severity, under the label 'motor disability'. Although selecting one specific disorder would have permitted a clearer analysis, without the need for compromises such as diluting GMFCS information into walker and non-walker statuses, the

Table 5
Univariable and multivariable analyses of factors associated with pathological sleep/Sleep Disturbance Scale for Children (SDSC) subscores (T score ≥70) for children with a motor disability.

	TOTAL		DIMS		SBD		SWTD		DOES	
	cOR	aOR	cOR	aOR	cOR	aOR	cOR	aOR	cOR	aOR
Male gender	0.47 (0.06–3.75)		0.70 (0.16–3.18)		0.62 (0.14–2.77)		1.07 (0.23–4.98)		0.84 (0.18–3.87)	
Older age	0.91 (0.80–1.05)		0.93 (0.83–1.05)		1.00 (0.89–1.11)		**0.82 (0.70–0.97)**	0.85 (0.72–1.01)	1.00 (0.89–1.14)	
Single–parent household	**4.85 (1.59–14.71)***	**4.63 (1.48–14.57)**	1.8 (0.66–4.94)		2.43 (0.97–6.11)*		1.79 (0.53–6.01)		1.50 (0.46–4.85)	
≥1 unemployed parent	Omitted		1.74 (0.20–15.20)		omitted		**6.43 (1.13–36.38)***	**12.68 (1.25–128.91)**	omitted	
≥1 parent of foreign nationality	2.56 (0.75–8.80)		2.18 (0.83–5.76)		2.04 (0.8–5.13)		3.16 (0.96–10.40)*	2.61 (0.73–9.35)	1.75 (0.64–4.77)	
Higher level of parental education	1.00 (0.81–1.23)		1.05 (0.89–1.25)		0.95 (0.81–1.12)		0.97 (0.79–1.19)		0.82 (0.67–1.00)*	0.90 (0.71–1.14)
Crowding (persons/bedroom)	0.72 (0.15–3.36)		0.71 (0.21–2.45)		0.54 (0.15–1.95)		1.91 (0.65–5.64)		***6.07 (2.31–15.95)****	**5.15 (1.48–17.91)**
Non–walker	2.33 (0.79–6.91)		2.41 (0.96–6.05)*	1.14 (0.38–3.42)	***4.96 (2.07–11.86)****	1.88 (0.61–5.79)	1.10 (0.34–3.62)		**3.43 (1.29–9.11)***	3.31 (0.83–13.15)
Tube–fed	3.23 (0.63–16.52)		2.59 (0.67–9.94)		***15.75 (5.31–46.70)****	**7.84 (2.04–30.05)**	2.38 (0.48–11.67)		**5.91 (1.64–21.26)***	3.72 (0.78–17.79)
Blindness	0.94 (0.11–7.67)		3.38 (1.00–11.40)*	1.78 (0.45–7.11)	1.07 (0.23–4.96)		0.88 (0.11–7.16)		0.69 (0.09–5.52)	
Epilepsy										
Controlled by ≤ 2 drugs	2.17 (0.54–8.68)	1.20 (0.23–6.19)	1.51 (0.40–5.73)	0.91 (0.21–3.93)	0.77 (0.17–3.58)	0.42 (0.07–2.41)	1.37 (0.28–6.79)	1.20 (0.15–9.47)	**3.63 (1.13–11.89)***	1.41 (0.28–7.06)
Seizures despite medication	**5.2 (1.40–19.31)***	**4.63 (1.18–18.18)**	5.56 (1.93–16.05)*	2.18 (0.56–8.52)	**5.05 (1.88–13.59)***	2.09 (0.53–8.30)	**5.43 (1.61–18.28)***	2.99 (0.54–16.61)	**3.60 (1.02–12.71)***	1.96 (0.41–9.38)
Intellectual disability										
Mild	1.16 (0.23–5.89)		1.97 (0.47–8.31)	1.73 (0.40–7.52)	1.07 (0.21–5.41)	1.15 (0.22–6.01)	empty	empty	0.82 (0.17–3.99)	
Moderate	0.94 (0.11–8.07)		0.97 (0.11–8.46)	0.88 (0.10–7.92)	1.69 (0.33–8.68)	1.88 (0.35–10.10)	2.46 (0.45–13.55)	3.81 (0.60–24.32)	0.65 (0.08–5.36)	
Severe/profound	2.55 (0.76–8.57)		**5.46 (1.90–15.68)***	3.29 (0.81–13.46)	***5.76** (**2.15–15.42**)**	1.81 (0.42–7.87)	**5.05 (1.56–16.32)***	3.48 (0.71–17.17)	1.98 (0.67–5.91)	
	HL $\chi^2 = 1.21$, $p = 0.751$		*HL $\chi^2 = 2.20$, $p = 0.821$*		*HL $\chi^2 = 4.81$, $p = 0.307$*		*HL $\chi^2 = 6.47$ ($p = 0.594$)*		*HL $\chi^2 = 4.81$, $p = 0.307$*	

aOR, adjusted odds ratio; cOR, crude odds ratio; DIM, difficulty in initiating and maintaining sleep; DOES, disorders of excessive somnolence; SBD, sleep breathing disorders; SWTD, sleep–wake transition disorders; TOTAL, Total SDSC score. Values in bold if $p < 0.05$; values in bold and italic where $p < 0.001$.
*If variable included in the multivariable logistic analysis because $p < 0.10$ in the univariable logistic regression.

decision to combine them into a single group was based on the fact that all their different diagnoses carried potential sleep disruptors, independently of their severity. Finally, as already mentioned, there was a lack of systematic and comprehensive behavioral and psychological assessments, including evaluations of pain. Thus, comorbidities such as autistic spectrum disorders, disruptive behavior, or anxiety were not integrated into our study, despite their known role in sleep disorders [33–35].

5. Conclusion

The present study strengthened the evidence that sleep disorders are more frequent among children with motor disabilities than among a contemporary peer sample of the general population, albeit with lower prevalence than previously reported. We believe this further underlines the need to investigate sleep quality for children with motor disabilities and their caregivers, especially when epilepsy is present.

Author contributions

Dr Jacquier and Dr Newman conceptualized and designed the study, and co-drafted the initial manuscript. Both approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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Conflict of interest

The authors have no conflicts of interest relevant to this article.

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.2018.11.016.

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