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Children with developmental dyslexia showed greater sleep disturbances than controls including problems initiating and maintaining sleep

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Abstract

Aim: Although there have been frequent clinical reports about sleep disturbances in children with learning disabilities, no data are available about the prevalence of sleep disturbances in children with developmental dyslexia (DD). This study evaluated sleep disturbances in children with DD referred to a hospital clinic and compared their scores with healthy controls.

Methods: We consecutively enrolled 147 children (66% male) aged 10.26 ± 2.63 years referred by clinical paediatricians to the Clinic for Child and Adolescent Neuropsychiatry at the Second University of Naples with DD and 766 children without DD (60% male) aged 10.49 ± 2.39 years recruited from schools in the same urban area. Sleep disturbances were assessed with the Sleep Disturbances Scale for Children (SDSC), which was filled out by the childrens' main carers.

Results: Compared to the controls, the children with DD showed significantly higher rates of above threshold scores on the total SDSC score ($p<0.001$) and on the subscales for disorders in initiating and maintaining sleep ($p<0.001$), sleep breathing disorders ($p<0.001$) and disorders of arousal ($p<0.001$)..

Conclusion: Sleep disorders were significantly more frequent in children with DD than in healthy controls. A possible relationship between dyslexia and sleep disorders may have relevant clinical implications.

Key words: developmental dyslexia, sleep disorders, Sleep Disturbances Scale for Children, sleep breathing disorders, disorders of arousal.

Key notes:

- No data are available about the prevalence of sleep disturbances in children with developmental dyslexia (DD), despite frequent clinical reports about sleep disturbances in children with learning disabilities,
- We studied 147 children with DD referred to a hospital clinic at a mean age of 10 years and compared their scores with 766 healthy controls.
- Sleep disorders were significantly more frequent in children with DD, including initiating and maintaining sleep.

INTRODUCTION

Developmental dyslexia (DD) is defined as a pattern of learning difficulties characterised by problems with accurate or fluent word recognition, poor decoding and poor spelling ability (1). According to International Classification of Disease -10 (ICD-10) criteria, DD is defined as an unexpected, specific and persistent failure to acquire efficient reading skills despite conventional instruction, adequate cognitive level and sociocultural opportunity (2). DD is the most frequent specific learning disorder in European children, with a prevalence ranging from 5.0% to 17.5% (3). This disorder may be characterised by specific reading deficits and visual, auditory and motor alterations (4), minor neurological signs (5), social difficulties (6) and internalising problems (7), which further contribute to the impairment associated with the disorder. Related conditions, such as putative sleep alterations in children with dyslexia, have been overlooked. Gaining insight into possible sleep disturbance in these children is very

relevant because sleep disturbance may further contribute to cognitive dysfunction and may be the target of preventive programmes aimed at decreasing the overall impact of dyslexia. Good quality of sleep and cognitive performance relationship is supported by the evidence of a link between the role of non-rapid eye movement sleep and instability in the child's cognitive performance and by mechanisms explaining how learning and cognitive performance depend on a good night's sleep (8-10). Very little data have been reported about the sleep architecture alterations associated with dyslexia (11,12) and there has not been a study to date that has evaluated the rates of sleep disturbances in children with DD compared to children without DD. A possible relationship between sleep disorders and dyslexia is plausible, considering that children affected by other neurodevelopmental conditions such as autism spectrum disorder or attention deficit hyperactivity disorder can present with sleep disorders (13-16). This study compared reported sleep disturbances between a sample of children with dyslexia and in gender and age-matched healthy controls. Given the exploratory nature of the study, no *a priori* hypotheses were formulated.

PATIENTS AND METHODS

We explored the reported sleep disturbances in a group of 147 children (66% male), with a mean age of 10.26 ± 2.63 years, who were consecutively referred by clinical paediatricians to the Clinic for Child and Adolescent Neuropsychiatry at the Second University of Naples with DD diagnosed according to ICD-10 criteria. They were compared with 766 healthy children (60% male), with a mean age 10.49 ± 2.39 years and comparable for age (p = 0.294), gender (p = 0.230), who were recruited from schools in the same urban area of the Campania Region. The inclusion criterion was the absence of any neuropsychiatric comorbid disorder, ruled out

following a psychiatric interview. The DD patients were recruited between January 2007 and May 2015**.**

Sleep disturbances evaluation

Parents or caregivers of the patients and controls filled out the Sleep Disturbances Scale for Children (SDSC) (17), a standardised questionnaire used to assess sleep problems at a developmental age. The scale has a high internal consistency of $\alpha = 0.79$ and test and retest reliability of $r = 0.71$ (17). The scale consists of 26 items, scored as pathological or normal according to the validation criteria, which uses a cut-off value of at least three episodes per week. Items are grouped into six disorder subscales: disorders in initiating and maintaining sleep, sleep breathing disorders, disorders of arousal, sleep-wake transition disorders, disorders of excessive somnolence and nocturnal hyperhidrosis. Written, informed consent was obtained from parents or caregivers of all the recruited patients and the study was approved by the Ethical Committee at the Second University of Naples, Naples, Italy.

Statistical Analysis

The chi-square test was used to compare the rates of the SDSC subscale scores rated as pathological between the children with DD and the controls. In addition, univariate logistic regression was performed in order to evaluate the association of DD, as the dependent variable,, to any of the six disorder subscale score, the independent variables, controlling for each other's factor We considered p values of ≤ 0.05 as statistically significant. All data were coded and analysed using the commercially available STATISTICA 6.0 package for Windows (StatSoft, Inc, Tulsa, Oklahoma, USA).

RESULTS

Compared to the controls, the children with DD showed significantly higher rates of SDSC pathological scores in the total SDSC score ($p<0.001$) and the following subscales: disorders

in initiating and maintaining sleep ($p<0.001$), sleep breathing disorders ($p<0.001$) and disorders of arousal ($p<0.001$) (Table 1). More specifically, children with DD showed higher rates in the number of times they woke up, nocturnal hyperkinesis and snoring ($p<0.001$) compared to control group children. (Table 2). Univariate logistic regression showed a significant relationship between DD and the total SDSC score, and the subscale scores for disorders in initiating and maintaining sleep, sleep breathing disorders and disorders of arousal (Table 1).

DISCUSSION

The main findings of the present study were the higher percentage of reported sleep disorders in children affected by DD, compared to controls, and the significant association between DD and a number of sleep disturbances. Although our cross-sectional design did not enable us to infer causation, our results set the ground for longitudinal studies exploring the causal relationship between sleep disorders and dyslexia. It is important to emphasise that, in our series, less than half of the children with dyslexia had sleep problems and it is therefore unlikely that sleep disorders can be a key causal factor. However, it is possible to hypothesise that there are associations between some sleep disorders and the severity of reading deficits, as suggested by studies on the role of sleep organisation in daily learning (18-22). A neurophysiological study showed an increase in slow spindles - sigma power at 11–12 Hz - in the sleep of dyslexic subjects that could be linked to a genetically more efficient thalamo-cortical system or to the obliged early adoption of acquired strategies in order to compensate for their specific learning disability (11). The role of overlapping disorders is also becoming increasingly clear. Conversely, the role of healthy sleep in neuropsychological processes, such as memory, attention (23, 24) and other executive functions (25) have been found to be linked to the pathophysiology of dyslexia and other learning disorders (26, 27). Our study also found as higher prevalence of some sleep disorders, namely disorders of initiating and

maintain sleep, sleep breathing disorders and disorders of arousal - in children with DD than in healthy children. This could be interpreted as a new relevant finding with regard to the multifactorial aetiology of this disorder, suggesting the relevance of sleep evaluation in DD management. Further studies are needed to confirm a possible role of sleep disturbances in dyslexia and to understand the possible clinical implications.

List of Abbreviations

DD, Developmental Dyslexia

ICD-10, International Classification of Disease-10

SDSC, Sleep Disturbances Scale for Children

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Table 1 Differences in percentages of pathological score in the SDSC test between children affected by Developmental dyslexia (DD) and typical developing children (Normal)

	DD (N=147) (%)	Normal (N=766) (%)	Chi-square	p	OR	IC 95%
DIMS pathological score	42.18	8.29	115.768	<0.001	8.000	5.28-12.12
SBD pathological score	27.89	13.94	16.590	<0.001	2.38	1.57-3.61
DA pathological score	45.58	11.09	103.203	<0.001	6.71	4.52-9.96
SWTD pathological score	12.24	12.63	0.000	0.997	0.96	0.56-1.65
DOES pathological score	6.80	7.41	0.010	0.921	0.91	0.45-1.82
SHY pathological score	5.44	8.27	0.972	0.324	0.64	0.30-1.37
SDSC TOT pathological score	18.37	2.35	64.151	<0.001	9.20	4.92-17.22

According to the SDSC validation criteria, scores≥ 71 for SDSC TOT, ≥17 for DIMS, ≥7 for SBD, ≥6 for DA, ≥14 for SWTD, ≥13 for DOES, ≥7 for SHY were considered as pathological.

Univariate Logistic regression (OR) and Chi-square test were applied

p values ≤0.05 were considered significant

Table 2: SDSC items in DD children compared with typically developing children

	DD (n=147) (%)	Control (n=766) (%)	Chi-square values	p[a]
1.Sleep less than 8 h	47.62	16.32	70.087	<0.001
2.Sleep latency >30 min	30.61	6.53	74.179	<0.001
3.Reluctant to go to bed	34.01	36.95	0.340	0.560
4.Difficulty getting to sleep at night	19.05	16.45	0.430	0.515
5.Anxiety when falling asleep	10.88	7.7	1.261	0.261
6.Hypnic jerks	15.65	13.05	0.506	0.477
7.Rhythmic movements while falling asleep	9.52	8.62	0.039	0.844
8.Vivid dream-like scenes while falling asleep	8.16	5.09	1.663	0.197
9.Falling asleep sweating	10.88	10.18	0.026	0.873
10.More than two awakenings per night	39.46	12.4	62.784	<0.001
11.Difficulty to fall asleep after awakenings	29.25	12.66	24.879	<0.001
12.Nocturnal hyperkinesias	43.54	21.41	31.059	<0.001
13.Sleep breathing difficulties	12.24	12.4	0.007	0.933
14.Sleep apnea	6.12	6.01	0.018	0.893
15.Snoring	65.31	17.23	149.572	<0.001
16.Night sweating	18.37	13.19	2.334	0.127
17.Sleepwalking	36.73	6.66	106.682	<0.001
18.Sleep talking	31.97	18.15	13.695	<0.001
19.Teeth grinding	23.81	6.79	39.496	<0.001
20.Sleep terrors	3.40	5.09	0.444	0.505
21.Nightmares	21.77	12.01	9.192	0.002
22.Difficulty in waking up in the morning	32.65	32.38	0.001	0.976
23.Awakes in the morning feeling tired	35.37	27.94	2.953	0.086
24.Sleep paralysis	5.44	7.57	0.547	0.460

25.Daytime somnolence	8.84	9.4	0.003	0.954
26.Sleep attacks	3.40	3.13	0.008	0.931

According to the SDSC validation criteria, frequency ≥3 times/week for each item was considered as pathological.

Chi-square test was applied

p values ≤0.05 were considered significant