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Correlation between sleep profile and behavior in individuals with specific learning disorder

Correlação entre o perfil do sono e o comportamento em indivíduos com transtorno específico da aprendizagem

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Keywords

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Behavior
Sleep
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ABSTRACT

Purpose: This study aimed to correlate sleep profile and behavior in individuals with Specific Learning Disorder (SLD). **Methods**: The Sleep General Habits Questionnaire, Sleep Diary, and Sleep Disturbance Scale for Children (SDSC) were used in analysis of sleep, whereas the Child Behavior Checklist (CBCL) inventory was used in analysis of behavior. **Results**: 65.5% of the individuals with SLD presented symptoms of sleep disorders, most frequently wakefulness-sleep transition and sleep disturbance total score, which showed values higher than acceptable. In addition, individuals with SLD presented higher sleep latency than those with typical development. Concerning behavior, 72.4% of the individuals with SLD presented clinical condition of behavior problems. In the control group, none of the participants showed symptoms of sleep or behavior problems. In the SLD group, correlation was observed between behavioral problems and sleep disturbance. **Conclusion**: Individuals with SLD showed high rates of sleep disturbance and behavioral problems. The worse the sleep disturbance, the worse the behavioral aspects in these individuals.

Descritores

Neurodesenvolvimento
Comportamento
Sono
CBCL
Aprendizagem

RESUMO

Objetivo: Correlacionar o sono e o comportamento em indivíduos com transtorno específico da aprendizagem. **Método:** Na análise do sono, foram utilizados o Questionário de Hábitos Gerais de Sono, o Diário de Sono e a Escala de Distúrbios do Sono em Crianças (EDSC) e, para análise do comportamento, foi utilizado o *Child Behavior Checklist* (CBCL). **Resultados:** 65,5% dos indivíduos com transtorno específico de aprendizagem apresentaram indicativo de distúrbios de sono, sendo os mais frequentes os distúrbios de transição sono-vigília e escores totais para distúrbios de sono acima do aceitável. Além disso, os indivíduos com transtorno específico de aprendizagem apresentaram maior latência de sono que o respectivo grupo controle. Quanto ao comportamento, 72,4% dos indivíduos com transtorno específico de aprendizagem apresentaram quadro clínico de problemas comportamentais. No grupo controle, nenhum dos participantes apresentou indicativo de problemas de sono ou comportamento. No grupo transtorno específico de aprendizagem, os distúrbios de sono encontrados apresentaram correlação com os problemas comportamentais. **Conclusão:** Indivíduos com transtorno específico da aprendizagem apresentaram altos índices de distúrbios de sono e alterações comportamentais. Quanto piores os distúrbios de sono, piores foram os aspectos comportamentais dos indivíduos com transtorno específico da aprendizagem.

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INTRODUCTION

Language is a complex higher cortical function that includes understanding, production, and use of different modes of communication (e.g., gestural, speaking and writing elements) determined by biological, psychic, regional, social and cultural/ethnic factors, and requires intact anatomo-functional basis associated with external stimuli to provide adequate development[1,2].

Among the various neurodevelopmental disorders cared in Speech-language Pathology practice, specific learning disorder (SLD), which includes the persistent disorders of reading, writing and mathematics, should be highlighted[3].

This diagnostic condition can affect school-age children and adolescents who necessarily present persistent failure in learning and using academic skills (reading, writing and/or mathematics), and is indicated by presence of the symptoms described in the Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[3], namely: (1) impairment in word reading accuracy, reading rate or fluency (2) impairment in reading comprehension; (3) impairment in spelling accuracy, grammar and punctuation accuracy, clarity or organization of written expression (4) impairment in mathematics with (5) number sense, memorization of arithmetic facts, accurate or fluent calculation and (6) accurate math reasoning. These disabilities must necessarily persist longer than six months, even with interventions developed by the school, pedagogues/psycho-pedagogues, or speech-language pathologists.

SLD is characterized by persistent deleterious impairment in basic academic reading (e.g., reading accuracy or fluency and comprehension), writing (e.g., spelling and grammar accuracy), and/or mathematics (number sense, calculation, and reasoning) skills[4]. The frequency of these impairments affects approximately 5-15% of schoolchildren - reading and writing difficulties are more frequently observed in males, whereas mathematics disabilities are more commonly found in females[5]. This diagnosis should be conducted by a multidisciplinary team through systematic assessment of the skills involved, analysis of school learning opportunities, chronological age, history of failure, school curriculum, and intervention without response in the short or medium term[6,7].

Etiological basis is influenced by genetics[8] and other correlated facts (e.g., overall health, behavior, and sleep) which can aggravate the clinical condition and be determinant for definition of the work team, therapeutic planning, and success of Speech-language Pathology treatment in these cases[9-11].

Sleep is a physiological process that can knowingly influence various behavioral aspects, such as hyperactivity, mood, and aggressiveness[9,10], as well as cognitive functions in children and adolescents[12]. Attention and memory, which are extremely important aspects in the development of spoken or written language, may also be negatively influenced by partial or total sleep deprivation[11]. Studies conducted with children with sleep disorders have reported cognitive and learning deficits[13,14].

In addition to sleep deprivation impair language processing and school performance; several studies have demonstrated that improvement in the quality of sleep enhances academic achievement[15,16].

Considering the high prevalence of sleep disorders in children with poor school performance[17], it is important to investigate whether sleep pattern is associated with the behavior of individuals with SLD, because this may be a factor that justifies or worsens the condition, which influences performance during pre- or regular school, or yet the success of Speech-language Pathology intervention.

The objective of the present study was to correlate sleep profile and behavior in individuals with SLD with its respective control group.

METHODS

Study sample

Study participants were 58 individuals of both genders aged 8-13 years divided into two groups: Specific Learning Disorder (SLD), composed of 29 individuals assessed in five 50-min sessions in a Speech-language Pathology school clinic (Centro Especializado em Reabilitação - CER - UNESP - Marília - SP) to define the diagnosis of SLD (Table 1), and its Control Group (Control), composed of 29 individuals with typical learning development (reading, writing, and mathematics) matched for sex and age to those in the study group (Table 1).

Individuals in both groups were attending a public school in the municipality where the research was conducted, enrolled in Elementary and Middle School. The study was approved by the Research Ethics Committee of the aforementioned Institution under protocol no. 0698/2013. All parents and/or legal guardians of the participants signed an Informed Consent Form (ICF) prior to study commencement.

Table 1. Characterization of the Control and Specific Learning Disorder (SLD) groups

Characteristics	SLD (n=29)	control (N=29)
Age in years (min-max)	8-13	8-13
Female n (%)	11 (37.9%)	11 (37.9%)
Male n (%)	18 (62.1%)	18 (62.1%)

Selection criteria

Inclusion criteria for the SLD group were as follows: schoolchildren of both sexes with a Speech-language Pathology diagnosis of SLD according to the definition, diagnostic characteristics, and classification of the Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[3].

Individuals underwent multidisciplinary diagnoses encompassing speech-language, neuropsychological and pedagogical aspects in a public university located in the countryside of Sao Paulo state conducted in three stages: (1) Clinical history; (2) Evaluation based on the Descriptive Mapping of Child Speech-language Pathology Assessment[18] and application of a School Performance Test (SPT)[19] comprising three subtests: Writing, Reading,

Arithmetic, and related assessments; and (3) Interview with teacher.

To receive a diagnosis of SLD, individuals had to present the following conditions in varying degrees:

(1) Clinical history: presence of history of language impairments prior to literacy initiation; history of difficulty in narrating stories and learning the letter-sound correspondence.

(2) Speech-language Pathology and related assessments - to be included in the SLD Group, individuals should necessarily present impairments as follows:

In reading skills such as discriminating between letters and numbers; identifying correspondence between letters of the alphabet and their respective names and between spoken and written words; reading of words and phrases; reading comprehension of sentences and/or small texts;

In writing skills such as copying, writing under dictation of sentences and small texts, spelling, mathematical-numeric and arithmetic skills (i.e., difficulty in identifying relationship between quantity and numeral); identifying mathematical relationships between quantities (e.g., of equivalence, order, different from..., larger and smaller than...); understanding and solving simple arithmetic problems;

In logical-mathematical reasoning (organizing, planning and performing calculations).

(3) Information provided by the teacher: difficulty in the three academic skills involved: reading, writing, and mathematics, for a certain time, even after pedagogical intervention conducted in the school (e.g., tutoring).

Dyslexic individuals that presented impairment in reading and writing, but typical performance in logical-mathematical reasoning were excluded from the study sample.

Inclusion criteria for the Control Group were as follows: individuals in the same age range of those in the SLD, matched for sex, with absence of school complaint, adequate performance in reading, writing, and mathematics according to age and schooling, and absence of history of psychiatric and neurological disorders.

Assessment instruments

General Sleep Habits Questionnaire

In this study, a version of this instrument adapted and validated by Belisio[20] was used, to which information on bedtime behavior, type of school, and study routine was added, resulting in 35 questions: 19 questions on routines, four on health, five on daily activities, and six on sleep environment.

Child Behavior Checklist (CBCL)

The Brazilian version of this behavior inventory was used in this study - Child Behavior Checklist for ages 6-18 and 4-18 (CBCL), whose objective is to register, in a standardized way, the description of parents and/or guardians about the behavior of their children[21].

Scores obtained in the CBCL items were converted into a "T" score for data analysis and classified into 11 behavioral scales: anxiety; depression; somatic complaints; social, thinking and attention problems; delinquency; aggressiveness; externalizing and internalizing scales; total score of behavior problems. The behavioral profile of each individual, classified into clinical, borderline and non-clinical scales, was drawn using the Assessment Data Manager (ADM) software.

Sleep Diary

This instrument is composed of six items that should be observed and noted by parents and/or guardians over a five-day period: bedtime, wake up time, hours slept, sleep state during the day, mood at waking up, and nocturnal awakenings.

Sleep Disturbance Scale for Children (SDSC)

The Brazilian version[22] of this instrument was used in the present study. It comprises 26 items for evaluation of sleep in children and adolescents with indication of six factors of sleep disorders, namely, disorder of initiating or maintaining sleep (DIMS); sleep breathing disorders (SBD); disorders of arousal/nightmares (DA); sleep-wake transition disorders (SWTD); disorders of excessive somnolence (DES); sleep hyperhidrosis (SHY), and a sleep disturbance total score (TS).

Statistical analysis

Descriptive analysis was performed to demonstrate dispersion of the data as mean, standard error of the mean (SE), and percentage. Analysis of Variance (ANOVA) was used for comparison between the groups, whereas the Spearman's rank correlation coefficient was used for correlation of the data.

RESULTS

Assessment of routines, general health, daily activities, and sleep environment showed that 34.5% of the individuals in the SLD Group reside with more than four people, which did not significantly differ from individuals in the Control Group (37.9%). No difference was also observed between the groups regarding room sharing (Table 2). With respect to health problems, feeding routine, use of medication, and medical or therapeutic treatment, individuals in the SLD presented higher percentages compared with those in the Control Group (Table 2). The parents and/or guardians of 34.5% of the individuals in the SLD reported that their children present poor quality of sleep, whereas this percentage was 6.9% in the Control Group (Table 2). Percentages of family members with sleep problems and individuals who doze during the day and have difficulty waking up in the morning were higher in the SLD than in the Control Group (Table 2). As for breathing aspects, the SLD presented higher percentage of snoring, bruxism, and obstructive sleep apnea compared with the Control Group (Table 2). Regarding behavior during sleep,

48.3% and 24.1% of the individuals in the SLD and Control Group, respectively, talk in their sleep (Table 2).

The average number of hours of sleep per night on weekdays in the SLD (9.3h ± 0.3h) did not differ significantly from that in the Control Group (8.6h ± 0.2h). In contrast, individuals in the Control Group presented higher mean number of hours of sleep in the weekend (9.9h ± 0.3h; p = 0.0008) than on weekdays. Bedtime and wake up time in the SLD did not differ from those in the Control Group on weekdays or in the weekend (Figure 1A); however, individuals in both groups went to bed later and slept in during the weekend (Figure 1A).

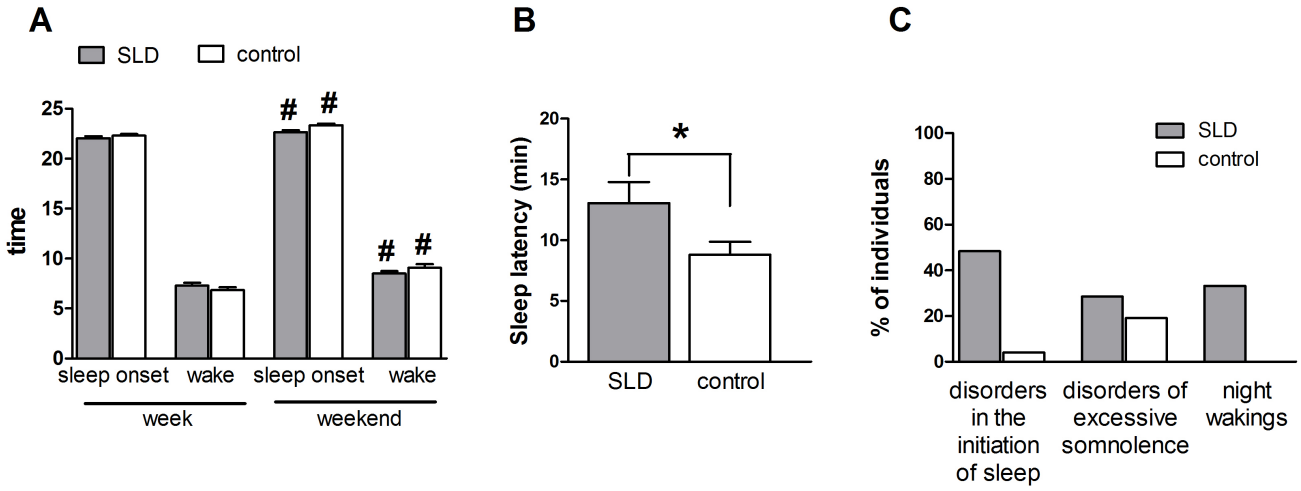
Comparison of time until sleep onset between the groups showed that the SLD presented longer sleep latency in minutes compared with that of the Control Group 13.0 ± 1.7 min and 8.8 ± 1.1 min, respectively (p = 0.01) (Figure 1B).

Regarding sleep disorders, according to the Sleep Disturbance Scale for Children (SDSC), 65.5% of the individuals in the SLD presented symptoms of sleep disturbance, with sleep-wake transition disorders (SWTD) (51.7%) most frequently observed, followed by sleep disturbance total score above acceptable (41.4%) (Table 3). Individuals in the Control Group showed no symptoms of sleep disorders.

Table 2. Quality-of-sleep influencing aspects in the Control and Specific Learning Disorder (SLD) groups

Characteristics	% SLD	% control
Live with more than four people	34.48 (N=10)	37.93 (N=11)
Room sharing	44.83 (N=13)	48.27 (N=14)
Report poor quality of sleep	34.48 (N=10)	6.89 (N=2)
Present health problems	41.37 (N=12)	0
Make use of continuous medication	51.72 (N=15)	0
Undergo medical treatment/therapy	41.37 (N=12)	6.89 (N=2)
Snore	51.72 (N=15)	20.68 (N=6)
Grind the teeth	48.27 (N=14)	17.24 (N=5)
Talk during sleep	48.27 (N=14)	24.13 (N=7)
Constantly change position during sleep	68.96 (N=20)	51.72 (N=15)
Wake up from sleep screaming	24.13 (N=7)	0
Sleepwalk	24.13 (N=7)	0
Have family members with sleep problems	55.17 (N=16)	24.13 (N=7)
Doze during the day	48.27 (N=14)	20.68 (N=6)
Drink coffee, tea, or soda	100	100
Present difficulty waking up in the morning	48.27 (N=14)	24.13 (N=7)
Complain about apnea	34.48 (N=10)	0

Caption: Percentage (%) of individuals who presented each parameter analyzed on routines, health, daily activities, and sleep environment of the Sleep Language Disorders (N=29) and Control (N=29) groups



Caption: In A, mean ± standard error of the mean (SEM) of the bed and wake up times of individuals on weekdays and weekends; # means weekdays ≠ weekends; p<0.05. In B, mean ± standard error of the mean (SEM) of the time elapsed for individuals to initiate sleep (sleep latency); * means SLD ≠ control; p<0.05. In C, percentage of individuals in both groups who had disorders in the initiation of sleep, disorders of excessive somnolence, and night wakings; N = 29 per group

Figure 1. Sleeping habits of individuals in the Specific Learning Disorder (SLD) and Control (CG) group

Analysis of behavior of the participants using the Child Behavior Checklist (CBCL) showed that 72.4% of the individuals in the SLD had a clinical condition of behavioral problems in at least one of the classifications of this inventory. No clinical conditions were found for behavioral problems in the Control Group.

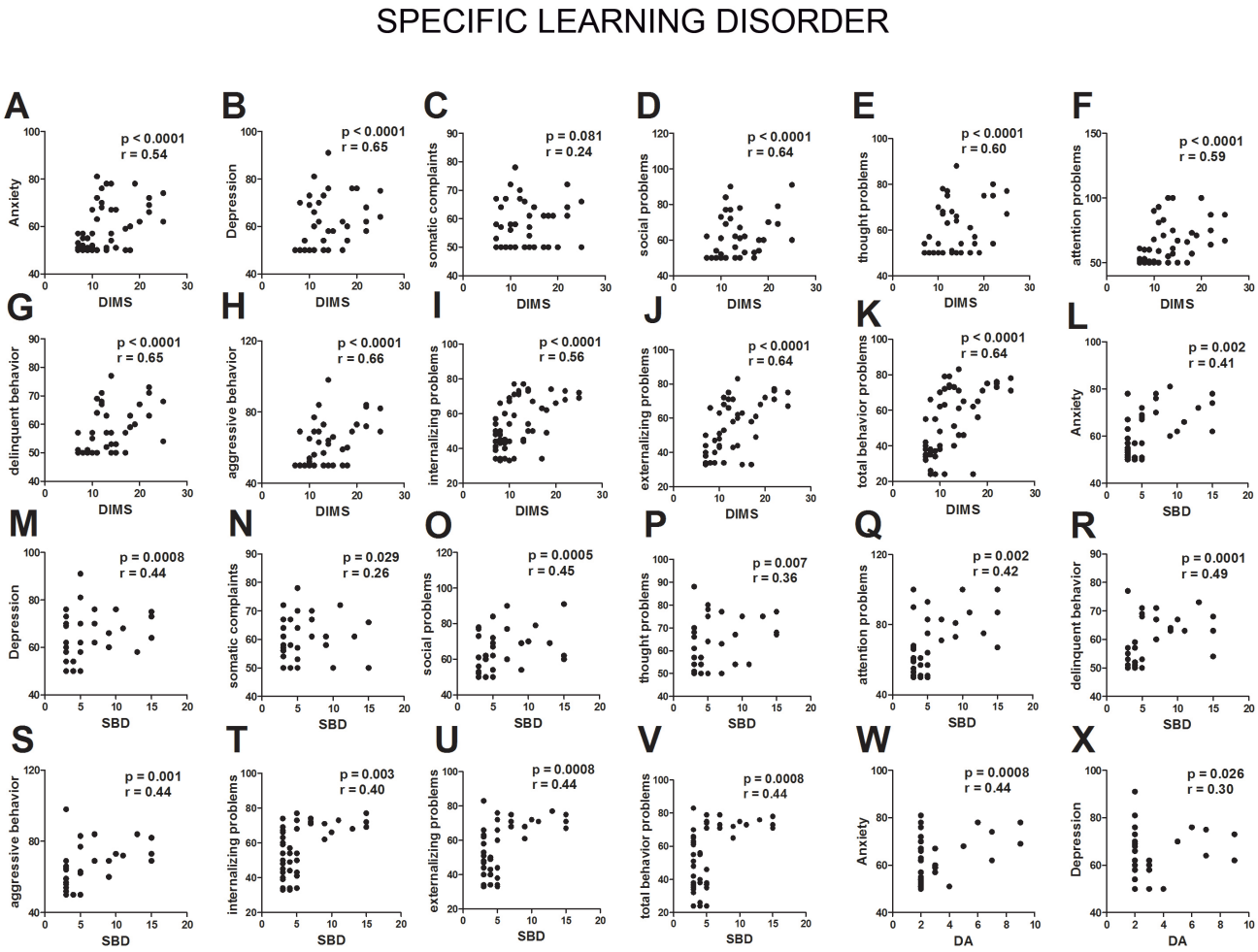
In the SLD, among the clinical scales of behavioral problems, 27.5% of the individuals were classified with anxiety, 27.5% with depression, 20.7% with somatic problems, 37.9% with social problems, 41.3% with thinking problems, 55.2% with attention problems, 24.1% with delinquency, and 31% with aggressiveness. The externalizing and internalizing scales and the total score of behavioral problems presented percentages of 58.6%, 48.3%, and 62.1%, respectively, in the SLD.

Correlation analyses between sleep disorders and behavioral problems in the SLD showed association of sleep disturbances (DIMS, disorder of initiating or maintaining sleep; SBD, sleep breathing disorders; DA, disorders of arousal/nightmares; SWTD, sleep-wake transition disorders; DES, disorders of excessive somnolence; SHY, sleep hyperhidrosis) and the sleep disturbance total score (TS) with problems of anxiety; depression; somatic complaints; social, thinking and attention impairments; delinquency; aggressiveness; externalizing and internalizing scales; total score of behavior problems (Figures 2-4).

Table 3. Sleep disorders in children and adolescents with Specific Learning Disorder (N=29)

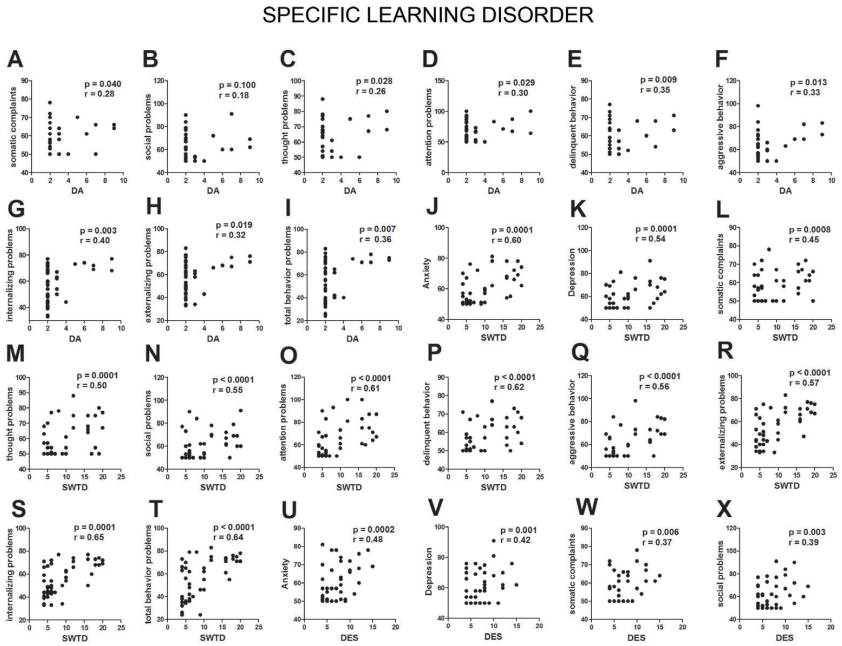
	DIMS	SBD	DA	SWTD	DES	SHY	TS
% of individuals with a score above acceptable	24.1	37.9	13.8	51.7	0	34.5	41.4

Caption: DIMS = disorder of initiating or maintaining sleep; SBD = sleep breathing disorders; DA = disorders of arousal/nightmares; SWTD = sleep-wake transition disorders; DES = disorders of excessive somnolence; SHY = sleep hyperhidrosis; TS = sleep disturbance total score



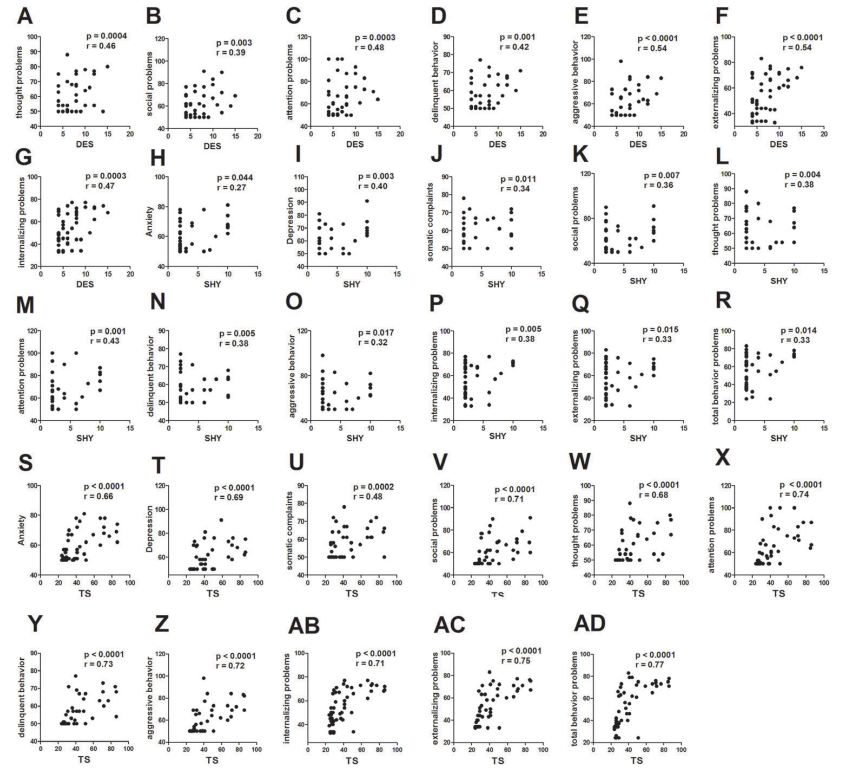
Caption: From A-K, correlations between disorder of initiating or maintaining sleep (DIMS) and behavior problems of anxiety (A); depression (B); somatic complaints (C); social problems (D); thought problems (E); attention problems (F); delinquent behavior (G); aggressive behavior (H); internalizing problems (I); externalizing problems (J); total score of behavior problems (K). From L-V, correlations between sleep breathing disorder (SBD) and behavior problems of anxiety (L); depression (M); somatic complaints (N); social problems (O); thought problems (P); attention problems (Q); delinquent behavior (R); aggressive behavior (S); internalizing problems (T); externalizing problems (U); total score of behavior problems (V); In W, correlation between disorders of arousal (DA) and anxiety; in X correlation between disorders of arousal (DA) and depression; N=29

Figure 2. Correlation between sleep disorders and behavior problems in individuals with specific learning disorder – Part 1



Caption: From A-I, correlations between disorders of arousal (DA) and behavior problems of somatic complaints (A); social problems (B); thought problems (C); attention problems (D); delinquent behavior (E); aggressive behavior (F); internalizing problems (G); externalizing problems (H); total score of behavior problems (I). From J-T, correlations between sleep-wake transition disorders (SWTD) and anxiety (J); depression (K); somatic complaints (L); social problems (M); thought problems (N); attention problems (O); delinquent behavior (P); aggressive behavior (Q); internalizing problems (R); externalizing problems (S); total score of behavior problems (T). From U-X, correlations between disorders of excessive (DES) and anxiety (U); depression (V); somatic complaints (W); social problems (X); N= 29

Figure 3. Correlation between sleep disorders and behavior problems in individuals with specific learning disorder – Part 2



Caption: From A-G, correlations between disorders of excessive somnolence (DES) and thought problems (A); social problems (B); attention problems (C) delinquent behavior (D); aggressive behavior (E); externalizing problems (F); internalizing problems (G). From H-R, correlations between sleep hyperhidrosis (SHY) and anxiety (H); depression (I); somatic complaints (J); social problems (K); thought problems (L); attention problems (M); delinquent behavior (N); aggressive behavior (O); internalizing problems (P); externalizing problems (Q); total score of behavior problems (R). From S-AD, correlations between sleep disturbance total score (TS) and anxiety (S); depression (T); somatic complaints (U); social problems (V); thought problems (W); attention problems (X); delinquent behavior (Y); aggressive behavior (Z); internalizing problems (AB); externalizing problems (AC); total score of behavior problems (AD); N= 29

Figure 4. Correlation between sleep disorders and behavior problems in individuals with specific learning disorder – Part 3

DISCUSSION

Results of the present study showed that individuals with specific learning disorder (SLD) (65.5%) presented higher percentages of sleep disturbance compared with those of individuals with typical development assessed in this and other studies (up to 40%)[23,24].

Considering that sleep plays an essential role in the processes of attention, memory formation, and brain plasticity and maturation, the data of this study emphasize the importance of investigating the quality of sleep and its disorders in conditions involving deficits in neural processes[9,12], such as SLD[12]. Assessment and treatment of sleep disorders prior to or concurrently with Speech-language Pathology intervention may result in improvement in behavior, school performance, and quality of life[15,17].

The SLD group presented higher percentages of individuals who wake up during the night and experience difficulties going back to sleep, snore, grind their teeth, constantly change position during sleep, talk and/or walk in their sleep, and present symptoms of sleep obstructive apnea compared with those of individuals in the Control Group.

An important component of this evaluation, in addition to the description of quality of sleep, is the identification of the subtypes of sleep disorders present[25]. The sleep disturbances most frequent found in the SLD were sleep-wake transition disorders (SWTD), sleep breathing disorders (SBD), sleep hyperhidrosis (SHY), and disorder of initiating or maintaining sleep (DIMS), as well as sleep disturbance total score (TS) above acceptable. Disorders of excessive somnolence (DES) was not present in this population probably due to the fact that 48% of individuals doze during the day and 100% drink stimulant beverages such as coffee and soda, which may mask excessive daytime somnolence.

SBD symptoms in the SLD corroborate the hypothesis reported in previous studies that changes in the respiratory pattern can lead to nocturnal sleep fragmentation - altering its cycle, and affect language development and academic performance[26,27].

Regarding behavior analysis, the present study showed high prevalence of altered behaviors in the SLD, with emphasis on attention problems. Previous studies have reported correlation between reading impairment and behavioral problems[28,29]. This study added data to this discussion also demonstrating that specific sleep disorders are associated with behavioral changes in SLD. In this case, the worse the sleep disturbances, the worse the behavioral problems observed. This finding reinforces the hypothesis that sleep disturbance could negatively influence the characteristics of this condition, especially behavior. Correlation between sleep and behavioral changes has been described in several conditions, such as autism[30], attention deficit hyperactivity disorder (ADHD), and even in schoolchildren with typical development[31], with improved behavior observed after treatment of sleep disorders[17,25].

This two-way correlation indicates that the investigation of sleep patterns and behavior in SLD can be beneficial to Speech-language Pathology treatment.

CONCLUSION

Individuals with specific learning disorder show high rates of sleep disturbance, mainly wakefulness-sleep transition, and show high rates of attention problems. The worse the sleep disorders, the worse the behavioral aspects in these individuals.

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REFERENCES

1. ASHA: American Speech-Language-Hearing Association. Definitions of communication disorders and variations [Internet]; Rockville, Maryland, EUA; ASHA; 1993 [cited 2017 May 4]. Available from www.asha.org/policy
2. Saur D, Schelter B, Schnell S, Kratochvil D, Küpper H, Kellmeyer P, et al. Combining functional and anatomical connectivity reveals brain networks for auditory language comprehension. Neuroimage. 2010;49(4):3187-97. http://dx.doi.org/10.1016/j.neuroimage.2009.11.009. PMid:19913624.
3. American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-5. 5. ed. Arlington: American Psychiatric Association; 2013. 991 p.
4. Moll K, Kunze S, Neuhoff N, Bruder J, Schulte-Ko¨rne G. Specific learning disorder: prevalence and gender differences. PLoS One. 2014;9(7):e103537. http://dx.doi.org/10.1371/journal.pone.0103537. PMid:25072465.
5. Schirmer C, Fontoura DR, Nunes ML. Distúrbios da aquisição da linguagem e da aprendizagem. J Pediatr. 2004;80(2):S95-103. http://dx.doi.org/10.1590/S0021-75572004000300012.
6. Silver CH, Ruff RM, Iverson GL, Barth JT, Broshek DK, Bush SS, et al. Learning disabilities: the need for neuropsychological evaluation. Arch Clin Neuropsychol. 2008;23(2):217-9. http://dx.doi.org/10.1016/j.acn.2007.09.006. PMid:17977692.
7. Pham AV, Riviere A. Specific learning disorders and ADHD: current issues in diagnosis across clinical and educational settings. Curr Psychiatry Rep. 2015;17(6):38. http://dx.doi.org/10.1007/s11920-015-0584-y. PMid:25894357.
8. Deriziotis P, Fisher SE. Speech and language: Translating the genome. Trends Genet. 2017;33(9):642-56. http://dx.doi.org/10.1016/j.tig.2017.07.002. PMid:28781152.
9. O'Brien LM, Gozal D. Neurocognitive dysfunction and sleep in children: from human to rodent. Pediatr Clin North Am. 2004;51(1):187-202. http://dx.doi.org/10.1016/S0031-3955(03)00184-6. PMid:15008589.
10. Zuculo GM, Knap CC, Pinato L. Correlation between sleep and quality of life in cerebral palsy. CoDAS. 2014;26(6):447-56. http://dx.doi.org/10.1590/2317-1782/20140201435. PMid:25590906.
11. Blissitt PA. Sleep, memory, and learning. J Neurosci Nurs. 2001;33(4):208-15. http://dx.doi.org/10.1097/01376517-200108000-00007. PMid:11497074.
12. Engle-Friedman M, Riela S, Golan R, Ventuneac AM, Davis CM, Jefferson AD, et al. The effect of sleep loss on next day effort. J Sleep Res. 2003;12(2):113-24. http://dx.doi.org/10.1046/j.1365-2869.2003.00351.x. PMid:12753348.
13. Rhodes SK, Shimoda KC, Waid LR, O'Neil PM, Oexmann MJ, Collop NA, et al. Neurocognitive deficits in morbidly obese children with obstructive sleep apnea. J Pediatr. 1995;127(5):741-4. http://dx.doi.org/10.1016/S0022-3476(95)70164-8. PMid:7472827.
14. Owens J, Spirito A, Marcotte A, Mcguinn M, Berkelhammer L. Neuropsychological and behavioral correlates of obstructive sleep apnea

syndrome in children: a preliminary study. Sleep Breath. 2000;4(2):67-78. http://dx.doi.org/10.1007/BF03045026. PMid:11868122.

15. Kaemingk KL, Pasvogel AE, Goodwin JL, Mulvaney SA, Martinez F, Enright PL, et al. Learning in children and sleep disordered breathing: findings of the Tucson Children's Assessment of Sleep Apnea (TucCASA) prospective cohort study. J Int Neuropsychol Soc. 2003;9(7):1016-26. http://dx.doi.org/10.1017/S1355617703970056. PMid:14738283.
16. Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bogels SM. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: a meta-analytic review. Sleep Med Rev. 2010;14(3):179-89. http://dx.doi.org/10.1016/j.smrv.2009.10.004. PMid:20093054.
17. Gregory AM, Sadeh A. Sleep, emotional and behavioral difficulties in children and adolescents. Sleep Med Rev. 2012;16(2):129-36. http://dx.doi.org/10.1016/j.smrv.2011.03.007. PMid:21676633.
18. Giacheti CM, Ferrari C. Roteiro descritivo da avaliação fonoaudiológica da criança. In: Giacheti CM, editor. Avaliação da fala e da linguagem: perspectivas interdisciplinares. Marília: Cultura Acadêmica; 2016. 270 p.
19. Stein LM. TDE: teste de desempenho escolar: manual para aplicação e interpretação. São Paulo: Casa do Psicólogo; 1994, 1-17.
20. Belísio AS, Louzada FM, Azevedo CVM. Influence of social factors on the sleep-wake cycle in children. Sleep Sci. 2010;3(2):82-6.
21. Bordin IA, Rocha MM, Paula CS, Teixeira MCTV, Achenbach TM, Rescorla LA, et al. Child Behavior Checklist (CBCL), Youth Self-Report (YSR) and Teacher's Report Form(TRF): an overview of the development of the original and Brazilian versions. Cad Saude Publica. 2013;29(1):13-28. PMid:23370021.
22. Ferreira VR, Carvalho LB, Ruotolo F, de Morais JF, Prado LB, Prado GF. Sleep disturbance scale for children: translation, cultural adaptation, and validation. Sleep Med. 2009;10(4):457-63. http://dx.doi.org/10.1016/j.sleep.2008.03.018. PMid:18706856.
23. Hochadel J, Frölich J, Wiater A, Lehmkuhl G, Fricke-Oerkermann L. Prevalence of sleep problems and relationship between sleep problems and school refusal behavior in school-aged children in children's and parents' ratings. Psychopathology. 2014;47(2):119-26. http://dx.doi.org/10.1159/000345403. PMid:24080494.
24. Gupta R, Bhatia MS, Chhabra V, Sharma S, Dahiya D, Semalti K, et al. Sleep patterns of urban school-going adolescents. Indian Pediatr. 2008;45(3):183-9. PMid:18367762.
25. Wiggs L, Stores G. Sleep patterns and sleep disorders in children with autistic spectrum disorders: insights using parent report and actigraphy. Dev Med Child Neurol. 2004;46(6):372-80. http://dx.doi.org/10.1017/S0012162204000611. PMid:15174528.
26. Machado Gomes A, Santos OM, Pimentel K, Marambaia PP, Gomes LM, Pradella-Hallinan M, et al. Quality of life in children with sleep-disordered breathing. Rev Bras Otorrinolaringol (Engl Ed). 2012;78(5):12-21. http://dx.doi.org/10.5935/1808-8694.20120003. PMid:23108815.
27. Fensterseifer GS, Carpes O, Weckx LLM, Martha VF. Mouth breathing in children with learning disorders. Rev Bras Otorrinolaringol (Engl Ed). 2013;79(5):620-4. http://dx.doi.org/10.5935/1808-8694.20130111. PMid:24141679.
28. Tomblin JB, Zhang X, Buckwalter P, Catts H. The association of reading disability, behavioral disorders, and language impairment among second-grade children. J Child Psychol Psychiatry. 2000;41(4):473-82. http://dx.doi.org/10.1111/1469-7610.00632. PMid:10836677.
29. Byars AW, deGrauw TJ, Johnson CS, Perkins SM, Fastenau PS, Dunn DW, et al. Language and social functioning in children and adolescents with epilepsy. Epilepsy Behav. 2014;31:167-71. http://dx.doi.org/10.1016/j.yebeh.2013.11.007. PMid:24434307.
30. Fadini CC, Lamônica DA, Fett-Conte AC, Osório E, Zuculo GM, Giacheti CM, et al. Influence of sleep disorders on the behavior of individuals with autism spectrum disorder. Front Hum Neurosci. 2015;18(9):347. PMid:26150777.
31. Vélez-Galarraga R, Guillén-Grima F, Crespo-Eguílaz N, Sánchez-Carpintero R. Prevalence of sleep disorders and their relationship with core symptoms of Inattention and hyperactivity in children with attention-deficit/hyperactivity disorder. Eur J Paediatr Neurol. 2016;20(6):925-37. http://dx.doi.org/10.1016/j.ejpn.2016.07.004. PMid:27461837.

Author contributions

AMF was responsible for the study design, collection, analysis and interpretation of the data, and writing of the manuscript; CMG participated in the study design, general orientation of its execution stages, analysis of the data and revision of the manuscript; NCS and LMGC participated in the analysis and interpretation of the data and writing of the manuscript; LP was responsible for the study design, general orientation of its execution stages, analysis and interpretation of the data, and writing of the manuscript.