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COGNITIVE DYSFUNCTION IN CHILDREN WITH SLEEP DISORDERS

Luciane Bizari Coin de Carvalho[1], Lucila Bizari Fernandes do Prado[2], Luciana Silva[3], Marilaine Medeiros de Almeida[3], Tatiana Almeida e Silva[3], Célia Maria Alcântara Machado Vieira[3], Álvaro Nagib Atallah[4], Gilmar Fernandes do Prado[5]

ABSTRACT - Sleep is basic for physical and cognitive development and some studies have suggested that there may be an association between sleep disorders (SD) and cognitive dysfunction (CD) in children. Little is known, however, about SD and cognition in 7-10-year-old children, a fact that motivated the present study. *Method*: We applied an SD questionnaire in 1180 children, 547 with SD and 633 without SD (CG), to assess cognition with a screening test (Bender Visual Motor Gestalt Test - BT). *Results*. We observed a similar frequency of CD in the children with SD (39%) and that ot the CG (40%). The 8-year-old children with SD presented a lower prevalence of CD than the CG (SD=6%, n=6; CG=13%, n=16; p=0.04). *Conclusion*: The frequency of children with CD was equal in the study and control groups when considering the total sample (7- to 10-year-old children). In contrast to our expectations, the SD group of 8-year-old children presented a lower frequency of CD than the control group.

KEY WORDS: sleep disorders, children and cognitive dysfunction.

Disfunção cognitiva em crianças com distúrbios do sono

RESUMO - O sono é fundamental no desenvolvimento físico e cognitivo, vários estudos na literatura sugerem haver associação entre distúrbio do sono (DS) e disfunões cognitivas (DC) em crianças. Pouco se sabe, no entanto, sobre DS e cognição na faixa etária de 7 a 10 anos, motivo porque empreendemos este estudo. *Método:* Aplicamos um questionário de DS em 1180 crianças: 547 com DS e 633 sem DS (GC), avaliando-se cognição pelo Teste Gestáltico de Bender (TB). *Resultados:* Observamos proporção semelhante de DC nas crianças com DS (39%) e nas do GC (40%). As crianças de 8 anos do DS apresentaram menor prevalência de DC do que as do GC (DS=6%, n=6; GC=13%, n=16; p=0,04). *Conclusão:* A proporção de crianças com DC foi igual nos grupos estudo e controle quando consideramos a amostra total (crianças de 7 a 10 anos). Contrariando nossas expectativas, o grupo DS de 8 anos apresentou menos DC que o grupo controle.

PALAVRAS-CHAVE: distúrbios do sono, crianças e disfunção cognitiva.

Sleep is basic for the physical and cognitive development of children[1], but studies about sleep disorders (SD) and their consequences in this age group are few and inconclusive. About 35 to 46% of school-age children and 20 to 25% of adolescents present some kind of SD. Twenty percent of school-age children snore, suffer from daily fatigue and experience difficulty to sleep at least once a week, and 14% of them have a poor quality of sleep[2]. Attempts have been recently made to show a relation between SD and learning problems[3] in children that present a poor quality of sleep, irregular bedtime schedules and fatigue during classes. Children without difficulties in waking up in the morning are more motivated during classes whereas children with sleep restriction present difficulty in abstract thinking and verbal creativity[4]. Children with fragmented sleep had lower perfomance in neurobehavioral tests[5], those with lower sleep efficiency had a higher percentage of incorrect responses in working memory tasks[6], and those with acute sleep restriction increased innatentive behaviors[7].

Sleep breathing disorders are highly prevalent among children and have been suggested to reduce cognitive performance more intensely than other SD, affecting memory, attention and visuo-constructive ability[8-10]. Academic performance

Sleep Disorders Center, Departments of Neurology and Emergency Medicine, Federal University of São Paulo São Paulo SP, Brazil (UNIFESP): [1]PhD, Department of Neurology, Sleep Disorders Center, UNIFESP; [2]MD, Department of Neurology, Sleep Disorders Center, UNIFESP; [3]Department of Neurology, Sleep Disorders Center UNIFESP; [4]MD, PhD, Brazilian Cochrane Center; [5]MD, PhD, Departments of Neurology and Emergency Medicine, Sleep Disorders Center, UNIFESP. Supported by FAPESP 00/07513-3.

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Dr. Gilmar Fernandes do Prado - Rua Claudio Rossi 394 - 01547-000 São Paulo SP - Brazil. E-mail:gilmar.dmed@epm.br

has been investigated in Brazil[11], but little information exists about SD and cognitive dysfunction in Brazilian 7- to 10-year-old children[12-13] and the few studies available involved inadequate samples, mainly because of the difficulty to study large samples in view of the fact that most tests for the assessment of cognitive function are difficult to apply.

On this basis, we undertook the present study evaluating the performance of SD children comparing with non-sleep disorder children by using a screening test for cognition.

METHOD

We studied 1180 children, 7- to 10 year-old, from August 1999 to June 2000, proceeding from 9 State Schools of Basic Education of the Region Center-South of the São Paulo City, Brazil. These schools had been drafted, among 35 possible ones, for representing each quarter of this region of which the university is a part. The study protocol (447/00) was approved by the institutional review board of the Federal University of Sao Paulo, UNIFESP. The Consent was signed by the responsible Director of Education, the principals of the schools and the parents of the children.

About 5400 Questionnaires of Alterations of Sleep in Infancy (QASI), adapted for the Portuguese of Brazil, from Bruni et al.[14] had been delivered. Until June 2000, 3612 questionnaires answered by the parents of the children had been returned and 589 were excluded because of incorrect filling in. For definitions of habits related to the normal sleep and SD, 3023 questionnaires were analyzed[15]. Six hundred and forty children presented witSD in the QASI[14] and, they were all included for cognitive evaluation. We also elected randomically 640 normal children from a total of 2383 as a control group (CG). We adopted a stratified procedure for randomization to pair for gender and age. A team of 12 trained psychologists had gone back to the schools and had assessed cognition with the screening test (Bender Visual Motor Gestalt Test - BT[16-18]), in 547 SD children and 633 CG group. The BT is aproppriated to screen cognition deficit because it can be rapidly applied (10 minutes) and has easy to understand instructions[16-18]. Fifty and three children of the group with SD and 7 children of the CG had not been tested because of absence during the days where the application proceeded by BT. The searching psychologist analyzed the BT and was unaware of which group the child belonged to: SD or CG. The SD group consisted of children with sleep breathing disorders (SBD), disorders of arousal (DA), difficulty in initiating and maintaining sleep (DIMS), disorders of sleep-wake transition (DSWT), and daytime sleepiness (DSS). Children taking medicines, presenting psychiatric disorders (psychosis, autism) or genetic syndromes were not assessed. The diagnosis of cognitive dysfunction (CD) was analyzed according to the BT criterias[16-18].

Statistical analyses: the data were analyzed in relation to the CG, i.e., by determining if the ratio of children with CD in the SD group differed from that observed in the CG. We used the chi-square and Fisher tests, with the level of significance set at $p<0.05$. The explanation variables were: gender, age (7-, 8-, 9- and 10-yo), total sleep time (< 8h and > 8h) and start time school (morning, afternoon).

RESULTS

The demographic data of this study population are shown in Tables 1 and 2. The SD group consisted of 79 children (14%) with sleep breathing disorders, 454 children (83%) with disorder of arousal, 16 children (3%) with difficulty in initiating

Table 1. Distribution of the SD and CG children by gender, total sleep time (TST) and start time to school (STS).

		SD		CG		Total	
		n	%	n	%	n	%
Gender	Boys	270	49	314	50	584	49
	Girls	277	51	319	50	596	51
TST	< 8 h	42	8	46	7	88	7
	> 8 h	491	92	578	93	1069	91
STS	Morning	301	55	332	52	633	54
	Affternon	246	45	301	48	547	46

Table 2. Distribution of SD and CG children by age (7, 8, 9 and 10 years-old).

	7 years		8 years		9 years		10 years		Total	
	n	%	n	%	n	%	n	%	n	%
SD	161	29	143	26	144	26	99	16	547	46
CG	164	26	161	25	158	25	150	24	633	54
Total	325	28	304	26	302	26	249	21	1180	100

Table 3. Distribution of cognitive dysfunction in sleep disorders group (sleep-breathing disorders - SBD; disorders of arousal - DA; difficulty in initiating and maintaining sleep - DIMS) and control group (CG) for all children, by gender, age (7, 8, 9, and 10 years old), total sleep time (<8h, >8h) and by start time to school (STS-M: morning; STS-A: afternoon). Cognitive dysfunction did not differ significantly to each group pair.

	SBD		CG		DA		CG		DIMS		CG	
	n	%	n	%	n	%	n	%	n	%	n	%
Total	79	34	633	40	454	39	726	40	16	50	1164	39
Boys	48	31	314	39	218	38	366	39	7	43	577	38
Girls	31	39	319	41	236	40	360	41	9	56	587	40
<8h	4	50	47	36	32	41	56	21	1	0	87	40
>8h	74	34	578	40	50	40	1019	39	410	39	659	40
STS-M	48	40	332	37	249	37	384	38	6	33	627	38
STS-A	31	26	301	43	205	41	342	42	10	60	537	41
7 yo	25	20	164	9	134	9	191	10	4	0	289	10
8 yo	24	25	161	36	116	30	188	34	2	0	302	32
9 yo	16	63	158	53	124	62	178	52	7	71	295	56
10 yo	14	43	150	66	80	65	169	66	3	100	246	65

Table 4. Distribution of cognitive dysfunction in sleep disorders group (disorders of sleep-wake transition - DSWT; daytime sleepiness - DSS) and control group (CG) for all children, by gender, age (7, 8, 9, and 10 years old), total sleep time (<8h, >8h) and by start time to school (STS-M: morning; STS-A: afternoon). Cognitive dysfunction did not differ significantly to each group pair.

	DSWT		CG		DSS		CG	
	n	%	n	%	n	%	n	%
total	84	46	1096	39	61	44	1119	39
boys	43	47	541	38	37	46	547	38
girls	41	46	555	40	24	42	572	40
<8h	11	64	77	36	8	50	80	38
>8h	14	50	1055	39	70	44	999	39
STS-M	40	40	593	37	36	39	597	37
STS-A	44	52	503	40	25	52	522	41
7 yo	22	18	303	9	19	11	306	10
8 yo	17	29	287	32	14	21	290	33
9 yo	29	55	273	56	14	79	288	55
10 yo	16	88	233	64	14	79	235	65

and maintaining of sleep 84 children (15%) with disorder of the sleep-wake transition, and 61 children (11%) with daytime sleepiness. There was no association among these sleep disorders and cognitive dysfunction (Tables 3 and 4). The grade and age variables were highly correlated and therefore were analyzed as single variable (Pearson Correlation = 0.946; p=0.01).

The gender distribution of children with CD did not differ between the SD group and CG: 122 (48%) were boys (Table 1). The age distribution of the children with CD in the SD group (n=212) and in CG (n=252) is shown in Table 2.

Fourteen SD children and 9 CG children did not report how much time they slept; of the 533 SD children and 624 CG children that provided this information, 491 (92%) and 578 (93%) children, respectively, slept more than 8 hours, and only 42 SD children and 46 CG children slept less than 8 hours, with no significant difference in the prevalence of CD between the two groups (41% and 37%, respectively).

Among the start time school - afternoon (STS-A) children, 246 (45%) were from the SD group and 301 (48%) from the CG. Of the start time school - morning (STS-M) children, 301 (55%) were from the SD group and 332 (52%) from the CG. The prevalence of CD did not differ significantly between these groups (40% and 38% respectively). Among the 8-year-old children with SD from STS-A, CD was more prevalent for the CG (CG=13%, n=16; SD=6%, n=6; p=0.04; OR=0.31; 95%CI=0.1 to 0.9).

DISCUSSION

The children sleep questionnaires answered by the parents are criticized for their imprecision because the parents cannot always know what happens to the children, mainly if they sleep in another room and do not make noise or call their parents[19-20]. Besides, some adults do not perceive the sleep of their child

as a "problem" and believe that sleep disorders are part of normal child development.

The questions about learning and cognitive skills depend on factors beyond those associated with SD, with an important influence of low income, children's work, lack of disease treatment, family disharmony, psychological problems and others, in addition to school difficulties. The complaints directly related to the mothers, such as the inability to impose limits to the children, anger roused by the children's demands and uncertainty about their mothering ability, produce anguish and anxiety in the child, which may manifest as sleep disorders[20].

Paradoxically, in this study we observed a higher frequency of CD among 8-year-old CG children from STS-A. We could not find an explanation for the better BT performance of SD children; the fact that the child wakes up many times at night or has a poor quality of sleep may indirectly stimulate other neural pathways that can be used in cognitive functions, giving an impression of learning when there is only training or an adaptation to determined functions[21-23]. Phenomena such as the excessive number of arousals, anxiety, concern with experiences and a search for external references[1] can be associated with functional activities predominantly depending on the right cerebral hemisphere, indirectly promoting a training for functions detected in the BT, masking the cognitive deficiency dependent on visuo-motor functions.

Literature studies on 7- to 10-year-old children suggest that these children present equal physical and psychological characteristics but, in some studies, the 8- year-old children presented different behaviors sometimes even opposite to the pattern of expected for this age[24-26]. In our study, 7- to 8-year-old children differed amongst themselves and in relation to the other ages, and 9- to 10-year-old children showed a similar pattern of sleep and cognition.

It has also been shown that 8-year-old children present increased slow wave sleep, increased REM[27] and many nightmares[28], findings that have not yet been been associated with any specific etiology, and that do not reveal associated physical or psychological disorders, although the excessive number of arousals causes irregular secretion of growth hormone[29].

With respect to cognitive development, we know that 8-year-old children differ from younger ones by being in the concrete operation period, i.e., they use egocentrism to understand relations and symbols, taking into account all the aspects of a situation, putting themselves in the place of others, perceiving the logic of the facts, but without the capacity to abstract ideas, which will only appear at about 12 years of age. They can, for example, perceive that dreams are inside their head and not actually present in the room; they know that dreams are unreal, but do not understand what they are, what they do and how they arrived there; they dominate the language and use it in the formation of groups, comparing themselves with their friends in terms of creativity and productivity. Sexuality is in the latency phase, although the children talk much about it and use it in their games as a determinant factor in the formation of rival groups[1].

These physical, cognitive, psychological, and adaptive characteristics of 8-year-old children indicate that these children are passing through a phase of many changes and with special patterns specific for this age. Further separate investigation of this age is needed for a better understanding of the causes and consequences of this differentiation. As a whole, from 7- to 10-year-old children do not present cognitive dysfunction associated with sleep disorders.

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