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Association of Sleep Disorder on Motor Function of Pre-School and School-aged Cerebral Palsy Children in a Tertiary Rehabilitation Centre of Eastern Zone, India

Mohakud K¹, Sahoo S^{2*}, Mishra DP³, Das SP⁴, Sahu RK⁵

¹MOT (Rehabilitation), PhD Scholar, Occupational Therapist, SVNIRTAR, Cuttack, Odisha, India; ²Professor & HOD, Department of Psychiatry, IMS & SUM Hospital, Siksha O Anusandhan (Deemed to be) University, Bhubaneswar, Odisha, India; ³MOT (Developmental Disabilities), PGDND, FAOT-NDD, MAPC (Clinical Psychology), Consultant Occupational Therapist, SVNIRTAR, Cuttack, Odisha, India; ⁴ Director, SVNIRTAR, Cuttack, Odisha, India; ⁵Sr. Occupational Therapist cum Jr. Lecture, SVNIRTAR, Cuttack, India.

ABSTRACT

Introduction: About 23-46 per cent of children with Cerebral Palsy suffer from sleep problems. It adversely impacts on learning, mental functioning, emotional function, the behavioural and social function of school-aged children. So a trial to investigate the association between sleep problems of pre-school and school-aged Cerebral Palsy (CP) children to their gross motor (GM) function.

Objective: To examine the association between sleep problems and gross motor function of the pre-school and school-aged children with CP.

Methodology: Sixty-two CP children of 3-10years age participate in the observational co-relational study. The Child's Sleep Habit Questionnaire (CSHQ) and Gross Motor Function Classification System, Expanded and Revised (GMFCS-E&R) were administered to measure sleep problems and gross motor function respectively.

Results: Data are analyzed by two-tailed Spearman correlation and found strong association persists between sleep problem and gross motor function of preschool and school-aged children with CP ($r = 0.868, p = 0.00$). The severity of sleep behaviour at various GMFCS -ER levels were analyzed by Kruskal-Wallis Test ($F = 11.33, p = 0.001$) and the post hoc test was applied by the Bonferroni method found as follows 5-1>4-1>3-1>2-1>2-5.

Conclusion: Sleep problem affects in achieving the gross motor function of Pre-school and school-aged children with CP.

Keywords: Sleep Problem, Cerebral Palsy, Motor Function, School Children, Association, Gross Motor

INTRODUCTION

Sleep is a complex physiological function for all living creatures. It does not mean a state of shut-down but as a state of activity. Sleep facilitate maturation, reorganization, and restoration of function. It is a unique and essential area of occupation, the naturally occurring events to support life and permit or promote adaptation to the environment.¹ Sleep facilitates growth and development through learning and mastery.² Good sleep means one can initiate and maintain sleep by disengaging from the environment automatically and effortlessly and successfully gate irrelevant stimuli.³ Sleep is

essential for children's physical, emotional well-being and plays a critical role in neurological development.⁴ Pre-school and school-aged children have greater sleep needs than adolescents and adults and also typically require 10 to 11 hours of sleep every day.⁵ Prevalence of sleep problems is more than 80% in children with neurodevelopmental disorders.^{6,7} Cerebral palsy (CP) is the most common unchanging neurological disorder of childhood motor disability characterized by multiple impairments and functional limitation as it affects the development of movement and posture.^{8,9} About 23 - 46% of children with Cerebral Palsy (CP) Children suffer from sleep problems.^{10,11} They have a prevalence of ini-

Corresponding Author:

Surjeet Sahoo, MD (Psychiatry), Professor & HOD, Dept. of Psychiatry IMS & SUM Hospital, Bhubaneswar, Odisha, India.

Phone: 9437080574; E-mail: surjeetsahoo@gmail.com

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tiation, maintenance, sleep-wake transition disorders, excessive sleepiness and arousal disorders.¹⁰ Sleep disorders in CP children may be due to various factors like mental retardation, visual impairment, seizure disorders, obstructive sleep apnea, restricted movements due to contractures and pain due to spasticity, dental caries and use of orthoses, anti-epileptic medications, etc.¹¹⁻¹⁵ Good sleep plays a critical role in the neurological development of children but sleep problems negatively affect the daytime functioning, emotional health, interpersonal relationships, and academic performance.¹⁶⁻¹⁹ Studies describes the relationship of sleep to the gross motor function of CP children.²⁰ Ghorbanpour Z et.al. represented the Correlation between Sleep Disorders and Function in Children with Spastic Cerebral Palsy,²¹ but there is a lack of literature focusing on the association of sleep disorders to the gross motor function of preschool and school-aged CP children in the eastern zone of India. Hence an initiative has been taken to investigate the association of sleep disorders to the gross motor function of preschool and school-aged CP children attending SVNIRTAR, Odissa. Hence our study hypothesized as sleep does have an association with gross motor function of preschool and school-aged CP children. Also, we propose to determine the effects of abnormal sleep behaviour of CP children on their gross motor development.

MATERIAL AND METHODS

Participants were recruited for the cross-sectional study attending pediatric out-patient & in-patient Department of Occupational Therapy, Swami Vivekananda National Institute of Rehabilitation Training And Research (SVNIRTAR), Olatpur, Cuttack, Odisha a tertiary level hospital in the field of rehabilitation. Sixty- two numbers of patients of preschool and school-aged children of age 4 to 10 years, diagnosed with CP were recruited through consecutive sampling method. Child having Intellectual Disability, brain hemorrhage, brain tumor, Down syndrome, congenital anomaly and associated chronic medical conditions cardiorespiratory conditions are excluded from the study. Also the Child having sensory processing disorder and who had undergone any soft tissue release, corrective deformity and recent spinal tap were not included in the study. Children under medications of antihistamine, CNS stimulants and anticonvulsants whose probable effects on sleep were excluded from the study. The purpose of the study is well explained to the parents or guardians of the participants. After the parents of the child filled the consent to participate in the study, data were collected using surveys in combination with interviews to ensure uniformity in the research process. The caregiver of each subject participated in structured face to face interviews which lasted an average of 45 minutes. The interviews were conducted in Odisha, the regional dialect spoken in Odisha. All questions

were translated from English to Odia by 2 translators using the back-translation method. Interviews were conducted by one researcher while another monitors the proceedings. Demographic data and information on sleep issues (CSHQ) and gross motor functions (GMFCS-ER) were collected during the interviews by using questionnaires. The questionnaires were filled out by the researchers who conducted the interviews due to the lack of reading literacy amongst some of the participant caregivers. At the end of each interview, the interviewee was allowed to clarify any doubts or ask questions. Custom made an odia-language survey with close-ended questions were used to collect the demographic data from the caregiver of the participants. The study was conducted for 6months from July to December 2019. The study was approved by the scientific and the ethical committee of the institutional board.

- I. The Children Sleep Habit Questionnaires (CSHQ) is a retrospective, 33-items abbreviated parent questionnaire for screening sleep behaviour in 4-10years children. It has 8 subscales of sleep domain like bedtime resistance, sleep-onset delay, sleep duration, sleep anxiety, night-waking, parasomnias, sleep disorder breathing, and daytime sleepiness. Items were rated on a three-point scale: “usually” if the sleep behaviour occurred five to seven times/week; “sometimes” for two to four times/week; and “rarely” for zero to one time/week. Higher scores indicate worse sleep behaviours or problems. A score above 41 is considered problematic sleep behaviour.²⁷
- II. GMFCS-E & R (Gross Motor Function Classification System Expanded and Revised) is used for measuring present abilities and limitations in gross motor function of children. GMFCS- E&R has five functional levels. LEVEL I - Walks without restriction. LEVEL II – Walks without restriction but with limitations. LEVEL III - Walks using a hand-held mobility device. LEVEL IV - Self-mobility with limitations; may use powered mobility. LEVEL V – self mobility severely limited and transported in a manual wheelchair.²⁸

STATISTICAL ANALYSIS

Data were tabulated and analyzed using SPSS version-20. General characteristics of the study population were analyzed by frequencies and cross-tabulation. The association of sleep habit with gross motor function of the preschool and school going CP children was done using two-tailed spearman’s correlation test between CSHQ and GMFCS-ER score of children. The severity of sleep behaviour at various GMFCS-ER levels was analyzed by the Kruskal-Wallis test and a post hoc test was applied by the Bonferoni method.

RESULTS

We approached 76 parents of eligible CP children of 4-10 years out of which 12 mothers did not give consent and 2 mothers did not complete all questionnaires. Hence 62 numbers of subjects were considered for analysis of this study. Among them 42 (68%) are male and 20 (32%) are female children. The mean age of the children participating in the study is 6.55 ± 1.8 years (Table-1a,1b). Spastic CP children are maximum in numbers ($n=50$, 81%) as compared to other types of CP children. Among 62 children, 25 numbers (40%) are in GMFCS-ER level-I; 17 numbers (28%) are in level-II; 7 numbers (11%) are in level-III 2 numbers (3%) are in level-IV and 11 numbers (18%) were in level-V. From the reported abnormal sleep behaviour in CSHQ, two domains were mostly affected. Those were domain sleep disorder breathing (46%) and the domain excessive daytime sleepiness (59.5%). These demographic characteristics are depicted in table-1a & the frequency of participants at different GMFCS levels 1b. Similarly, table -2 shows the Correlations between CSHQ to GMFCS-ER scores. The results in our study showed a significant relationship persists between sleep habits with gross motor function of the preschool and school going CP children as the $r=0.868$ ($p=0.00$). (Table-2).

To compare the effect of sleep behaviour on gross motor function of preschool and school going CP children at the various GMFCS-ER levels data were analyzed with the mean difference between the CHSQ total score and GMFCS-ER levels by Kruskal-Wallis test. We found a significant difference between the CHSQ total score and GMFCS-ER levels ($F=11.33$, $p=0.001$) depicted in the table-3.

However, on post hoc analysis Bonferroni test was done to find the difference size at various GMFCS-ER levels and found as follows $5-1 > 4-1 > 3-1 > 2-1 > 2-5$ depicted in the table-4. This indicates GMFCS-ER level is affected by CSHQ total score of all CP children.

DISCUSSION

Our study demonstrated preschool and school-aged CP children's sleep habit is associated with their gross motor function which corroborates with the finding of the study of Munyumu et al.²²⁻²⁶ We found in our study a strong association exists between sleep behaviour to the gross motor function of preschool and school going CP children and also in abnormal sleep behaviour in CSHQ, domain sleep disorder breathing (46%) and the domain excessive day time sleepiness (59.5%) were mostly affected in our study sample. This also corroborates with the finding of previous studies.^{24,21}

Spastic and dyskinetic varieties of CP have participated in this study. In these types of CP children, total body involvement may be a cause for the increased occurrence of pain or

involuntary movements. Hence these children were more affected in the domain of sleep disorder breathing due to motor abnormality or pathology in CP.²¹ As a result, the initiation and maintenance of sleep is affected in these children and daytime sleepiness is maximum affected in our study sample. In the other part of our study, we found that preschool and school-aged CP children having abnormal sleep behaviour shows poor abilities in gross motor function. In post hoc analysis it reveals that gross motor function classification levels are also affected by the sleep score. That means those who have more abnormal sleep behaviour their gross motor function achievement is more affected. In contrast to other studies GMFCS-ER level V is maximum affected with the sleep score, which is congruent with the study of Munyumu et al.^{20,27,28} Hence our study explains the abnormal sleep habit has a negative impact on the gross motor development which is similar with the findings of previous studies.^{28,30,25} A good number of studies show that fine motor skills Gross motor skills are improved with good or normal sleep but which corroborates with the finding similar to our study.²⁵ In our study we used GMFCS-ER which reveals the sequential development and locomotor component of the children. So here the gross motor function is concerning more of sequential development and the locomotor component of these children. These skills involve coordinated movement of the skeletal muscles.³¹

Sleep is very much essential for the consolidation phase of memory enhancement of this skill learning.³⁰ The neurophysiology supporting this phenomenon is that the children with good sleep, have better learning with the enhancement of motor memory formation when performing any physical activities which support the result of our study.^{29,30} Also if the practice is done for a gross motor activity with a good sleep habit, there is twelve to thirty per cent improvement of performance and skill in both acquisition and retention of motor learning.^{28,30} This occurs due to changes in the electrophysiological, neurochemical, molecular and cellular structure of the brain leading to long term memory of motor control.³² Previous literature depicts that sleep allows for learning-related changes of the brain's activity which is proved in fMRI.

Early learning phase the cerebellum activity shifts from the cerebellar cortex to the dentate nucleus, and with the increase in practice shifts from a cortico-cerebellar to a cortico-striatal network.^{33,34} In normal sleep habits there is an increase in activity in the parietal cortex and in the caudate nucleus which enhances

Performance with less physical practice.³⁵ Also the sleep increases the neural activity levels in the central nervous system, which decreases conscious control and increase of automatic movement control mechanism.³¹ So CP children having good sleep have better learning and control over the skill or motor control mechanism. Hence preschool and

school-aged CP children having abnormal sleep habits have poor gross motor functional abilities.³⁶

LIMITATIONS AND FUTURE RECOMMENDATIONS

The different stages and domains of sleep are not examined for effects on gross motor function abilities which can be considered for future research. Also, the quality of sleep is not measured by polysomnography and actigraphy rather used CSHQ. The CSHQ assesses the frequency of sleep behaviour over a 1week period which may have parental and recall bias. Other factors affecting gross motor functions are not included in the study which can be recommended for further research. The sample size is small to generalize the findings.

CONCLUSION

Sleep habit has a strong association with gross motor function abilities of preschool and school-aged children with Cerebral palsy. Children with good sleep habit behaviour have better gross motor functional abilities like cognition and social developmental milestone. So, sleep issues not be neglected and properly intervened from infancy in CP children to achieve a good sleep habit for a better motor performance leading to a better quality of life.

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Authors Contribution:

KM, SS: Concept and design, Final approval of the version to be published. DPM: Manuscript drafting SPD: Data collection and analysis RKS: Final editing and revision

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Table 1: (a) Sociodemographic Data

Sl. No	Baseline characteristics	Value	
1.	No of subjects	62	
2.	Age range (years)	4 – 10	
3.	Mean age	6.55±1.8	
4.	Gender	Male	42(68%)
		Female	20(32%)
5	Types of CP	Spastic diplegic	52(84%)
		Dyskinetic	10(16%)

Table 1: (b) Frequency of subjects at different GMFCS level.

Level	Number	Percentage %
I	25	40
II	17	28
III	7	11
IV	2	3
V	11	18

Table 2: Correlations between CSHQ to GMFCS-ER score

Tools used	Number of subject(n)	Sphearman rho (r)	P value
CSHQ	62	0.868	0.00
GMFCS	62	0.868	

**Correlation is significant at the p< 0.0 level (2-tailed)

Table 3: Kruskal -Wallis test between CSHQ and GMFCS

Tool	Mean (n)	SD	95% CI	Chi-square Test	P value
CSHQ	77.56	30.035	69.94-85.19	18.787	0.001
GMFCS	2.26	1.436	1.89-2.62		

Table 4: Comparisons with (I) gmfcs and (J) gmfcs

Multiple Comparisons						
Dependent Variable: CSHQ						
Bonferroni						
(I) GMFCS	(J) GMFCS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-46.758*	3.318	0.000	-56.45	-37.07
	3	-60.337*	4.590	0.000	-73.74	-46.93
	4	-64.480*	7.888	0.000	-87.52	-41.44
	5	-65.580*	4.016	0.000	-77.31	-53.85
2	1	46.758*	3.318	0.000	37.07	56.45
	3	-13.579	4.781	0.062	-27.54	.38
	4	-17.722	8.001	0.308	-41.09	5.64
3	5	-18.822*	4.234	0.000	-31.19	-6.46
	1	60.337*	4.590	0.000	46.93	73.74
	2	13.579	4.781	0.062	-.38	27.54
4	4	-4.143	8.606	1.000	-29.28	20.99
	5	-5.243	5.290	1.000	-20.69	10.21
	1	64.480*	7.888	0.000	41.44	87.52
5	2	17.722	8.001	0.308	-5.64	41.09
	3	4.143	8.606	1.000	-20.99	29.28
	5	-1.100	8.315	1.000	-25.38	23.18
5	1	65.580*	4.016	0.000	53.85	77.31
	2	18.822*	4.234	0.000	6.46	31.19
	3	5.243	5.290	1.000	-10.21	20.69
	4	1.100	8.315	1.000	-23.18	25.38

*. The mean difference is significant at the 0.05 level.