Original Article

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Impact of Environment on Motor Function and Methods of Mobility in Children with Cerebral Palsy: A Cross-sectional Study

Paediatrics Section

HEMACHITHRA CHINNIAH[1], ELANSURIYAN SAMBANDAM[2]

ABSTRACT

Introduction: Activities of Daily Living (ADL) in children with Cerebral Palsy (CP) include a variety of environmental settings. Environmental setting plays an important role in clinical assessment and therapeutic intervention to improve the mobility in children with CP. There are various environmental factors like movable surfaces, stairs, carpeting, physical obstacles, which facilitate or constrain the mobility of children with CP.

Aim: To study the differences in motor function and gait speed at different environmental settings and find out the usual mobility methods of children with CP in home, school and community settings.

Materials and Methods: A cross-sectional study was conducted in the Outpatient Department (OPD) of Paediatrics at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India. The duration of the study was seven months, from February 2022 to August 2022. A total of 50 CP children aged between 4-12 years were included and demographic details were collected. Type of CP, gross motor function, gait speed and methods of mobility were evaluated at home, community and school in all the children with CP. Gross Motor Function Measurement (GMFM 88-E), One-Minute Walk Test (1MWT) and parent checklist for mobility methods were used as outcome measures to collect the data and analysed with Wilcoxon signed-rank test and Friedman test.

Results: The mean age of the study population was 8.34±1.62 years, which included 29 (58%) male children and 21 (42%) female children. Gross motor function and gait speed varied across the environment and statistically significant differences (p-value=<0.001) were observed in the home, community and school. Results related to methods of mobility showed that, most of the children, 38 (76%) walk alone in the home and are carried by adults in the community 30 (60%) and use all mobility methods in school.

Conclusion: The present study concluded that, the gross motor function, gait speed and methods of mobility varied across the different environmental settings (home, community and school). Motor function and gait speed were better at home, followed by the school than the community. The common method of mobility was walking alone at home and being carried by adults in the community.

Keywords: Central nervous system, Community setting, Functional disability, Gait speed, Walk test

INTRODUCTION

The CP is one of the commonest childhood disabilities that occur from lesion in the Central Nervous System (CNS) before, during, and after birth [1]. It is characterised by impairments in motor control that contribute to functional limitations in posture and mobility [1]. The severity of neuromuscular and musculoskeletal impairments in CP children is extremely variable and continues to change throughout the individual's lifespan [2]. Mobility is very important as changes in mobility may affect overall participation in society, including access to education, the community, and future employment. During middle childhood and early adolescence, changes in body structure and function, and the contextual features of environmental settings, may all affect mobility [3,4]. Identification of environmental barriers is very much needed which helps to improve the quality of life. The relationship between the functional capacity and performance of CP children is better understood by the concept of person-environment interaction [5]. The interaction of the person with the environment leads to the performance of an activity [6].

In children with CP, the contextual features (physical, temporal, and social) of their home, school, and community are likely to have an important impact on the performance of mobility. Contextual features include physical features like stairs, carpeting and social features like coping skill with peers and expectations related to the age appropriate mobility [5]. Only a few researchers examined differences in the mobility of children with CP across environmental settings [7-9]. Most standardised tests were administered in a controlled setting without environmental distractions. By minimising environmental factors, helps to measures a child's capability but may not reflect a child's performance in everyday settings [5].

Kurinjichelvan S and Chinduja S stated that, making changes in the environmental factors facilitate participation of children with CP and clinicians should change their intervention focus from biological framework to biopsychosocial framework to provide better improvement for beneficiaries [7]. Knowledge of the effect of environmental settings on the usual mobility methods of children with CP would provide basic information for further inquiry into specific environmental factors that either facilitate or constrain the mobility of children with CP. Tieman B et al., conducted a study comparing the gross motor capability and performance across different environment using GMFM-88 in which gait variables were not included [8]. Palisono RJ et al., have done a study on participation of youth CP children in different environment [9]. However, previous studies are insufficient to conclude the effect of environment on the performance of children with CP [7-9].

Hence, present study was planned, including gait speed (1MWT) in children as one of the variable which helps to analyse the gait and functional capacity across the different environment. The present study was conducted with the aim to find out the usual mobility methods of children with CP in home, school and community settings and to examine differences in motor function and gait parameters in different environmental settings.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Outpatient Department (OPD) of Paediatrics at Rajah Muthiah Medical College and

Hospital, Annamalai University, Chidambaram, Tamil Nadu, India. The duration of the study was seven months, from February 2022 to August 2022. Study was commenced after taking permission from Institutional Ethics Committee (ref no- PMR/DRC- 028/2022). The purpose of the study was clearly explained to the parents and children and informed written consent from parents was obtained before the study.

Inclusion criteria: Children with clinically diagnosed CP, aged between 4-12 years, who were able to walk with or without support were included.

Exclusion criteria: Children, who were exposed to recent neurological and orthopaedic surgery, uncontrolled seizures, visual and hearing impairment, acute illness or injury, unable to follow the instruction were excluded.

Sample size calculation: A total of 50 CP children, who presented in the Paediatric OPD and Physical Medicine and Rehabilitation (PMR) OPD at Rajah Muthiah Medical College and Hospital within the study duration were enrolled in the study by convenient sampling.

Study Procedure

Baseline measurements were recorded: name, age, gender, height, weight, Body Mass Index (BMI), GMFCS level (level I-walks without limitations, level II- walks with limitations, level III- walks using a hand held mobility device) and type of CP. The CP children were categorised using topographical classification and further divided into subtypes of spastic CP (diplegia, hemiplegia and quadriplegia [10]. After the baseline measurements the gross motor function was assessed using GMFM-88 scale [11] and gait speed was evaluated using the 1MWT [12]. Information related to mobility methods was obtained using a parent reported checklist.

GMFM-88 scale: It is a standardised, criterion-referenced test designed to measure the change in the gross motor function of children with CP. GMFM consists of 88 items grouped into five dimensions ranging from lying and rolling (A) to walking, running and jumping (E). Dimension E was used in the present study. Four-point ordinal scale (0- does not initiate; 1- initiates; 2- partially completes; 3- completes) was used to score each item by observing the child's performance. Each dimension scores were entered as a percentage of the maximum score for that particular dimension [11].

One-Minute Walk Test (1MWT): Presents a valid, feasible and reliable tool, commonly used among children with CP. Each child was allowed to walk for one minute and covered a distance and the number of steps was recorded and gait speed was calculated [12].

Parent checklist for mobility methods: It included information on the child's usual mobility methods in the home, school, and outdoors or community settings. Parent questionnaires provide a qualitative, accurate assessment of children's skills in a natural environment. Parent reports of children's current skills have consistently been shown to be a sensitive, reliable, and valid source of information. The parents of the CP children were asked to choose the common mobility methods of their children in the following settings; home, school and community [8]. This questionnaire consisted of nine ranks of mobility methods ranges from walks alone (rank 1) to pushed by adult (rank 9). The data were recorded in three settings at home, school and community and analysed with appropriate statistical tools.

STATISTICAL ANALYSIS

In the present study, Statistical Package for Social Sciences (SPSS) version 22.0 has been used for the analysis. An alpha level of 5% has been taken. Categorical variables are expressed as the number of patients and the percentage of patients. Continuous variables are expressed as mean, median and standard deviation. Descriptive analyses were completed for age, gender, anthropometric measurements, types of CP and motor functional level. Comparison of GMFM and gait speed across the home, school and community were analysed using Wilcoxon signed-rank test and Friedman Test as appropriate. In order to analyse differences in mobility across settings, the nine mobility methods from the parent checklist were converted from nominal level data into ordinal level data using a ranking system.

RESULTS

In the present study, 29 (58%) were male children and 21 (42%) were female children with a mean age of 8.34±1.62 years. Mean BMI was 13.6±1.25 [Table/Fig-1]. In the present study, all the 50 children had spastic CP.

Variables	Mean±SD
Age (years)	8.34±1.62
Height (cm)	116.96±5.28
Weight (kg)	18.76±2.69
BMI	13.6±1.25
Gender	**N (%)**
Male	29 (58%)
Female	21 (42%)

[Table/Fig-1]: Distribution of basic characteristics of the study population.
SD: Standard deviation; (Age, gender, anthropometric measurements)

In the present study, 24 (48%) children were observed as spastic diplegia with the GMFCS Level II, 21 (42%) children were observed as spastic hemiplegia with the GMFCS level I and 5 (10%) children were observed as spastic quadriplegia with the GMFCS level III [Table/Fig-2].

Types	GMFCS Level	n (%)
Spastic-hemiplegia	I	21 (42%)
Spastic-diplegia	II	24 (48%)
Spastic-quadriplegia	III	5 (10%)
Total		50 (100%)

[Table/Fig-2]: Distribution of types of Cerebral Palsy (CP) and motor function level (GMFCS).

GMFM-88 (E) score was highest in the home setting and least was attained in a community setting. There was a significant difference observed in the home, community and school, with the p-value<0.001 [Table/Fig-3].

Variables	Mean/Std. Deviation	p-value
GMFM-E: Home (A)	80.18±6.75	<0.001
GMFM-E: Community (B)	28.70±6.29	
GMFM-E: School (C)	55.88±9.76	

[Table/Fig-3]: Mean and standard deviation of GMFM-88 (E) at different settings.
p-value: Probability value

Mean gait speed in home was 0.28±0.06 m/sec, in community was 0.18±0.05 m/sec, in school was 0.25±0.07 m/sec. This reveals children in the home setting had higher gait speed and lower gait speed at school, the lowest gait speed in the community. It was also observed that, there was a significant difference between the home, community and school, with the p-value<0.001 [Table/Fig-4].

Gait speed (m/sec)	Mean±SD	p-value
Home (A)	0.28±0.06	<0.001
Community (B)	0.18±0.05	
School (C)	0.25±0.07	

[Table/Fig-4]: Mean and Standard deviation of gait speed at different settings.
p-value: Probability value

It was observed that, 38 (76%) children walk alone in the home and 30 (60%) children carried by adult in the community. It was also observed that, children used all types of mobility methods equally in the school [Table/Fig-5].

Types of mobility	Home n (%)	Community n (%)	School n (%)
1- Walks alone	38 (76%)	0	3 (6%)
2- Takes steps with walls/ furniture	11 (22%)	4 (8%)	10 (20%)
3- Walks with walking aid	1 (2%)	5 (10%)	11 (22%)
4- Takes steps with adult hand	0	7 (14%)	15 (30%)
5- Rolls, creeps, crawls	0	4 (8%)	10 (20%)
6- Regular wheelchair	0	0	0
7- Battery-powered wheelchair	0	0	0
8- Carried by adult	0	30 (60%)	1 (2%)
9- Pushed by adult	0	0	0
Total	50	50	50

[Table/Fig-5]: Comparison of method of mobility across home, community and school (Parent questionnaire).
n: Number, %: Percentage

DISCUSSION

The present study aimed to investigate the impact of the environment on gross motor function, gait speed and methods of mobility in children with CP. In the present study, all the 50 children had spastic CP and the basic characteristic of the study population was analysed. From the results, it was observed that, the mean age of the study population was 8 to 9 years. The gender was equally distributed in the present study which was observed, as male children 58% and female children 42%. The results related to the types of CP revealed that, the present study included a greater number of spastic diplegia followed by spastic hemiplegia and a smaller number of spastic quadriplegia. Spastic CP is the commonest type of CP. In the present study, 50 children were included based on the GMFCS level and the observed result showed that, most of the children belongs to the level I and level II and a smaller number of children belongs to level III which shows that, most of the children observed with mild and moderate level disability. Gross motor function was evaluated using GMFM-88(E). The observed result showed that, the gross motor function scores (dimension-E) are better in the home setting followed by school and then community. GMFM is a good predictor of physical domain motor functions related to mobility is improved in-home setting, moderate in school and poor in the community [13]. The observed results were consistent with the study done by Fatudimu MB et al., concluded that, GMFM scores were significantly higher when measured at home than a hospital setting [14]. Palisona RJ et al., stated that, CP children need more adult assistance in outdoor and community than at home [9]. Gait speed in different clinical settings was assessed by a 1MWT which is a valid, feasible and reliable tool commonly used in CP children. Gait speed is a measure of walking activity that is linked to functional ability and quality of life in children with CP [15,16]. Pirpiris M et al., and Duffy CM et al., stated that, gait speed is the predictor of the level of community ambulation and may be a valuable measure of disability [17-19]. The observed results related to gait speed showed that, there was a difference in gait speed in a different environment which showed the statistical significance.

The gait speed varied across the environment. External factors like uneven surfaces and obstacles in the community environment played an important role in decreasing gait velocity. The observed gait speed was more or less similar in both home and school and reduced in the community. This may be due to the contextual features in the environment. Similar results were obtained in the study done by Carcreff L et al., the impact of the environment was examined by comparison of children's mobility methods at home versus school and in the outdoor community [20]. The parent checklist was used to collect data related to methods of mobility in different settings. Parent reports are a feasible and practical way to collect information about children's performance across all settings. Wilson BN et al., stated that parent reported check list for mobility methods provide a qualitative, accurate assessment of children's skills in a natural environment [21]. The parent checklist in the present study, utilised a recognition format that has greater reliability than an identification format. The observed results showed that, the mobility methods varied across home, school and community. The result indicates that most of the children walked alone at home, a lesser number of children walked alone at school, and none of the children walked alone at outdoors or community. Similar results were obtained in a study done by Palisano RJ et al., observed that, children were less dependent at home and more dependent on adults in the community setting [9].

It was also observed that, children used all methods of mobility in school and 30% of the children takes steps with an adult hand. This result correlates well with the study done by Diwan S et al., observed a combination of mobility methods used by children and most of the children were lifted by parents or supported by parents by one finger in school [22]. Tieman BL et al., found children's performance was better in their home than at their school and outdoor setting [8]. Tieman B et al., found higher ranked mobility methods at home, lower ranked mobility methods at school, and lowest ranked mobility methods in the community [23]. The observed results showed that, the motor function, gait speed and methods of mobility varied across the environment. The present study has few strengths that it was carried out among CP children in the rural population. The outcome measures used in the present study (gross motor function, gait speed and mobility methods) cover all the physical domains.

Limitation(s)

The present study is a small sample study, further studies are needed with the large sample. In the present study, correlation between gross motor function, gait speed and mobility methods were not evaluated. The authors included only the physical domains and the psychological domain was not evaluated in different settings. Personal factors, affecting motor function were not included in the present study.

CONCLUSION(S)

The study results concluded that, the gross motor function, gait speed and methods of mobility were better at home, followed by the school than the community. The common method of mobility is walking alone at home and being carried by an adult in the community. The physiotherapist should pay attention to physical examination in different settings and find out the contextual features enhancing the methods of mobility. Further research is needed to focus on contextual features that affect mobility and find out the relationship between motor function and methods of mobility. It was concluded that, the environment plays an important role in determining motor function, gait speed and methods of mobility among children with CP.

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PARTICULARS OF CONTRIBUTORS:
1. Lecturer, Department of Division of PM&R, Rajah Muthiah Medical College and Hospital (RMMCH), Annamalai University, Chidambaram, Tamil Nadu, India.
2. Postgraduate Student, Department of Division of PM&R, Rajah Muthiah Medical College and Hospital (RMMCH), Annamalai University, Chidambaram, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Hemachithra Chinniah,
Lecturer, Department of Division of PM&R, Rajah Muthiah Medical College and Hospital (RMMCH), Annamalai University, Kanagasabai Nagar, Chidambaram, Tamil Nadu-608001, India.
E-mail: chitupt@gmail.com

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