Original Article

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Factors Affecting Ambulatory Status in Children with Cerebral Palsy: A Cross-sectional Study

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ABSTRACT

Introduction: Cerebral Palsy (CP) is one of the most common causes of physical disabilities in childhood. Most children with CP are facing limitations of walking and other physical activities. Limitation in ambulation presents potential barriers to activities of daily life, participation in physical, recreational, and social activities, which further hampers the quality of life. Thus, attainment of walking is an important goal for the children with CP, as well as doctors for optimum rehabilitation plan.

Aim: To study the ambulatory status in different types of CP and factors affecting ambulatory status in children with CP.

Materials and Methods: This observational, cross-sectional study was conducted in the Outpatient Department of Physical Medicine and Rehabilitation (PMR) of VMMC and Safdarjung Hospital, New Delhi, India, from November 2018 to April 2020. Total 100 children with CP of age group 2-18 years were enrolled in the study. The type of CP was determined based on tone pattern and limb involvement. Walking ability was assessed using Gross Motor Function Classification System (GMFCS), Functional Mobility Scales (FMS) and Gillette Functional Assessment Questionnaire (FAQ). Factors such as age of independent sitting, presence of accompanying impairments which may influence the walking ability were also studied. Quantitative variables were compared using Kruskal-Wallis test and qualitative variables were compared using Chi-square test.

Results: In the study population of 100 children with CP, 68 were males and 32 were females. Total 55% were independent ambulators, 14% were ambulatory with aids and 31% were non ambulators. 86% had spastic CP, 6% had dyskinetic CP, 6% had mixed CP and 2% had hypotonic CP. Among spastic CP (86), 56% had diplegia, 16.2% had quadriplegia, 24.4% had hemiplegia and 3.4% had triplegia. Children with spastic hemiplegia showed highest potential for independent walking. Among 100 children with CP, 56% achieved independent sitting by 2 years of age, 31% achieved independent sitting after 2 years of age and 13% did not achieve sitting. Total 82.14% of children who achieved independent sitting by 2 years of age were ambulatory without aids. Total 36% of total children had no impairments, 44% had one or two impairments and 20% had three or more impairments. Total 88.8% of children who had no impairments were ambulatory without aids, thus showed good walking potential. Where as 70% of children who had three or more impairments were non ambulators.

Conclusion: The spastic hemiplegia type of CP, achievement of independent sitting by 2 years of age and absence of accompanying impairments are good prognostic predictors of ambulation in children CP.

Keywords: Association, Prognosis, Type of cerebral palsy, Walking ability

INTRODUCTION

The Cerebral Palsy (CP) is one of the most common causes of physical disabilities in childhood, which occurs with an overall prevalence rate of 2.11 per 1000 live births [1]. Cerebral palsy is described "as a group of permanent disorders of development of movement and posture causing activity limitation that are attributed to non progressive disturbances that occurred in developing foetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behaviour by epilepsy and secondary musculoskeletal problems" [2].

Cerebral palsy can be classified into various types based on tone pattern and based on distribution of limb involvement. Based on tone pattern CP is classified as spastic, dyskinetic, hypotonic and mixed. Dyskinetic includes athetoid, choreiform, ballistic and ataxic types. Based on distribution of limb involvement CP is classified as diplegia (lower limbs affected more than upper limbs), hemiplegia (upper limb frequently more affected than lower limb), quadriplegia (bilateral upper limb and lower limb distribution), and triplegia (combination of diplegia and quadriplegia but with asymmetric upper limb involvement) [3,4].

Various scales used for assessing functional level and motor development in CP are Gross Motor Function Classification System (GMFCS) [5], Functional Mobility Scales (FMS) [6] and Gillette Functional Assessment Questionnaire (FAQ) [7]. There is no previous study which has simultaneously used GMFCS, FMS and Gillette FAQ to assess the ambulation. Study of walking ability based on number of accompanying impairments (rather than a specific impairment), is also particular to this study.

Early identification of ambulatory potential and knowledge of factors that might influence the maintenance of ambulatory capacity would favour the planning of realistic treatment goals.

Hence, present study was conducted to assess the ambulatory status in different types of CP and various factors affecting ambulatory status in children with CP. Three scales- GMFCS, FMS and Gillette FAQ were used simultaneously to assess ambulatory status. Study also highlights use of FMS and Gillette FAQ along with GMFCS as functional assessment scales for children with CP. Influence of age of independent sitting and increasing number of accompanying impairments on walking ability were also studied.

MATERIALS AND METHODS

This observational cross-sectional study was conducted in the Outpatient Department of Physical Medicine and Rehabilitation, of VMMC and Safdarjung Hospital, New Delhi, India, from November 2018 to April 2020. Due approval from the Institute Ethics Committee was taken (IEC/VMMC/SJH/Thesis/October/2018-48).

Inclusion criteria: Hundred children diagnosed with CP of both genders, belonging to age group 2-18 years were enrolled after obtaining written informed consent from the parents.

Exclusion criteria: Children with any co-existing neuromuscular disorders, metabolic disorders and genetic disorders were excluded from the study.

Sample size calculation: The study of Keeratisiroj O et al., observed 48.2% of children with CP were capable of ambulation [8]. Taking this value as reference, the minimum required sample size with 10% margin of error and 5% level of significance is 96 patients. So, total sample size taken is 100. Formula used is:- $N \geq \{p(1-p)\}/(ME/Z_{\alpha})^2$;

Where, $Z\alpha$ is value of Z at two-sided alpha error of 5%, ME is margin of error and p is proportion of patients capable of ambulation.

Study Procedure

For each patient relevant history including antenatal, perinatal and postnatal periods and developmental milestones (gross motor, fine motor, language and social milestones) were recorded. Anthropometry including head circumference and body weight was recorded. Detailed age adjusted neurological examination was done and any abnormalities in tone, posture, movement and reflexes were recorded. Accompanying impairments including visual, auditory, speech and cognitive impairments were recorded. Children with CP were classified on the basis of tone pattern as spastic, dyskinetic, hypotonic and mixed. Spastic CP was classified based on limb involvement as diplegia, quadriplegia, hemiplegia and triplegia [3,4].

Children, who walked a distance of atleast 20 feet with the help of walking aids or assistive devices (canes, crutches, walker, frames etc.,) were considered as ambulatory with aids and those who walked the same distance without any walking aids or assistive devices were considered as ambulatory without aids. Children who were completely dependent for ambulation or those required a manual wheel chair for ambulation were considered as non ambulatory [9].

Parameters: Walking ability of children with CP was assessed using GMFCS, FMS and Gillette FAQ.

- Gross Motor Function Classification System (GMFCS) [5] classified gross motor function on the basis of severity from level I (walks without restriction) to level V (very limited self-mobility, even with assistive technology).
- Functional Mobility Scales (FMS) [6] assessed mobility at 5 m (e.g., short distances in house), 50 m (e.g., mobility at school) and 500 m (long distances e.g., shopping centre). Ratings were given from highest score 6 (independent on all surfaces) to lowest score 1 (uses wheel chair). Children who crawled the distance was marked as C and who could not complete distance was marked as N.
- Gillette Functional Assessment Questionnaire (FAQ) FAQ [7] classified levels from 1-10. At level 1 child could not take any step at all, Levels 2-4 described limited house hold mobility. At level 5 and 6 child preferred walking for household mobility. From level 7 child walk community distances. Level 10 is the best where child is typically able to keep up with peers. Walking ability based on the above scales was correlated with type of CP based on tone pattern and limb involvement. Factors such as age of achievement of independent sitting and presence of accompanying impairments which may influence the walking ability of children with CP were also studied.

STATISTICAL ANALYSIS

All categorical variables were presented in number and percentage (%) and continuous variables were presented as mean±SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used. Quantitative variables were compared using Kruskal Wallis test (as the data sets were not normally distributed) between the groups. Qualitative variables were compared using Chi-square test. A p-value <0.05 was considered statistically significant. The data was entered in MS Excel spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

Total 100 children belonging to age group 2-18 years participated in the study. Total 68 were males and 32 were females (male to female ratio 2.1:1). The mean age of the study population was 5.85±3.4 years. Out of 100, 86 of 100 (86%) had spastic CP, 6 of 100 (6%) had dyskinetic CP, 6 of 100 (6%) had mixed CP and 2 of 100 (2%) had hypotonic CP. Among children with spastic CP, 48 (56%) had diplegia, 14 (16.2%) had quadriplegia, 21 (24.4%) had hemiplegia and 3 (3.4%) had triplegia. The most common type of CP (based on tone pattern) was spastic type (86 of 100). Diplegia was the most common type of spastic CP [Table/Fig-1].

Based on tone pattern (n=100)		Based on limb involvement (n=86)	
Spastic	86 (86)	Diplegia	48 (56)
Dyskinetic	6 (6)	Hemiplegia	21 (24.4)
Hypotonic	2 (2)	Quadriplegia	14 (16.2)
Mixed*	6 (6)	Triplegia	3 (3.4)

[Table/Fig-1]: Types of CP. Values are represented as number (%).
*Mixed CP (Spastic+Dyskinetic). Diplegic (both lower limbs), Hemiplegic (one upper limb and lower limb), Quadriplegic (all 4 limbs), Triplegic (3 limbs- both lower limbs and one upper limb)

Out of 100 children, 55 were ambulatory without aids, 14 were ambulatory with aids (e.g., cane, crutches, walker) and 31 were non ambulatory. Among different types of CP, 90.48% of children with spastic hemiplegia were ambulatory without aids. Association of ambulatory status with type of CP was statistically significant [Table/Fig-2]. Association of GMFCS [Table/Fig-3] with type of CP based on tone pattern (p-value=0.011) and distribution of limb involvement (p-value <0.0001) was statistically significant. Association of FMS (5 m, 50 m, 500 m) with type of spastic CP based on limb involvement was statistically significant [Table/Fig-4-6]. Association of Gillette FAQ with type of spastic CP based on limb involvement was also statistically significant [Table/Fig-7]. Among different types of CP, spastic hemiplegia showed the highest ambulation.

Total 87 of 100 children had achieved independent sitting, of which 56 achieved by 2 years of age. Total 82.14% of children who achieved independent sitting by 2 years of age were ambulatory without aids. Association of ambulatory status with age of independent sitting was statistically significant [Table/Fig-8]. Out of 100 children, 36 had no accompanying impairments and rest 64 had atleast one impairment. Total 20 had only one impairment (speech impairment-6, visual impairment-12, cognitive impairment-2), 24 had two accompanying impairments (speech and cognition-14, vision and cognition-6, speech and vision-4) and 20 had three or more accompanying impairments (vision, speech and cognition-17, hearing, speech and cognition-1, vision, speech, cognition and hearing impairment-2).

Ambulatory status	Type of CP based on tone pattern (n=100)					Type of CP based on limb involvement (n=86)				
	Spastic n (%)	Dyskinetic n (%)	Hypotonic n (%)	Mixed n (%)	p-value	Diplegia n (%)	Quadriplegia n (%)	Hemiplegia n (%)	Triplegia n (%)	p-value
Without aids	48 (55.8)	4 (66.6)	1 (50%)	2(33.3)	0.025	26 (54.2)	1(7.1)	19 (90.5)	2 (66.7)	<0.0001
With aids	9 (10.5)	1 (16.7)	0	4 (66.6)		7 (14.6)	0	1 (4.7)	1 (33.3)	
Non ambulatory	29 (33.7)	1 (16.7)	1 (50)	0		15 (31.2)	13 (92.9)	1 (4.7)	0	

[Table/Fig-2]: Association of ambulatory status with type of Cerebral Palsy (CP). Values represented as number (%). p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test

GMFCS level	Types of CP based on tone pattern (n=100)					Types of CP based on limb involvement (n=86)				
	Spastic (n=86) n (%)	Dyskinetic (n=6) n (%)	Hypotonic (n=2) n (%)	Mixed (n=6) n (%)	p-value	Diplegia (n=48) n (%)	Quadriplegia (n=14) n (%)	Hemiplegia (n=21) n (%)	Triplegia (n=3) n (%)	p-value
I	2 (2.3)	0	0	1 (16.7)	0.011	0	0	2 (9.5)	0	0.0001
II	47 (54.6)	4 (66.7)	1 (50)	1 (16.7)		27 (56.3)	1 (7.1)	17 (81)	2 (66.7)	
III	8 (9.3)	1 (16.7)	0	4 (66.7)		6 (12.5)	0	1 (4.7)	1 (33.3)	
IV	25 (29)	1 (16.7)	0	0		14 (29)	10 (71.4)	1 (4.7)	0	
V	4 (4.65)	0	1 (50)	0		1 (2)	3 (21.4)	0	0	

[Table/Fig-3]: Association of Gross Motor Function Classification System (GMFCS) level with type of CP. Values represented as number (%).
p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test

FMS 5 m	Type of CP based on tone pattern (n=100)					Type of CP based on limb involvement (n=86)				
	Spastic n (%)	Dyskinetic n (%)	Hypotonic n (%)	Mixed n (%)	p-value	Diplegia n (%)	Quadriplegia n (%)	Hemiplegia n (%)	Triplegia n (%)	p-value
6	11 (12.8)	1 (16.7)	0	1 (16.7)	0.496	6 (12.5)	0	5 (23.8)	0	0.0002
5	39 (45.3)	3 (50)	1 (50)	4 (66.6)		22 (45.8)	1 (7.1)	14 (66.6)	2 (66.6)	
2	11 (12.8)	1 (16.7)	0	1 (16.7)		6 (12.5)	3 (21.4)	1 (4.7)	1 (33.3)	
C	20 (23.3)	0	0	0		13 (27.1)	6 (42.8)	1 (4.7)	0	
N	5 (5.8)	1 (16.7)	1 (50)	0		1 (2.1)	4 (28.6)	0	0	

[Table/Fig-4]: Association of Functional Mobility Scales (FMS) 5 m with type of CP. Values represented as number (%).
p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test; C- represents children who crawled the distance; N- who could not complete the distance; Children with value '4,3,1' not available

FMS 50 m	Type of CP based on tone pattern (n=100)					Type of CP based on limb involvement (n=86)				
	Spastic n (%)	Dyskinetic n (%)	Hypotonic n (%)	Mixed n (%)	p-value	Diplegia n (%)	Quadriplegia n (%)	Hemiplegia n (%)	Triplegia n (%)	p-value
6	3 (3.5)	0	0	1 (16.7)	0.178	0	0	3 (14.3)	0	<0.0001
5	43 (50)	3 (50)	1 (50)	1 (16.7)		25 (52.1)	1 (7.1)	15 (71.4)	2 (66.6)	
3	1 (1.2)	0	0	0		1 (2.1)	0	0	0	
2	10 (11.6)	1 (16.7)	0	4 (66.6)		7 (14.6)	0	2 (9.5)	1 (33.3)	
1	1 (1.2)	0	0	0		0	1 (7.1)	0	0	
C	11 (12.8)	0	0	0		5 (10.4)	5 (35.7)	1 (4.7)	0	
N	17 (19.8)	2 (33.3)	1 (50)	0		10 (20.8)	7 (50)	0	0	

[Table/Fig-5]: Association of Functional Mobility Scales (FMS) 50 m with type of CP. Values represented as number (%).
p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test; C- represents children who crawled the distance; N- who could not complete the distance; Children with value '4' not available

FMS 500 m	Type of CP based on tone pattern (n=100)					Type of CP based on limb involvement (n=86)				
	Spastic n (%)	Dyskinetic n (%)	Hypotonic n (%)	Mixed n (%)	p-value	Diplegia n (%)	Quadriplegia n (%)	Hemiplegia n (%)	Triplegia n (%)	p-value
6	2 (2.3)	0	0	1 (16.6)	0.038	0	0	2 (9.5)	0	0.0004
5	30 (34.8)	1 (16.6)	1 (50)	0		16 (33.3)	0	13 (61.9)	1 (33.3)	
4	2 (2.3)	0	0	0		1 (2.1)	0	0	1 (33.3)	
2	5 (5.8)	0	0	0		4 (8.3)	0	1 (4.7)	0	
1	6 (6.9)	1 (16.6)	0	4 (66.6)		3 (6.2)	2 (14.3)	1 (4.7)	0	
N	41 (47.6)	4 (66.6)	1 (50)	1 (16.6)		24 (50)	12 (85.7)	4 (19.1)	1 (33.3)	

[Table/Fig-6]: Association of Functional Mobility Scales (FMS) 500 m with type of CP. Values represented as number(%).
p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test; C- represents children who crawled the distance; N- who could not complete the distance; Children with value '3' not available

Gillette FAQ	Type of CP based on tone pattern (n=100)					Type of CP based on limb involvement (n=86)				
	Spastic n (%)	Dyskinetic n (%)	Hypotonic n (%)	Mixed n (%)	p-value	Diplegia n (%)	Quadriplegia n (%)	Hemiplegia n (%)	Triplegia n (%)	p-value
1	9 (10.5)	1 (16.6)	1 (50)	0	0.428	4 (8.3)	5 (35.7)	0	0	0.022
2	17 (19.7)	1 (16.6)	0	0		10 (20.8)	6 (42.8)	1 (4.7)	0	
3	5 (5.8)	0	0	0		3 (6.2)	2 (14.3)	0	0	
4	3 (3.5)	0	0	2 (33.3)		2 (4.2)	0	1 (4.7)	0	
5	6 (6.9)	1 (16.6)	0	0		3 (6.2)	1 (7.1)	2 (9.5)	0	
6	5 (5.8)	1 (16.6)	0	2 (33.3)		2 (4.2)	0	2 (9.5)	1 (33.3)	
7	15 (17.4)	1 (16.6)	1 (50)	1 (16.6)		11 (22.9)	0	3 (14.3)	1 (33.3)	
8	15(17.4)	1 (16.6)	0	0		8 (16.6)	0	6 (28.6)	1 (33.3)	
9	10 (11.6)	0	0	1 (16.6)		5 (10.4)	0	5 (23.8)	0	
10	1 (1.16)	0	0	0		0	0	1 (4.7)	0	

[Table/Fig-7]: Association of Gillette FAQ level with type of CP. Values represented as number (%).
p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test

Total 88.88% of children who had no accompanying impairments were ambulatory without aids. The association of ambulatory status with number of accompanying impairments was statistically significant [Table/Fig-9].

Age of independent sitting (n=87)*	Ambulatory without aids	Ambulatory with aids	Non ambulatory	p-value
Before or by 2 years (n=56)	46 (82.14%)	8 (14.29%)	2 (3.57%)	<0.0001
After 2 years of age (n=31)	9 (29.03%)	6 (19.35%)	16 (51.61%)	

[Table/Fig-8]: Association of ambulatory status with age of achievement of independent sitting. Values represented as number (%).
p-value <0.05 is statistically significant. *Of 100 children 87 achieved independent sitting. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test

Ambulatory status	Number of accompanying impairments (n=100)				p-value
	Nil (n=36)	One (n=20)	Two (n=24)	Three and more (n=20)	
Ambulatory without aids	32 (88.88%)	13 (65%)	6 (25%)	4 (20%)	<0.0001
Ambulatory with aids	4 (11.11%)	3 (15%)	5 (20.8%)	2 (10%)	
Non ambulatory	0 (0%)	4 (20%)	13 (54.2%)	14 (70%)	

[Table/Fig-9]: Association of ambulatory status with number of accompanying impairments. Values represented as number (%).
p-value <0.05 is statistically significant. Quantitative variables were compared using Kruskal Wallis test between the groups. Qualitative variables were compared using Chi-square test

DISCUSSION

Out of 100 children, 86 (86%) had spastic CP, 6 (6%) had dyskinetic CP, 6 (6%) had mixed CP and (2%) had hypotonic CP. Among children with spastic CP, 48 (56%) had diplegia, 14 (16.2%) had quadriplegia, 21 (24.4%) had hemiplegia and 3 (3.4%) had triplegia. Similar to previous studies [10-13] the present study also observed spastic type as the predominating type.

Out of 100 children with CP, 55% (55) were ambulatory without aids. This is similar to the findings from previous studies [14-16]. However, Laisram N and Saha S and Keeratisiroj O et al., observed lesser number of independent ambulators (34.9% and 39.4%, respectively) [8,17].

Majority (48 of 86; 55.8%) of children with spastic CP were ambulatory without aids. 4 (66.7%) children with dyskinetic CP were ambulatory without aids. Of 2 children with hypotonic CP, one was ambulatory without aids and other was non ambulatory. Four of 6 (66.7%) of children with mixed CP were ambulatory with aids. Total 48 of 86 (55.8%) children with spastic CP were ambulatory without aids. Among spastic CP hemiplegia showed highest potential for independent walking (19 of 21 children; 90.5%), whereas spastic quadriplegia showed lowest potential for independent walking (1 of 14; 7.1%). Twenty six of 48 (54.2%) of spastic diplegia and 2 of 3 (66.7%) of children with triplegia also showed independent ambulation. Laisram N and Saha S reported that 94.9% of hemiplegics were ambulatory without aids [17]. Previous studies also observed similar findings [18,19]. Vasconcellos RLM et al., and Nordmark E et al., reported that spastic quadriplegic CP as predominantly non ambulatory, which is consistent with findings of present study [20,21]. The present study reinforces that spastic hemiplegics were the most successful ambulators.

Assessment of GMFCS in different types of CP showed, 80 (93%) children of spastic CP in level II-IV. All children with dyskinetic CP showed GMFCS levels between II-IV. All children with mixed CP were in between level I-III. Among spastic CP, 17 hemiplegics (80.95%) were at level II and rest 2 (9.5%) were at level I and showed highest ambulation. Total 13 (92.86%) children with spastic quadriplegia were at levels IV-V and showed lowest ambulation. Shevell MI et al., in their study observed similar findings [14].

Assessment of Functional Mobility Scales (FMS) 5 m showed, 50 (58%) spastic, 4 (66.6%) dyskinetic, 5 (83.3%) mixed CP walked independently with rating of 6 or 5. Among spastic CP, 19 (90.5%) hemiplegics, 28 (58.3%) diplegics, 2 (66.7%) triplegics and 1 (7.14%) quadrplegics walked independently at FMS 5 m with ratings 6 or 5. At FMS 50 metres, 46 (53.5%) spastic, 3 (50%) dyskinetic, 2 (33.3%) mixed CP walked independently. Among spastic CP, 1 (7.14%) quadriplegics, 18 (85.7%) hemiplegics completed 50 m independently. At FMS 500 m 32 (37%) spastic, 1 (16.7%) dyskinetic, 1 (50%) hypotonic and 1 (16.67%) mixed CP completed independently. Among spastic CP 15 (71%) hemiplegics walked FMS 500 m independently. None of quadriplegics could walk the distance independently. Two (9.5%) hemiplegics completed the distance with best rating of 6 and showed successful ambulation. Walking ability of spastic hemiplegic children at FMS distances were comparable with the findings of Rodby-Bousquet E and Hagglund G [22]. Functional Mobility Scales (FMS) scores were seen to vary with subtypes of CP in the present study.

Gillette Functional Assessment Questionnaire assessment showed 40 (46.5%) children with spastic CP between VII-IX levels, 4 (66.7%) dyskinetic CP between V-VIII levels, 4 (66.67%) mixed CP between IV-VI levels. Among spastic CP, 15 (71.4%) hemiplegics showed successful ambulation (level VII-X), 24 (50%) diplegics between 7 to 9 levels, 14 (92.86%) children with quadriplegia at (levels I-III) and showed lowest ambulation. All children (3 of 3) with spastic triplegia were between VI-VIII levels.

In the present study, 69 (69%) children could walk with or without ambulatory aids. In overall, spastic CP showed favourable ambulatory potential. Children with spastic hemiplegia had the highest potential for independent walking. Children with spastic quadriplegia had poor ambulatory potential, and were more dependent on their care-givers. This is why they have poor ambulatory potential and functional ability. A 68.75% children with spastic diplegia were ambulatory with or without aids. All children with spastic triplegia were ambulatory with or without hand-held assistive devices. Children with mixed CP showed a better ambulation than children with dyskinetic CP. Children with hypotonic CP were very less in number (2 of 100) and therefore difficult to comment regarding their overall walking potential. It was observed that neurological subtype is a powerful predictor of functional status related to ambulation. Thus present study reinforces that the type of CP was a strong predictor for prognosticating ambulation in children with CP. Comparison of present study with contrast studies is summarised in [Table/Fig-10] [8,14,17,18,22].

Association of ambulatory status with age of independent sitting showed, 82% of children who achieved independent sitting by 2 years of age were able to walk independently. The present study findings were consistent with findings of Keeratisiroj O et al., and Laisram N and Saha S [8,17]. Montgomery PC [19] concluded that the best skill for predicting ambulation was sitting. Early gross motor milestones, especially sitting, are important for predicting walking since antigravity muscles for the trunk and postural control during sitting is necessary for the upright position development [23].

Strong association between ambulatory status and number of accompanying impairments was observed in the present study. Thirty six had no any accompanying impairments and rest 64 had atleast one impairment. Maximum of four accompanying impairments were observed simultaneously. Most common impairments observed were visual, speech, hearing and cognitive impairment. 88.88% of children who had no impairments were ambulatory without aids, whereas, 70% of children with three or more impairments were non ambulatory. Similar findings were observed by Iloeje SO and Ogoke CC [18] and Vasconcellos RLM et al., [18,20]. The study suggests that total number of accompanying impairments in a child with CP may give an indication of functional abilities of the child.

The present study shows that type of CP, age of independent sitting and presence of accompanying impairments affected walking ability in children with CP.

Authors name and year of the study	Place of the study	Sample size	Age	Walking ability	Type of cerebral palsy	Conclusion
Keeratisiroj O et al., [8]	Thailand	533	2-18 years	Independent ambulators-186	Spastic, Dyskinetic, Ataxic, Hypotonic, Mixed	Type of CP (spastic hemiplegia), sitting independently by 2 years of age, eating independently were positive predictors of ambulation.
Laisram N and Saha S 2017 [17]	India	175	2 years and above	Independent ambulators-39.4%	All types	Spastic hemiplegia, independent sitting by 2 years of age, mild spasticity were positive predictors of ambulation.
Shevell MI, et al., 2009 [14]	Canada	243	2 years and above	66% capable of independent ambulation assisted or non assisted	All types	89% had spastic CP; Type of CP was strong predictor for ambulation.
Rodby-Bousquet E and Hagglund G 2012 [22]	Sweden	562	3-18 years	57% to 63% walked 5 to 500 m of FMS without walking aids (assessment done using Functional Mobility Scale)	All types	Walking performance varied between the subtypes of CP.
Iloeje SO and Ogoke CC 2017 [18]	Nigeria	100	9-96 months	54% were ambulatory. All spastic hemiplegics were ambulatory	Spastic, Extrapyramidal, Hypotoi, Mixed	Type of CP, aetiological factors, malnutrition, number of accompanying impairments were positively associated with walking ability in children with CP.
Annie Mathew and Nonica Laisram, 2022	India	100	2-18 years	55% were ambulatory without aids and 14% were ambulatory with aids	Spastic (diplegia, hemiplegia, quadriplegia, triplegia). Dyskinetic, Hypotonic, Mixed	Spastic hemiplegic type of CP, achievement of independent sitting by 2 years of age and absence of accompanying impairments are good prognostic predictors of walking in children with CP

[Table/Fig-10]: Comparison of the present study with various studies [8,14,17,18,22].

Limitation(s)

Few limitations noted in the present study include analysis of broad age groups together, comparatively small sample size and recall bias owing to the cross-sectional design of the study. Unequal distribution of cases with respect to age groups and subtypes of CP were also considered as limitation of study.

CONCLUSION(S)

The present study highlights that spastic hemiplegia type of CP, achievement of independent sitting by two years of age and absence of accompanying impairments are good prognostic predictors of walking potential in children with CP. The study helps to assess ambulation in different types of CP and assists in planning for optimum rehabilitation interventions. Early interventions and awareness programs among parents and care givers are recommended to identify the influencing factors, to prognosticate walking potential and to improve walking ability of children with CP. Regular monitoring and follow-up is required to maintain and improve walking ability in children with CP.

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