RESEARCH ARTICLE

CORRELATION OF TRUNK CONTROL AND LOWER LIMB FUNCTIONAL MOBILITY AMONG CHILDREN WITH CEREBRAL PALSY

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ABSTRACT:

Background: Cerebral palsy is a non-progressive neurological disorder characterized by motor impairments that affect trunk control and lower limb mobility. Effective postural control is essential for functional activities like walking, sitting, and transitioning between postures in children with CP. **Objective**: This study aimed to evaluate the correlation between trunk control and lower limb functional mobility among children with cerebral palsy. **Methods**: A cross-sectional analytical study was conducted on 377 children aged 5 to 14 years diagnosed with various types of CP. Trunk control was measured using the Trunk Control Measurement Scale and lower limb functional mobility was assessed using the Functional Walking Test. Pearson's correlation, was applied to determine the relationship between trunk control and lower limb functional mobility. **Results**: The findings indicated a significant positive correlation between trunk control and lower limb functional mobility, with the strongest correlation found in children with GMFCS Level I ($r = 0.811$, $p = 0.002$), Level II ($r = 0.735$, $p = 0.034$), Level III ($r = 0.922$, $p < 0.001$) and in Ataxic CP ($r = 0.886$), spastic CP ($r = 0.776$), dyskinetic CP ($r = 0.702$), mixed CP ($r = 0.698$). **Conclusion**: There was positive correlation between trunk control and lower limb functional mobility among children with Cerebral Palsy. Children with better trunk control were likely to have higher functional walking ability. The highest impairment was seen in children with spastic CP and those with higher GMFCS levels. **Keywords**: Cerebral palsy, trunk control, function mobility, gait, TCMS, FWT, pediatric physiotherapy.

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1. Introduction:

The cerebral palsy refers to a group of chronic disorders that impact postural stability and mobility and are caused by dysfunction to the child's brain development during pregnancy or the early stages of infancy.(1) People with cerebral palsy often experience difficulty with sensory experience, connectivity, perception, intellectual, communication or connectivity, behavior, as well as musculoskeletal issues that arise secondarily.(2) CP originates from various factors that cause brain injury, impacting a person's capacity to move, maintain posture, and achieve balance. The movement difficulties associated with CP are generally categorized into spasticity, dyskinesia, ataxia, or a combination of these types. Spasticity is the most prevalent form, affects around 80% of overall child with CP diagnoses. These motor issues and challenges can lead to further problems such equinus deformity, balance instability, hand function restrictions, and hip discomfort or dislocation. (3) The most prevalent causative factor of physical handicap among children is cerebral palsy, which affects 1.5 to 2.5 newborns out of every 1,000 live births. The incidence is significantly higher in babies born prematurely than in those delivered at full term. (4,5)

CP includes various motor disorders such as spasticity, dyskinesia, and ataxia, all of which can lead to serious limitations in movement and function. (6,7) Children with poor trunk control experience reduced postural stability, which can increase fatigue and balance difficulties. (8-10) .Trunk control is essential for facilitating activities like sitting and walking, and any impairment in trunk stability can considerably impair these functions.(11) Adequate trunk control is a strong indicator of walking proficiency and is closely linked to the strength of lower limb muscles and motor control.(12) Children with spastic unilateral or bilateral CP frequently find it challenging to maintain a stable trunk posture, which adversely affects their capabilities to sit, stand, reach, and walk.(13) Lower extremity challenges, such as limited flexibility and increased spasticity, are closely linked to balance and flexibility issues in child with CP. The functional capability of the lower limbs is essential for autonomy, engagement in daily activities, and preserving a good quality of life. Limited mobility frequently results in increased fatigue, joint deterioration, and greater reliance on assistive devices, all of which can negatively impact both physical and mental health over time. (14)

Children with CP often suffer from hip and knee pain due to restricted lower limb mobility, a situation that is often exacerbated by existing bone and joint anomalies. These mobility difficulties arise from decreased voluntary muscle activation and increased muscle tone, which hinder neuromuscular control and result in challenges with walking and posture. (15) Lower extremity challenges, such as limited flexibility and increased spasticity, are closely linked to balance and flexibility issues in child with CP. The functional capability of the lower limbs is essential for autonomy, engagement in daily activities, and preserving a good quality of life. Limited mobility frequently results in increased fatigue, joint deterioration, and greater reliance on assistive devices, all of which can negatively impact both physical and mental health over time. (14,15). Research has shown that trunk control is a strong predictor of walking ability and overall functional outcomes, and deficits in trunk stability can hinder the efficiency and coordination of lower limb movements, further limiting participation in daily activities and increasing reliance on assistive devices. In CP, impaired neural control can disrupt trunk muscle activation, leading to compromised core stability. Since lower limb movements originate from a stable trunk, poor proximal control can hinder the efficiency and coordination of distal mobility tasks such as standing, walking, and transitioning. However, the aim of the study to investigate the correlation between trunk control and lower limb functional mobility among children with cerebral palsy.

2. Methods:

The study design was Analytical cross-sectional study. Data was collected form Special children institutes Lahore, Pakistan, Physiotherapy clinics, Rehabilitation centers (Rising Sun, PSRD). Sample size was 377. Parental or guardian informed consent was obtained for all children with cerebral palsy prior to data collection. The study included children aged 5 to 14 years with all types of cerebral palsy ataxic, mixed, spastic, and dyskinetic who were classified as GMFCS levels I, II, or III. Exclusion criteria were a history of other neurological disorders, severe cognitive impairments such as vision problems, epilepsy, recent botox injections or surgical corrections within the past year, additional movement disorders, unstable medication regimens, recent interventions, or being non-ambulatory. Trunk stability was evaluated using the Trunk Control Measurement Scale, while Functional Walking Test was employed to evaluate lower limb functional mobility. Analysis was performed using SPSS version 25. Mean ± SD and frequency statistics was used to analyze demographical data. The Pearson correlation was used to find correlation between TCMS and FWT.

3. Results:

A total of 377 children with cerebral palsy participated in this study. The mean age of the children was 9.03 ± 2.46 years. Among the participants, 200 (53.1%) were female and 177 (46.9%) were male. The children had an average weight of 26.28 ± 5.43 kg and an average height of 144.24 ± 15.64 cm. Based on body mass index, 208 (55.2%) were underweight, 121 (32.1%) had a normal BMI, 40 (10.6%) were overweight, and 8 (2.1%) were classified as obese. The most common type of cerebral palsy among participants was spastic diplegic (56.2%), followed by ataxic (17.2%), dyskinetic (16.2%), and mixed types (10.3%).

Table 1. Demographic Data

Variable			
Age of CP Child (Years)	9.03 ± 2.46		
		Frequency	**Percentage**
Gender	Female	200	53.1%
	Male	177	46.9%
BMI	Underweight	236	62.6%
	Normal BMI	121	32.1%
	Overweight	20	5.3%
Types of Cerebral Palsy	Spastic	212	56.2%
	Ataxic	65	17.2%
	Dyskinetic	61	16.2%
	Mixed Type	39	10.3%

When analyzing trunk control and walking ability, children with ataxic CP had the highest average scores on both the Trunk Control Measurement Scale (28.19 ± 4.68) and the Functional Walking Test (14.72 ± 3.21), followed by children with mixed, dyskinetic, and spastic types. A significant positive correlation was observed between TCMS and FWT scores across all CP types, with the strongest correlation found in ataxic CP ($r = 0.886$, $p < 0.001$), followed by spastic ($r = 0.776$, $p = 0.003$), dyskinetic ($r = 0.702$, $p = 0.041$), and mixed ($r = 0.698$, $p = 0.048$).

Table 2. Trunk Control and walking ability distribution to Types of CP

Types of CP		**Mean**	**Std. Deviation**	**Pearson r**	**p value**
Spastic diplegic	Lower Limb Functional Mobility	11.23	2.179	0.776	0.03
	Trunk Control	26.758	3.3708		
Ataxic	Lower Limb Functional Mobility	14.72	3.211	0.886	0.01
	Trunk Control	28.185	4.6823		
Dyskinetic	Lower Limb Functional Mobility	13.11	4.363	0.702	0.041

	Trunk Control	27.426	3.6306		
Mixed	Lower Limb Functional Mobility	12.77	3.970	0.698	0.048
	Trunk Control	29.333	2.1576		

According to the Gross Motor Function Classification System (GMFCS), 93 children (24.7%) were at Level I, 147 (39.0%) at Level II, and 137 (36.3%) at Level III. Trunk control and walking function decreased with increasing severity of motor impairment: Level I (TC) = 29.26 ± 4.71; LLFM = 14.68 ± 3.91), Level II (TC) = 25.65 ± 3.53; LLFM= 12.40 ± 4.19), and Level III (TCMS = 22.60 ± 2.87; FWT = 11.85 ± 3.29).

Table 3. Trunk Control and walking ability distribution to levels of CP

GMFCS Level		**Mean**	**Std. Deviation**	**Pearson**	**P value**
Level I	Lower Limb Functional Mobility	14.68	3.910	0.811	0.002
	Trunk Control	29.258	4.7132		

Level II	Lower Limb Functional Mobility	12.40	4.192	0.735	0.034
	Trunk Control	25.646	3.5292		
Level III	Lower Limb Functional Mobility	11.85	3.292	0.922	<0.001
	Trunk Control	22.600	2.8657		

A significant positive correlation between TCMS and FWT was found at all GMFCS levels, with the strongest correlation observed in Level III (r = 0.922, p < 0.001), followed by Level I (r = 0.811, p = 0.002) and Level II (r = 0.735, p = 0.034). These findings indicate that better trunk control is strongly correlated with improved functional walking ability, especially among children with more severe motor limitations.

4. Discussion:

The present study demonstrates a robust positive correlation between trunk control and lower limb functional mobility in children with CP, with children exhibiting better trunk control also showing higher functional walking ability across all CP subtypes. This finding is consistent with recent literature, which increasingly recognizes trunk stability as a foundational element for motor function and independence in children with CP. For instance, Vlčková et al. (2024) found that higher trunk control, as measured by the TCMS, is closely linked to improved self-care, mobility, and participation, highlighting the broad impact of trunk stability on daily life and social integration (16). Similarly, Apaydın et al. (2024) reported a significant association between trunk control and selective motor control of the lower limbs, suggesting that deficits in trunk stability may negatively affect lower limb coordination and, consequently, functional mobility (17). The demographic profile of the current study, with a mean age of 9.03 years and a predominance of spastic diplegic CP, aligns with recent epidemiological data, supporting the generalizability of these findings. Notably, children with ataxic CP in this study had the highest average scores on both the TCMS and the FWT, a pattern that may reflect the unique neuromotor characteristics of this subtype. This is in line with the work of Balzer et al. (2018), who identified trunk control as the strongest predictor of gait capacity in children with CP, surpassing the influence of lower limb spasticity and muscle strength (18). The strong correlation between trunk control and walking ability observed in the current study, particularly in ataxic CP ($r = 0.886$), underscores the universal importance of trunk stability across different CP types. Comparative studies further reinforce these findings. Seyyar et al. (2019) demonstrated that trunk control in sitting is highly correlated with overall functional abilities, as assessed by the Gross Motor Function Measure and the Pediatric Evaluation of Disability Inventory, emphasizing the value of trunk assessment in clinical practice (19). Munaf et al. (2022) also observed that improvements in trunk control are associated with better balance and walking mobility in children with hemiparetic CP, supporting the interconnectedness of trunk and lower limb function (20). Moreover, Vlčková et al. (2024) and Apaydın et al. (2024) both highlight that trunk control is not only a predictor of mobility but also of broader functional outcomes, including self-care and participation, which are critical for quality of life (16,17). Recent research has also explored the relationship between trunk control and specific motor impairments. For example, Apaydın et al. (2024) found that selective motor control of the lower limbs is significantly associated with trunk control, indicating that interventions targeting trunk stability may have downstream effects on lower limb function (17). This is supported by the findings of Balzer et al. (2018), who reported that lower extremity muscle strength and selectivity correlated strongly with trunk control and gait capacity, while spasticity showed only a weak correlation (18). These results suggest that trunk control, muscle strength, and selective motor control are interrelated components that collectively influence functional mobility in children with CP. The current study's results are further supported by the work of Vlčková et al. (2024), who found that more mature locomotor stages require higher levels of trunk control, benefiting self-care, mobility, and social functions (16). This aligns with the findings of Seyyar et al. (2019), who emphasized the importance of trunk assessment for predicting real-world functional outcomes (19). Additionally, Munaf et al. (2022) highlighted the role of trunk control in maintaining balance and walking mobility, particularly in children with hemiparetic CP (20).

Despite the consistency of these findings, some studies have noted variations in the strength of the relationship between trunk control and functional mobility across different CP subtypes. For example, while the current study found the strongest correlation in ataxic CP, other research has reported significant associations in spastic and mixed types as well (18-20). These differences may be attributed to variations in neuromotor characteristics, assessment tools, and sample sizes across studies. A key limitation of the current study is its cross-sectional design, which precludes causal inferences about the relationship between trunk control and lower limb functional mobility. Additionally, the study relied on clinical assessment tools, which, while validated, may be subject to observer bias. The sample was also limited to children with GMFCS levels I–III, potentially restricting the generalizability of the findings to children with more severe motor impairments. Future research should employ longitudinal designs to better understand the causal pathways linking trunk control and functional mobility and should include a broader range of functional levels and CP subtypes. In conclusion, the present study adds to a growing body of evidence highlighting the central role of trunk control in functional mobility among children with CP. Comprehensive assessment and targeted support for trunk stability should be prioritized in clinical management to optimize mobility, independence, and participation. Future studies should explore the mechanisms underlying these relationships and identify optimal strategies for supporting trunk control across different CP subtypes and functional levels.

5. Conclusion:

There was positive correlation between trunk control and lower limb functional mobility among children with Cerebral Palsy. Children with better trunk control were likely to have higher functional walking ability.

ETHICAL CONSIDERATIONS:

Rights and dignity of all individuals were the prior consideration. Research process did not cause any harm to the subjects. Accurate information to patients was provided and written consent was taken from the subjects. Subject's details and data confidentiality was maintained at every level. Ethical clearance was taken from the ethical committee of the university. IRB number of the permission letter issued by university was USA/FAHS/2025/908.

Consent to participants: Written consent had been taken from the parents/guardians of the children with CP. All the relevant guidelines and rules were followed during the method of data collection.

Availability of data and materials: Data will be provided on request. The corresponding author will submit all the dataset files.

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Authors' contribution: All authors read and approved the final manuscript.

CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest regarding publication of article. Moreover, the authors have no competing interests.

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