

Original Article

Effects of Lower Extremity Functional Training (LIFT) on Gross Motor Function and Gait in Children with Spastic Cerebral Palsy

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ABSTRACT

Background: Children with spastic cerebral palsy face challenges in mobility due to impairments in gross motor function and gait. Lower Extremity Functional Training (LIFT) is posited as a potential intervention to ameliorate these difficulties.

Objective: This study aimed to evaluate the effectiveness of LIFT on enhancing gross motor function and gait in children with spastic cerebral palsy.

Methods: Employing a Randomized Controlled Trial design, the study recruited 22 participants and allocated them into intervention and control groups. Over six weeks, the intervention group received LIFT along with baseline treatment, while the control group received only baseline treatment. Outcomes were measured using the 2-minute Walk Test, Single Leg Stance Test, and Gross Motor Function Measure (GMFM).

Results: Post-intervention, the intervention group exhibited a statistically significant improvement in the Single Leg Stance Test ($p=0.032$). However, no significant differences were observed in the 2 Minute Walk Test ($p=0.448$) and GMFM ($p=0.289$) between the intervention and control groups. Within-group comparisons showed significant improvements from pre- to post-intervention in both the Single Leg Stance Test ($p=0.006$) and the 2 Minute Walk Test ($p=0.012$) for the intervention group, and in the 2 Minute Walk Test ($p=0.003$) and GMFM ($p=0.004$) for the control group.

Conclusion: While LIFT resulted in significant within-group improvements in single-leg balance, it did not demonstrate a significant advantage over baseline treatment alone in improving overall gait and gross motor function in children with spastic cerebral palsy. Further research with larger sample sizes and longer intervention durations may be necessary to ascertain the full impact of LIFT in this population.

Keywords: Spastic cerebral palsy, gross motor function, gait, Lower Extremity Functional Training (LIFT), Randomized Controlled Trial.

INTRODUCTION

Cerebral palsy (CP), as the leading cause of childhood disability affecting 1.5- 2.5 per 1000 live births annually, presents complex challenges in therapeutic management, particularly in its most common form, spastic CP. This condition, characterized by increased muscle tone, impaired motor control, and varied symptoms such as pain, involuntary movements, and joint contractures, necessitates a multifaceted approach to treatment. Traditional methods primarily focused on physical therapy and medication, but recent trends have shifted towards a more integrated, multidisciplinary strategy. This evolution in treatment prioritizes not just addressing spasticity but also emphasizes strength training, motor learning approaches, and Lower Extremity Functional Training (LIFT).

Recent studies have significantly contributed to understanding and advancing these therapeutic approaches. Bıyık's 2023 study, for instance, highlighted the benefits of combining treadmill training with botulinum toxin injections and routine physical therapy in

children with spastic bilateral CP, showing improvements in walking quality, functional mobility, and hip and ankle dynamics (1, 2). This indicates the potential effectiveness of integrating pharmacological interventions with physical therapies (3).

LIFT, encompassing lower extremity strength training, functional activities, and skill-based exercises, aims at enhancing gross motor skills and neuromuscular coordination (4, 5). Its principles of structured practice, active participation, and skill progression are designed to improve strength, balance, and overall motor function, thereby enhancing the quality of life and functional independence in children with spastic CP (6).

These studies collectively point to a trend towards dynamic, multifaceted treatment approaches in CP rehabilitation, integrating strength and resistance training with functional tasks tailored to individual needs. However, despite these advancements, there is a noticeable gap in long-term, comprehensive studies that would provide a deeper understanding of the enduring impacts of these interventions on CP, especially in different subtypes and severities of the condition.

Further, Chaudhari and BV, 2020 research emphasized the importance of functional progressive resistance exercises in enhancing muscle tone and dynamic balance (7, 8). Dudoniene 2023, study demonstrated that task-oriented training, when combined with conventional physiotherapy, significantly improves the quality of life more effectively than conventional physiotherapy alone (9, 10). Additionally, Bekteshi 2023 research on LIFT emphasized its feasibility and effectiveness, especially when administered in home settings by caregivers, in improving gait capacity and walking ability in children with unilateral spastic CP (11).

This leads to the rationale for further research: to explore the long-term effects and potential optimization of these integrative treatment protocols (12, 13). The objective would be to not only fill the existing gaps in CP rehabilitation research but also to develop more effective, personalized treatment strategies that can significantly enhance the functional outcomes and quality of life for children with CP, addressing their specific needs and challenges (14, 15).

To find out the effects of Lower Extremity Functional Training (LIFT) on gross motor function and gait in children with spastic cerebral palsy.

MATERIAL AND METHODS

The study was designed as a Randomized Controlled Trial to investigate the effects of Lower Extremity Functional Training (LIFT) on gross motor function and gait in children with spastic cerebral palsy (16). Conducted over a period of six months, following the approval of the research synopsis, the study was set in two locations: Rising Sun Institute for Special Children Lahore and Rex Medical Center. The overarching research was managed and overseen at Riphah International University, Lahore.

For the purpose of the study, participants were recruited using a non-probability convenience sampling technique, adhering to the 2010 CONSORT guidelines for randomization. Eligible patients were identified based on specific inclusion and exclusion criteria, and informed consent was obtained from their guardians. The random assignment of participants to either the intervention or control group was facilitated through a chit selection process, ensuring an unbiased distribution.

The study's sample size was meticulously calculated using an online calculator, EPITOOL, drawing on data from a previous related study. With a confidence level of 95% and a power of 0.9, the initial sample sizes for both groups were set at 12 participants each. Considering an attrition rate of 10%, the final sample size was adjusted to 26 participants, with 13 in each group.

Participants in the intervention group received LIFT in addition to baseline treatment. This approach included skill progression and resistance training targeting balance, strength, and coordination impairments in the lower extremities. Specific exercises incorporated into the LIFT regime were tandem walks, balance boards, one-leg standing, sit-to-stands, sit-ups, stair climbs, and vertical jumps. These exercises were conducted at a moderate intensity for one hour per day, five days a week, over a six-week period.

The control group, meanwhile, was provided with baseline treatment aimed at improving gait and gross motor skills. This treatment involved resistive and stretching exercises for the quadriceps, hamstrings, adductors, and abductors. Similar to the intervention group, the control group received moderate-level intervention for one hour per day, five days a week, for six weeks.

For the evaluation of outcomes, the study employed three primary data collection tools:

2-minute Walk Test: This test was chosen for its cost-effectiveness and suitability in clinical settings, particularly considering the low attention span and capabilities of children. It involved measuring the distance covered by a participant during a two-minute walk.

Single Leg Stance Test: Used to assess balance control and static posture on the affected side, this test is valuable for monitoring musculoskeletal and neurological status.

The Gross Motor Function Measure (GMFM): This scale, consisting of 66 items divided into five dimensions, was used to assess changes in gross motor functions over time. The dimensions covered included lying and rolling, sitting, crawling and kneeling, standing, and walking, running, and jumping.

In the study examining the effects of Lower Extremity Functional Training (LIFT) on children with spastic cerebral palsy, data analysis was conducted using SPSS version 25.0. Initially, data including participants' age, gender, GMFC levels, and scores from various tests were entered and cleaned for accuracy. Descriptive statistics were generated to summarize the dataset, followed by the Shapiro-Wilk test to assess the normality of distributions, particularly for the 2-minute walk test. Comparative analyses were conducted using the Wilcoxon Signed Rank Test for within-group comparisons and the Mann-Whitney U test for between-group comparisons. These tests determined the statistical significance of differences in pre- and post-intervention scores, guiding the evaluation of the study's hypotheses. P-values were carefully examined to ascertain the impact of LIFT, with values less than 0.05 indicating a rejection of the null hypothesis and supporting the alternate hypothesis. The analysis focused on interpreting these results in relation to the impact of LIFT on gross motor function and gait, ensuring that findings were clearly reported and contextualized within the broader research landscape.

RESULTS

Table 1: Participant Demographics and Baseline Characteristics

Variable	Category	Intervention Group (n=11)	Control Group (n=11)	Total (n=22)
Gender	Male	8	6	14
	Female	3	5	8
Age (Years)	Mean	10.18	11.00	10.59
	Std. Deviation	2.92	2.75	2.80
GMFC Level	Level 1	4	4	8
	Level 2	7	7	14

Table 1 presents the demographics and baseline characteristics of the participants. In the intervention group (n=11), there were 8 males and 3 females, whereas the control group (n=11) comprised 6 males and 5 females, totaling 14 males and 8 females among all participants (n=22). The mean age of the intervention group was 10.18 years with a standard deviation of 2.92, slightly younger than the control group, which had a mean age of 11.00 years and a standard deviation of 2.75. The overall mean age for both groups combined was 10.59 years with a standard deviation of 2.80. Regarding the Gross Motor Function Classification System (GMFC) levels, both groups were evenly matched, with 4 participants at Level 1 and 7 at Level 2 in each group, making a total of 8 at Level 1 and 14 at Level 2 across the study.

Table 2: Between-Group Comparisons (Post-Intervention)

Assessment	Mean Rank	Sum of Ranks	Z-value	P-value
Single Leg Stance Test				
Intervention Group	8.55	94.00	-2.141	0.032
Control Group	14.45	159.00		
2 Minute Walk Test				
Intervention Group	10.45	115.00	-0.759	0.448
Control Group	12.55	138.00		
Gross Motor Function Measure				
Intervention Group	10.05	110.50	-1.061	0.289
Control Group	12.95	142.50		

Table 2 provides a comparison between the intervention and control groups in terms of their performance on various assessments post-intervention. In the Single Leg Stance Test, the intervention group had a mean rank of 8.55 and a sum of ranks of 94.00, showing a statistically significant improvement with a Z-value of -2.141 ($p=0.032$). The control group had a mean rank of 14.45 and a sum of ranks of 159.00. In the 2 Minute Walk Test, the intervention group's mean rank was 10.45 with a sum of ranks of 115.00, but the improvement was not statistically significant (Z-value of -0.759; $p=0.448$). The control group had a mean rank of 12.55 and a sum of ranks of 138.00. For the Gross Motor Function Measure, the intervention group had a mean rank of 10.05 and a sum of ranks of 110.50, showing a non-significant improvement with a Z-value of -1.061 ($p=0.289$), while the control group had a mean rank of 12.95 and a sum of ranks of 142.50.

Table 3: Pre- and Post-Intervention Assessments (Within Group Comparison)

Assessment	Group	Pre-Test Mean Rank	Post-Test Mean Rank	Z-value	P-value
Single Leg Stance Test	Intervention	0.00	5.00	-2.724	0.006
	Control	9.00	4.50	-1.684	0.092
2 Minute Walk Test	Intervention	3.00	5.78	-2.507	0.012
	Control	0.00	6.00	-2.941	0.003
Gross Motor Function Measure	Intervention	9.00	5.11	-1.891	0.059
	Control	0.00	6.00	-2.963	0.004

Table 3 highlights the changes within each group from pre- to post-intervention. In the Single Leg Stance Test, the intervention group showed a significant improvement from a pre-test mean rank of 0.00 to a post-test mean rank of 5.00 (Z-value of -2.724; $p=0.006$). The control group also improved, from a pre-test mean rank of 9.00 to a post-test mean rank of 4.50, but the change was less significant (Z-value of -1.684; $p=0.092$). In the 2 Minute Walk Test, the intervention group improved from a pre-test mean rank of 3.00 to a post-test mean rank of 5.78 (Z-value of -2.507; $p=0.012$), and the control group showed a substantial improvement from a pre-test mean rank of 0.00 to a post-test mean rank of 6.00 (Z-value of -2.941; $p=0.003$). For the Gross Motor Function Measure, the intervention group improved from a pre-test mean rank of 9.00 to a post-test mean rank of 5.11 (Z-value of -1.891; $p=0.059$), and the control group improved from a pre-test mean rank of 0.00 to a post-test mean rank of 6.00 (Z-value of -2.963; $p=0.004$).

DISCUSSION

The primary aim of this study was to assess the impact of lower extremity functional training (LIFT) on the gross motor function and gait of children with spastic cerebral palsy (17, 18). The intervention spanned 8 weeks, during which participants' gross motor function classification system (GMFCS) scores, single-leg stance test results, and two-minute walk test outcomes were recorded both prior to treatment and at its conclusion (18).

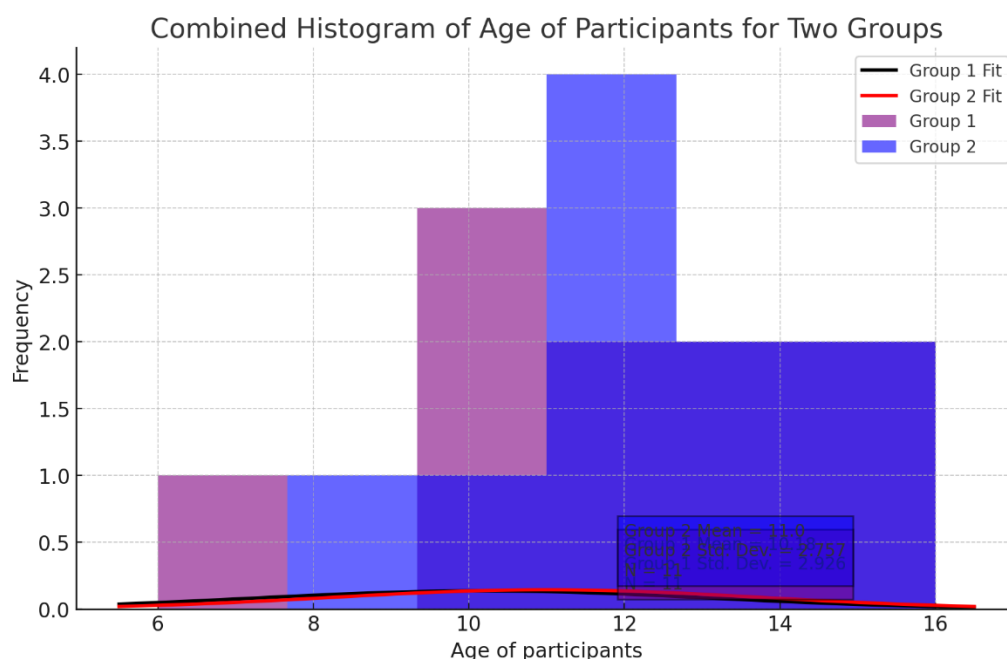


Figure 1 Comparative Histogram

intervention in children with cerebral palsy (19, 20). Similarly, the present study also found no statistical significance between groups in terms of intervention impact (21, 22).

In contrast, McDermott's 2020 research suggested that a longer intervention period might be necessary to observe significant changes in gait deviation, although some improvements in gait performance were noted (23). Peltoniemi's study, which used a six-minute walk test, saw modest improvements in two participants (24, 25). The current study, utilizing a two-minute walk test and incorporating the single-leg stance test to evaluate unilateral strength, suggests a similar need for extended intervention to yield more pronounced results (26).

The key finding of this study was that there was a discernible difference in outcomes for groups A and B by the study's end, indicating changes resulting from the treatment. However, a detailed between-group analysis revealed no statistically significant difference, suggesting that the addition of LIFT to baseline treatment did not differ in effect from baseline treatment alone.

This finding aligns with Antonia Thamm's 2021 study, which involved 18 children over 12 weeks. Thamm found no significant changes in gait kinematics, the 6-minute walk test, or GMFM scores post-

Talgeri's research in 2023 also explored the effects of exercise intervention on children with spastic CP, specifically through Swiss ball training (27). This study reported significant improvements in trunk control and balance, which differ from the current study's lack of significant findings with the LIFT approach (28).

Sharjeel Anjum and colleagues' 2019 study took a different approach by focusing on lower limb strength training in children with spastic diplegia (16). Their findings indicated that strength training could enhance strength and physical abilities, which is somewhat supported by the improvements observed within the intervention group of the current study, which included functional mobility and balance training (29).

Bhavini K. Surana's randomized control trial in 2019 presented evidence that lower extremity functional training could improve the one-minute walk test in children with CP (17). This lends credence to the potential effectiveness of such interventions in enhancing gait capacity and performance, though the present study used a two-minute walk test for its measurements.

In a broader context, Julia Balzer et al.'s 2018 study highlighted the significance of trunk control and lower extremity function in influencing gait capacity in children with CP (30). This past research suggested that trunk control is a strong predictor of gait capacity, a notion that is somewhat corroborated by the current study, which also identified improvements in gross motor function following lower extremity functional training.

CONCLUSION

In conclusion, the present study recorded improvements within the intervention group, specifically in single-leg balance, yet these did not translate into a significant edge over baseline treatments in terms of enhancing overall gait and gross motor functions. Such outcomes suggest that the benefits of Lower Extremity Functional Training (LIFT) may be limited to specific functional gains rather than broad-based improvements when compared to standard therapeutic approaches. This inference is drawn within the constraints of the study's relatively brief duration and the use of a shorter walk test for assessment. Consequently, there is a need for further investigation involving larger cohorts, extended durations of intervention, and a wider array of evaluative measures to comprehensively determine the efficacy of LIFT.

The implications of these findings are multifaceted. While LIFT appears promising for targeted improvements, its role in comprehensive motor function enhancement remains unclear. These results underscore the necessity for more nuanced research methodologies that extend beyond the conventional frameworks, potentially incorporating longer assessment tools like the six-minute walk test which might yield additional insights. There is also an implicit suggestion that intervention strategies for children with spastic cerebral palsy should be tailored to individual needs, taking into consideration the varying responses to different types of training. Given the study's limitations, including its sample size and intervention period, future research should aim to address these gaps, providing a more definitive guide for clinicians and therapists in the application of LIFT within therapeutic programs.

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