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Research Article

A COMPARATIVE EFFECT OF PLYOMETRIC TRAINING & STRENGTHENING EXERCISE ON GROSS MOTOR FUNCTION & QUALITY OF LIFE IN CHILDREN WITH HEMIPLEGIC CP: A COMPARATIVE STUDY

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Abstract

Background: Hemiplegic CP is connected to impaired gross motor function, muscle weakness, and reduced quality of life (QOL). Although strengthening exercises are widely used in rehabilitation, evidence comparing their effectiveness with plyometric training is still restricted.

Methods: A comparative study was carried out at Santosh college of Occupational therapy involving 48 children aged 8–14 years with hemiplegic CP were divided into two groups: Group A (plyometric training, n=24) & Group B (strengthening exercises, n=24). Both groups got supervised treatment for 30 minutes, 3 times per week, for 3 months. GMFM-88 and Peds QL were assessed before and after the intervention.

Results: Baseline traits were similar between the two groups ($p > 0.05$). Post-intervention, both Group A and Group B demonstrated significant improvements in gross motor function (POST-GMFM-88) and quality of life (POST-Peds QL) ($p < 0.001$).

Conclusion: Both plyometric and strengthening exercise programs effectively improved gross motor function and QOL in hemiplegic CP children. However, plyometric training resulted in significantly greater functional and QOL gains, suggesting that it may be a more effective rehabilitation approach for this population.

Keywords: Hemiplegic cerebral palsy; Plyometric training; Strengthening exercise; Gross motor function; Quality of life; GMFM-88; Peds QL

1. Introduction

A collection of conditions known as cerebral palsy (CP) are defined by non-progressive brain injury that impairs motor function because of aberrant central nervous system regulation of the skeletal musculature [1]. It affects the child's posture, mobility,and balance. It usually happens during pregnancy and is brought on by an anomaly or disruption in the developing, immature brain [2]. Hemiplegia, in which one side of the body is much more afflicted than the other, affects limb [1]. Children affected by hemiplegic cerebral palsy commonly present with a variety of motor dysfunctions, Problems such as muscle spasticity, weaknessexcessive simultaneous contraction of muscles, abnormal muscle activation, and reduced nerve signals to the leg muscles affect movement and lower limb function [2].

According to the WHO, QOL characterizes how an individual perceives their position in life in respect to their goals, expectations, standards, concerns, and cultural and value systems. Overall, QOL reflects the general well-being of individuals and communities [1].

Plyometric exercises, a form of resistive strengthening where a muscle is contracted eccentrically and then quickly concentrically, include high-velocity, high-impact movements like hopping, jumping, bounding, and throwing [3]. It is a rapid, strong movement that consists of an eccentric contraction and a series of reactionary workouts, immediately followed by an explosive concentric contraction [1].

Children with cerebral palsy benefit greatly from strength training, which enhances their flexibility, posture, strength, and walking, enabling them to carry out their ADLS &IADLs more easily and enhancing

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their overall performance, appearance, health, and overall QOL [4].

Strength training plays a crucial function in enhancing posture, everyday living activities, and reducing pain and impairment. In athletic and rehabilitative programs, resistance exercises typically improve muscle strength, tone, and performance [5].

This study looks at how plyometric training and strengthening exercises affect hemiplegic cerebral palsy children's gross motor function and QOL to close the research gap. By assessing several interventions, the study aims to determine the best strategy for improving this population's gross motor function &QOL. The findings will assist therapists optimize treatment strategies to enhance gross movement and QOL in hemiplegic CP, therefore supporting evidence-based rehabilitation practices.

2. METHODOLOGY

2.1 Study Design and Setting

A comparative study was examined, analyzed and authorized by Santosh College of Occupational Therapy's Institutional Ethics Committee. (Ref. No. **SCOT/JULY-.25/EC PEADS-02**) and data was collected from SantoshMedical College and Hospital, Ghaziabad and Aaradhya Therapeutic Services and Rehabilitation centre, Noida, India. Each participant gave written, informed permission.

2.2 Participants

Children between the ages of 8-14 who had been diagnosed with Hemiplegic CP. Exclusion criteria included Children with Orthopaedic surgery in past one year, Botox injection in past 6 months, cardiac problems or uncontrolled seizures, intellectual disability, visual or auditory problems that interfere with rehabilitation programs. A total of 48 participants were recruited and randomised into the Group a Plyometric exercise (n=24) and Group B Strengthening exercise (n=24) using Random sampling by Chit method.

2.3 Intervention

Group A: ReceivedPlyometric exercises like vertical jumping, lateral jumping, forward jumping, side to side jumping, box landing, step jumping each done for 5 minutes for 3 sessions each week for 30 minutes, for3 months.

Group B: Received Strengthening exercises like Quadriceps and hamstring muscles exercise for 20 minutes and core exercise for 10 minutes, each done in 3 sets which is 8-15 repetitions for 3 sessions each week for 30 minutes, for3 months.

2.4 Outcome Measures

- **Peds QL:** This exam focuses in kid's academic, socioemotional, and physical growth (Alzagh et.al., 2023).
- **GMFM-88:** GMFM is intended to track how CP children's gross motor function changes over time (Ina Elfant Asher).

2.5 Statistical Analysis

To evaluate the data, SPSS version 29.0 was employed. The expression for continuous variables was mean ± SD. Independent t-test use for baseline analysis between two groups. Wilcoxon Signed Rank Test use for within-group analysis. The Mann-Whitney U test usefor between group analysis. P-value less than 0.05 was considered statistically significant.

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3. RESULTS

3.1Demographic details of subjects.

The sample comprised 48 participants with a mean age of 9.08 and 9.17 years and an equal gender distribution (24 males, 24 females). Detailed demographic distributions are presented in Table 1.

S. No	Base line characteristics	Group A	Group B
1.	No. of Participants	24	24
2.	Age Range (year)	8-14	8-14
3.	Gender: Male- Female-	12 12	12 12
4.	Intervention	Plyometric Exercise	Strengthening Exercise

3.2 Descriptive Statistics

The table shows that the plyometric and strengthening exercise groups were comparable at baseline, with similar mean age and equal gender distribution. This demographic homogeneity ensures that any post-intervention differences in gross motor function and QOL can be attributed to the type of exercise intervention rather than age or gender differences.

Stats	Category	Plyometric Exercise Group n (%) / Mean ± SD	Strengthening Exercise Group n (%) / Mean ± SD
Age (years)	Mean ± SD	9.08 ± 1.02	9.17 ± 0.96
Gender	Male	12 (50.00%)	12 (50.00%)
	Female	12 (50.00%)	12 (50.00%)

3.3Baseline Assessment Pre-Data Analysis

The table shows that a statistically significant baseline difference was present in gross motor function (PRE-GMFM-88) between groups, while no significant baseline difference was observed in QOL (PRE-Peds QL).

Scale	t	P Value	Interpretation
PRE-GMFM-88	2.43	0.019	Statistically significant difference
PRE-Peds QL	1.641	0.108	No, statistically significant difference

3.4 Comparison of GMFCS Level and Modified Ashworth Scale Between Groups (n = 24 per group)

The table indicates that both the plyometric and strengthening exercise groups had a comparable distribution of GMFCS levels and spasticity grades at baseline. This similarity confirms that the groups were functionally equivalent prior to intervention, allowing any observed changes in gross motor function and QOL to be attributed to the respective exercise programs.

Variable	Category	Plyometric Exercise n (%)	Strengthening Exercise n (%)
GMFCS Level	Level I	20 (83.3%)	20 (83.3%)
	Level II	4 (16.7%)	4 (16.7%)
Modified Ashworth Scale	Grade 1	18 (75.0%)	18 (75.0%)
	Grade 1+	6 (25.0%)	6 (25.0%)
Overall Interpretation		Comparable distribution	Comparable distribution

3.4 Post-Data Analysis of Outcome measure

According to study's objectives and alternative hypotheses, the table demonstrates a highly statistically significant post-intervention difference in both gross motor function (POST-GMFM-88) and quality of life (POST-PedsQL) between the plyometric and strengthening exercise groups, indicating that the interventions had a differential impact on these outcomes.

Scale	t	P Value	Interpretation

POST-GMFM-88	−7.794	<0.001	Statistically significant difference
POST-Peds QL	−9.638	<0.001	Statistically significant difference

3.5 Within Analysis Wilcoxon Signed Ranks Test for Plyometric Exercise and Strengthening Exercise in Pre-Post Data

The Wilcoxon rank analysis shows that almost all participants (47 out of 48) demonstrated improvement in both GMFM-88 and Peds QL scores following the intervention, with no negative ranks and only one tie. This indicates a significant overall post-intervention improvement in gross motor function and QOL among hemiplegic CP children.

Ranks		N	Mean Rank	Sum of Ranks
GMFM-88 Post-Intervention - GMFM-88 pre-intervention	Negative Ranks	0[a]	.00	.00
	Positive Ranks	47[b]	24.00	1128.00
	Ties	1[c]		
	Total	48		
Peds QL Post-Intervention - Peds QL Pre-Intervention	Negative Ranks	0[d]	.00	.00
	Positive Ranks	47[e]	24.00	1128.00
	Ties	1[f]		
	Total	48		

a. GMFM-88 Post-Intervention < GMFM-88 Pre-Intervention

b. GMFM-88 Post-Intervention > GMFM-88 Pre-Intervention

c. GMFM-88 Post-Intervention = GMFM-88 Pre-Intervention

d. Peds QL Post-Intervention < Peds QL Pre-Intervention

e. Peds QL Post-Intervention > Peds QL Pre-Intervention

f. Peds QL Post-Intervention = Peds QL Pre-Intervention

3.6 Between Analysis on Plyometric Exercise and Strengthening Exercise in Pre-Post Data

The Mann–Whitney U test indicates a statistically significant between-group difference in GMFM-88 scores at baseline and post-intervention, with a markedly stronger difference after intervention, while PedsQL scores showed no significant baseline difference but a highly significant post-intervention difference.

Test Statistics[a]

Scale	GMFM-88 Pre-Intervention	GMFM-88 post-intervention	Peds QL Pre-Intervention	Peds QL post-intervention
Mann-Whitney U	166.000	47.000	222.500	122.500
Wilcoxon W	466.000	347.000	522.500	422.500
Z	-2.516	-4.969	-1.354	-3.416
Asymp. Sig. (2-tailed)	.012	<.001	.176	<.001

a. Grouping Variable: Plyometric Exercise=1, Strengthening Exercise=2

4.DISCUSSION

According to the present study, the two intervention groups had comparable baseline demographics, including an equal mix of genders and roughly matched ages. Such homogeneity is essential in paediatric rehabilitation research since age and sex are known to influence motor development, neuromuscular maturation, and response to therapeutic exercise in cerebral palsy (CP) children [6]. The study's internal validity is strengthened by the groups' similar demographics, which reduce the possibility of confounding effects and enable detected post-intervention differences to be predominantly attributed to the intervention protocols rather than participant-related bias.

Comparable functional categorization and spasticity levels between groups provided additional evidence of baseline equivalency. Most participants were categorized as GMFCS Level I, with fewer kids in Level II, suggesting that the sample's motor impairments were generally minor. Furthermore, similar muscular tone characteristics prior to intervention are suggested by the preponderance of Grade 1 spasticity on the MAS in both groups. This consistency improves the reliability of between-group comparisons since functional severity and spasticity levels are strongly correlated with gross motor performance and exercise responsiveness [7, 8]. The claim that post-intervention gains accurately represent treatment benefits is strengthened by the lack of baseline clinical discrepancies.

Despite general baseline similarities, pre-intervention gross motor function differed statistically significantly between groups, despite similar quality of life measurements. Given the diversity of motor control, compensatory techniques, and contextual factors, baseline motor performance variability is not unusual in treatment trials involving CP children [9]. Crucially, the lack of baseline differences in quality of life implies that both groups had comparable levels of functional involvement and well-being before the intervention, offering a solid basis for assessing improvements in psychosocial outcomes connected to the intervention.

Both the plyometric and strengthening exercise groups showed notable gains in gross motor function and QOL post intervention period. These findings align with studies demonstrating that children with hemiplegic CP benefit from systematic physical exercise in terms of neuromuscular coordination, muscle strength, and functional mobility [10, 11]. Enhancements in quality of life further demonstrate the wider advantages of physical training, which go beyond improvements in motor skills to include greater involvement, self-assurance, and perceived functional independence.

Nearly all participants showed consistent improvements from before to after the intervention, according to within-group analyses, and there was no indication of functional loss. Most positive rank changes highlight the safety and therapeutic benefits of both exercise modalities in paediatric neuro rehabilitation. These consistent gains imply that focused exercise regimens can be successfully included into rehabilitation plans to support children with CP's physical and mental health.

In terms of improvements in gross motor function and QOL, a comparative study found that the plyometric exercise group did better than the strengthening exercise group. Rapid stretch-shortening cycles, dynamic posture control, and functional movement patterns are highlighted in plyometric training, which may more effectively promote neuromuscular adaptation and motor learning in hemiplegic CP children [12, 13]. High-velocity, task-specific exercises may be especially useful in improving functional performance related to everyday activities, according to the better results shown in the plyometric group.

5 CONCLUSION

In conclusion, the findings show that plyometric and strengthening exercise programs are effective in improving the gross motor function& overall QOL of children of hemiplegic CP. However, plyometric training appears to confer additional benefits, leading to significantly greater post-intervention gains. These results support the rejection of the null hypothesis and validate the alternative hypotheses, emphasizing the importance of incorporating dynamic, functional exercise modalities particularly plyometric training into paediatric CP rehabilitation programs.

6 DECLARATIONS & ETHICAL STATEMENTS

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- **Authors' Contributions:** SDconceptualized the study, drafted the protocol, carried out data collection, and wrote the initial manuscript draft. RKS oversaw the project and made key revisions to the book. The manuscript was modified and submitted by PR and PK. The final manuscript was reviewed and approved by all writers.
- **Ethical Approval and Consent: Ethical Clearance: (Ref. No.SCOT/JULY-.25/EC PEADS-02)**Authorized by Santosh College of Occupational Therapy's Institutional Ethics Committee. Every individual participant in the research gave their informed consent to participate in the intervention and have their data published.
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- **Data Access Statement:**Data collection created and examined in study will provided

by corresponding author upon reasonable request.

- **AI Disclosure:** This study's conception, implementation, data analysis, and paper writing did not make use of artificial intelligence techniques.

7. Conflict of Interest: Nil

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