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Influence Of Using Standing Frame With Time Variations On Locomotive Abilities And Quality Of Life In Non-Ambulant Spastic Cerebral Palsy

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ABSTRACT

Background: Cerebral palsy (CP) is a heterogeneous group of persistent, non-progressive mobility and posture impairments which are caused by damage to the brain while the infant or fetus is still growing. It is marked by a lack of normal control over motor functions and affecting the child's ability to explore, speak, learn and become independent. Objective: To evaluate influence of using standing frame with time variations on locomotive ability and quality of life in non-ambulant cerebral palsy. Subjects and Methods: Sixty-six children having spastic CP (diplegia and quadriplegia) of both sexes took-part in this study. All children in this study were received standing exercise program for 60 minutes/3 sessions per week for 6 consecutive months. They were assigned into 3 groups: Group A. Twenty-two children were received standing exercise program 3 times per week and using standing frame for one hour daily. Group B. Twenty-two children were received standing exercise 3 times per week and using standing frame for three interrupted hours daily. Group C. Twenty-two children were received standing exercise 3times per week and using standing frame for 5 interrupted hours daily. They were re-evaluated after 6 months of treatment. Growth motor function measure, pediatric balance scale and hand-held dynamometer used to assess locomotive ability and quality of life questionnaire to assess quality of life. Results: There was a significant increase in quadriceps, hip abductors, hip extensors, and back extensors strength in groups A, B & C post-treatment compared with baseline values. There was a significant improvement in GMFM and PedsQL in groups A, B & C post-treatment compared with baseline values). Conclusion: Using standing frame with time variations has an effect on locomotive abilities and quality of life in non-ambulant spastic cerebral palsy.

Keywords: *Standing frame, locomotion, Cerebral palsy, Quality of life. , Functional ability.*

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1. INTRODUCTION

Cerebral palsy (CP) is a heterogeneous group of persistent, non-progressive mobility and posture impairments which are caused by damage to the brain while the infant or fetus is still growing (1).

Among of the main signs of CP is spasticity, which is a major problem that impairs movement, causes pain and impairment, and makes everyday activities difficult or impossible. The motor nerve fibers that regulate muscle function are damaged in children with cerebral palsy, resulting in unopposed muscular contraction and rigidity, which causes defects in posture and gait (2).

An individual's functional ability may be defined as their actual or anticipated capability to carry out the activities and tasks that are often expected of them. An individual's functional capacity, which is associated with their psychological and physiological well-being, is a major determinant of their quality of life (QOL) (3)

Standing frames, an example of adaptive equipment, allow users to maintain an upright posture by providing external, adjustable support. By mechanically stressing the lower extremities and spine, these standing programs aim to reduce or eliminate motor complaints, promote proper posture, and increase bone density and development (4)

Modified Ashwarth Scale was thought to be with satisfactory reliability and validity in preliminary evaluation of abnormal muscle tone in clinical practice. It has a lot of advantages such as being convenient, simple and easy to master in short period. Also, it has interrater and intrarater reliability to assess typical spasticity and normal muscle tone because there was significant difference between them (5)

No movement is needed to measure isometric muscle strength with a hand-held dynamometer. Two approaches are utilized: one is called the break method, requiring the tester's force isometrically increased through the HHD for a predetermined duration, after which it slightly surpasses the patient's force; and the other involves the make method, in which the child exerts their maximum effort against the HHD that the tester is holding stationary (6).

The PBS is a 14-item criterion-referenced assessment that uses a 0–4 scale to evaluate how well a subject can maintain a steady state and anticipate and respond to changes in environmental stimuli. The maximum possible score for the child was 56, which was determined by adding together all of the elements (7)

The pediatric QOL inventory has both general sections that may be used with children who are healthy and those who are dealing with chronic illnesses, and sections that are tailored to particular diseases or health issues. It has 23 items total, including five items for social functioning, five items for emotional functioning, eight items for physical functioning, along with five items for school functioning (8)

The aim of this study was to investigate the impact of using standing frame for one hour on strength, balance, functional ability and quality of life in non-ambulant spastic cerebral palsy.

2. MATERIAL AND METHODS:

Study design:
This study was accepted by the ethical research committee, at the Physical Therapy faculty, Cairo university, Egypt, under the serial number P.T.REC/012/003784, also this research was registered at clinical trials with ID PACTR202208807237148.A written consent form was gained from patients prior to contribution in this study.

Participants:
A total number of Sixty-six children with spastic CP (diplegia and quadriplegia) of both sexes took-part in this study. They collected from General Hospital in Gharbia city. They were assigned into three equal groups; They were chosen based on the following criteria: **Inclusion criteria:** They had cerebral palsy in form of spastic diplegia or quadriplegia. They had spasticity grade ranging from 1+ to 2 based on modified Ashworth scale. They were able to understand and follow commands and instruction during assessment and treatment. They were non-ambulant; they were level IV and V according to GMFC**. Exclusion criteria:** Fixed deformity of upper or lower limbs. Contractures. Surgical intervention in the lower limb (tenotomy or tendon release). Botilinum toxin injection in lower limb in the last six months, Visual or auditory defect, Cardiovascular or respiratory defect, Severe mental retardation.

Randomization
An informed permission form was completed by all participants before the study began. The participants' identity and privacy were assured, and the procedures used were in accordance with all applicable laws and institutional regulations. All subjects were randomly assigned to one of three groups.

Interventions
The subjects randomized into three equivalent groups, A, B & C:

Group A. Twenty-two children were received standing exercise program 3 times per week and using standing frame for one hour daily.

Group B. Twenty-two children were received standing exercise 3 times per week and using standing frame for three interrupted hours daily.

Group C. Twenty-two children were received standing exercise 3times per week and using standing frame for 5 interrupted hours daily. They were re-evaluated after 6 months treatment.

For treatment:
1. Standing frame:
The child was supported in standing position with 5 belts tightened across his body and fixes him against standing frame. Children in each group were supported on standing frame for different periods as follows:
Group A. The children were supported (standing) on standing frame for one hour daily.
Group B. The children were supported (standing) on standing frame for three interrupted hours daily.
Group C. The children were supported (standing) on standing frame for 5 interupted hours daily. They were re-evaluated after 6 months to determine the most beneficial scadule for children to apply

2. Conventional physical therapy program (2 hours) for both groups:

a. Trunk control exercise from prone and supine on wedge.
b. Facilitation of pelvic girdle control.
c. Facilitation of standing.
d. Facilitation of postural mechanisms.
e. Stretching exercise.

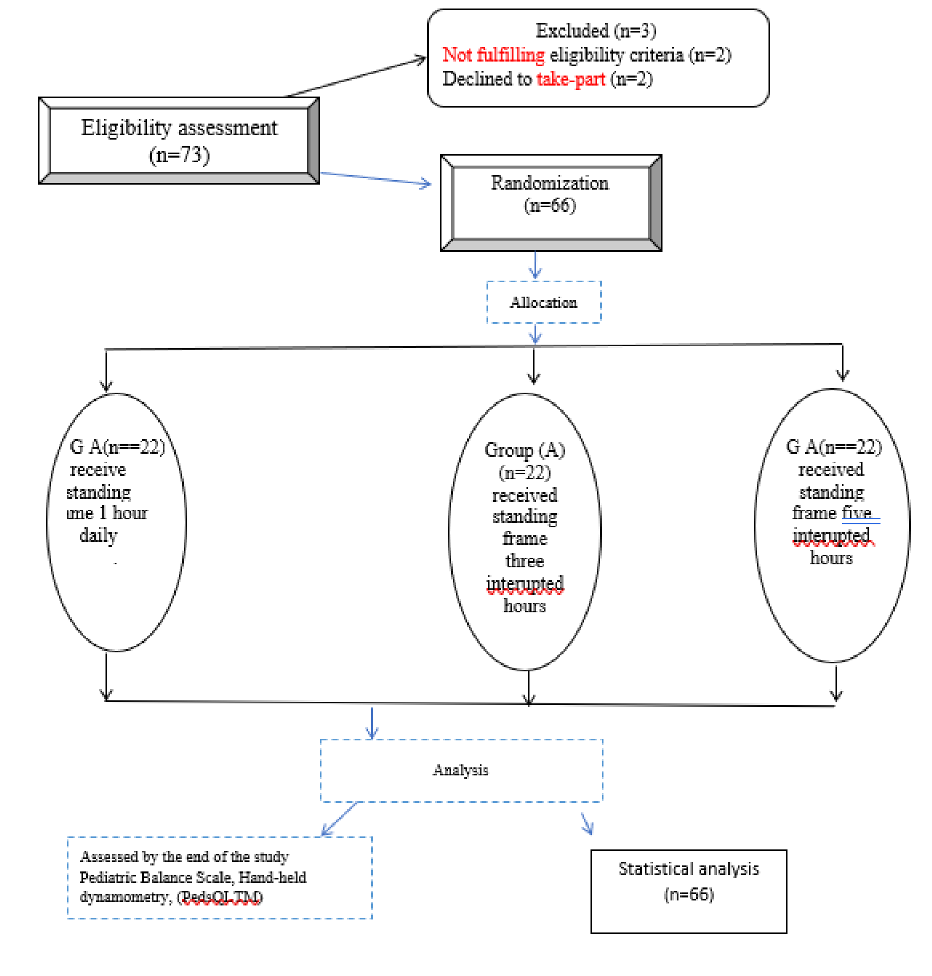

Fig ( ): Flow chart of study participants

Outcome measures:

- **The Pediatric Balance Scale** was used to assess balance. It is designed to be used with school-aged children who have low to moderate movement impairment. Children between the ages of 5 and 15 participated in the pilot study (12).
- **Hand-held dynamometry** utilized to evaluate the strength of muscles in children suffering from spastic cerebral palsy. When assessing the supine hip flexors and extensors, the flexors and extensors of the knee, in addition to the dorsiflexors of the ankle, HHD shows acceptable reliability (13).
- **The Pediatric Quality of life Inventory TM Generic Core Scale (PedsQLTM 4.0)** was utilized to evaluate

QOL. These questionnaires were answered either by the patient or by a proxy of the patient (e.g., parent) **(Varni et al., 2001).** The WHO's fundamental health aspects are included, such as role (school) functioning.

- **In the PedQLTM 4.0** generic core scales, there are a total of 23 questions. These items cover several aspects of a child's functioning, including their physical health with 8 items, emotional functioning with 5 items, social interactions with 5 items, and school performance with 5 items (14).

To do the statistical analysis, we used SPSS, version 25.0 for Windows, which is developed and maintained by IBM Corp. in Armonk, NY, USA. The normality of the data distribution was checked using the Shapiro-Wilk test, and the homogeneity of the variances among groups was checked using the Levene's test. A one-way analysis of variance was used to compare the ages of the groups. The distribution of sexes among the groups was compared using a chi-squared test. Muscle strength, PBS, GMFM, in addition to PedsQL were evaluated for within- and between-group effects using a mixed multivariate analysis of variance (MANOVA). The Bonferroni correction was used to do post hoc pairwise comparisons. All statistical tests were conducted with a significance threshold of $p < 0.05$.

Sample size calculation

To avoid type II error, sample size calculation was performed using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany) expecting large difference between groups; and revealed that the required sample size required for this study was N=66. Calculation is made with α=0.05, power 80%, effect size = 0.4.

Statistical analysis:

Statistical analysis was done utilizing the Statistical Package for the Social Sciences (SPSS) version 25.0 for Windows (IBM Corp., Armonk, NY, USA). The normality of the data distribution was checked using the Shapiro-Wilk test, and the homogeneity of the variances between groups was determined using Levene's test. A one-way analysis of variance was used to compare the ages of the groups. The distribution of genders between the groups was compared using a chi-squared test. Muscle strength, PBS, GMFM, and PedsQL were evaluated for within- along with between-group effects using a mixed MANOVA. The Bonferroni correction was used to do post hoc pairwise comparisons. For all statistical tests, a p-value less than 0.05 was used as a significant threshold.

3. RESULTS:

Subject characteristics:

The subject characteristics of groups A, B, and C are shown in Table (1). The distribution of gender and age amongst the groups was not significantly different ($p > 0.05$).

Table 1. Basic characteristics of participants.

	Group A	Group B	Group C	p-value
	mean ± SD	mean ± SD	mean ± SD	
Age (years)	5.50 ± 0.96	5.68 ± 0.89	5.64 ± 0.85	0.79
Sex, N (%)				
Girls	8 (36%)	10 (45.5%)	9 (41%)	0.83
Boys	14 (64%)	12 (54.5%)	13 (59%)	

SD, standard deviation; p value, Probability value

<u>Impact of treatment on muscle strength, PBS, GMFM and PedsQL:</u>

A significant interaction between treatment and time was shown by the mixed MANOVA ($F = 26.31$, $p = 0.001$, $\eta^2_o = 0.76$). A significant main impact of time was noted ($F = 458.71$, $p = 0.001$, $\eta^2_p = 0.98$). The treatment's main impact was statistically significant ($F = 20.43$, $p = 0.001$, $\eta^2_p = 0.72$).

Within group comparison

A significant improvement was observed in quadriceps, hip abductors, hip extensors, and back extensors strength in groups, A, B & C post-treatment compared with baseline values ($p < 0.01$). (Table 2). A significant improvement was noted in GMFM and PedsQL in groups, A, B & C post-treatment compared with baseline values ($p < 0.01$). There was a significant increase in PBS in Groups B and C ($p < 0.001$), while there was no significant change in PBS in Group A ($p = 0.28$). (Table 3).

Between group comparison

A significant improvement was noted in quadriceps, hip abductors, hip extensors, and back extensors strength, as well as PBS, GMFM, and PedsQL scores in Group C compared to Group A ($p < 0.001$) as well as Group B ($p < 0.05$) post-treatment. Additionally, Group B showed a significant improvement in all outcome measures compared with Group A ($p < 0.05$) post-treatment. (Table 4).

Table 2. Mean muscle strength pre and post treatment of group A, B and C:

Strength (kg)	Group A	Group B	Group C
	mean ± SD	**mean ± SD**	**mean ± SD**
Quadriceps			
Pre treatment	3.52 ± 0.80	3.44 ± 0.53	3.67 ± 0.71
Post treatment	3.78 ± 0.71	4.45 ± 0.69	5.20 ± 1.10
MD (95% CI)	-0.26 (-0.46 : -0.06)	-1.01 (-1.21: -0.82)	-1.53 (-1.73: -1.34)
	p = 0.01	***p = 0.001***	***p = 0.001***
Hip abductors			
Pre treatment	3.11 ± 0.47	3.02 ± 0.50	3.06 ± 0.51
Post treatment	3.68 ± 0.38	4.06 ± 0.53	4.45 ± 0.47
MD (95% CI)	-0.57 (-0.72: -0.43)	-1.04 (-1.19: -0.90)	-1.39 (-1.53: -1.24)
	p = 0.001	***p = 0.001***	***p = 0.001***
Hip extensors			
Pre treatment	2.81 ± 0.54	2.78 ± 0.44	2.76 ± 0.38
Post treatment	3.24 ± 0.57	3.71 ± 0.46	4.23 ± 0.58
MD (95% CI)	-0.43 (-0.64: -0.22)	-0.93 (-1.15: -0.72)	-1.47 (-1.68: -1.25)
	p = 0.001	***p = 0.001***	***p = 0.001***
Back extensors			
Pre treatment	3.74 ± 0.42	3.71 ± 0.48	3.55 ± 0.41
Post treatment	4.20 ± 0.46	4.63 ± 0.52	5.15 ± 0.61
MD (95% CI)	-0.46 (-0.67: -0.24)	-0.92 (-1.13: -0.70)	-1.60 (-1.81: -1.38)
	p = 0.001	***p = 0.001***	***p = 0.001***

SD, Standard deviation; MD, Mean difference; CI, Confidence interval; p value, Probability value

Table 3. Mean PBS, GMFM and PedsQL pre and post treatment of group A, B and C:

	Group A	Group B	Group C
	mean ± SD	**mean ± SD**	**mean ± SD**
PBS			
Pre treatment	2.05 ± 0.21	2.09 ± 0.29	2.14 ± 0.35
Post treatment	2.23 ± 0.69	4.14 ± 0.77	6.32 ± 0.78
MD (95% CI)	-0.18 (-0.52: 0.16)	-2.05 (-4.52: -3.84)	-4.18 (0.30: 1.03)
	p = 0.28	***p = 0.001***	***p = 0.001***
GMFM			
Pre treatment	41.37 ± 3.83	40.21 ± 4.14	39.77 ± 4.34
Post treatment	51.91 ± 4.75	58.34 ± 6.46	63.71 ± 4.68
MD (95% CI)	-10.54 (-12.36: -8.73)	-18.13 (-19.95: -16.32)	-23.94 (-25.76: -22.13)
	p = 0.001	***p = 0.001***	***p = 0.001***

PedsQL			
Pre treatment	27.27 ± 7.36	29.55 ± 9.87	28.41 ± 8.78
Post treatment	34.09 ± 12.31	71.29 ± 11.71	84.45 ± 11.84
MD (95% CI)	-6.82 (-11.69: -1.94)	-41.74 (-46.61: -36.87)	-56.04 (-60.92: -51.17)
	p = 0.007	***p = 0.001***	***p = 0.004***

SD, Standard deviation; MD, Mean difference; CI, Confidence interval; p value, Probability value

Table 4. Comparison muscle strength, PBS, GMFM and PedsQL between *group A, B and C post treatment.*

Outcome	**Group A vs B**		**Group A vs C**		**Group B vs C**		η^2_p
	MD (95% CI)	**p value**	**MD (95% CI)**	**p value**	**MD (95% CI)**	**p value**	
Quadriceps	-0.67 (-1.29: -0.05)	0.03	-1.42 (-2.04: -0.81)	0.001	-0.75 (-1.37: -0.14)	0.01	0.33
Hip abductors	-0.38 (-0.72: -0.05)	0.02	-0.77 (-1.10: -0.43)	0.001	-0.39 (-0.72: -0.05)	0.02	0.32
Hip extensors	-0.47 (-0.86: -0.08)	0.01	-0.99 (-1.38: -0.60)	0.001	-0.51 (-0.90: -0.12)	0.007	0.37
Back extensors	-0.44 (-0.82: -0.05)	0.02	-0.95 (-1.34: -0.57)	0.001	-0.52 (-0.90: -0.13)	0.006	0.36
PBS	-1.91 (-2.45: -1.37)	0.001	-4.09 (-4.63: -3.55)	0.001	-2.18 (-2.72: -1.64)	0.001	0.84
GMFM	-6.43 (-10.31: -2.55)	0.001	-11.80 (-15.68: -7.92)	0.001	-5.37 (-9.25: -1.49)	0.004	0.46
PedsQL	-37.20 (-45.85: -28.54)	0.001	-50.36 (-59.02: -41.71)	0.001	-37.20 (-21.82: -4.51)	0.002	0.77

MD, Mean difference; CI, Confidence interval; p value, Probability value; η^2_p, Partial Eta Squared.

4. DISCUSSION:

This study was done to examine the influence of using standing frame with time variations on locomotive abilities and QOL in non-ambulant spastic CP.
Evaluation of children in all groups was performed before as well as after six months of intervention by using GMFM to assess gross motor function, HHD to assess strength, PBS to asses balance and PedsQLTM 4.0 to assess quality of life.
According to Hombergen et al. (2012), CP is a movement disorder. Children with CP often struggle with ADLs because their movements are impaired and inefficient, which puts them at risk of deconditioning**.**

Spastic diplegic CP have lack of postural control which causes the child inability to keep center of gravity within base of support, perturbations and instability makes active motor control difficult and so, delay motor function (19).

Children with spastic diplegia have a lot of problems in balance which affect their motor functions and quality of life (20)**.**

This study's findings are consistent with those of Rapson et al. (2022) (21) who found that a modified procedure increased the time that children with CP spent standing on their hips during migration. The recommended duration is 60 minutes, five times weekly, with a control group standing for only 30 minutes, three times weekly, for a total of 12 months.

This is in line with the findings of a small case series by Gibson et al. (2009) (22) that evaluated the effects of using a standing frame for an hour daily for six weeks on 5 non-ambulant children with CP, ranging in age from six to nine years old. One 6-week period of using the standing frame was followed by two 6-week periods of not using it. The utilization of a standing frame for hamstring stretches was mentioned as a potential enhancement.

Barbier et al. (2022) (23) found that non-ambulant CP children who utilize a static standing frame in real life had superior bone health as well as reduced bone resorption than children who dont. This conclusion is consistent with their findings.

Also, agree with **Paleg et al., (2013), Goodwin et al., (2018), Goodwin et al., (2018) , Goodwin et al., (2019**) (24,25,26,27) whom stated that standing frame provides supports communication, improves self-confidence, increases alertness, improved access to environment, aids cognitive development and provides more opportunities for peer interaction.

The findings are in line with those of Susan et al. (2009) (28) who found that caregivers reported a small improvement in the ease of transfers and ADLs after periods of standing frame usage. In children with CP who are unable to walk, there is preliminary evidence that using a standing frame for only six weeks might significantly lengthen their hamstrings and perhaps make it easier for them to do activities of daily living.

Macias L. (2005), (29) examined the effects of a standing device on abduction in children exhibiting spastic diplegia over the long term, and their findings are consistent with ours. This research found that those who participated in the study had normal hip development markers at age 5, a broader base of support, and additionally preserved range of motion in the hip adductor muscles. With abduction, weight-bearing had overall good benefits on hip growth and muscle balance for functional gait.

5. CONCLUSION:

From the obtained outcomes, there is evidence that using standing frame with time variation has significant effect on functional ability and QOL in non-ambulant children with CP.

6. LIMITATIONS AND RECOMMENDATIONS:

- This study has several limitations. Furthermore, the study didn’t constitute other potential confounding factors including comorbidities, lifestyle factors, and psychological stress, which could influence the prevalence and child's ability to explore, speak, learn.
- Further studies are required to assess the effect of using standing frame for one hour on strength, balance, functional ability and quality of life in non-ambulant spastic cerebral palsy more than samples and patients and more than six months.

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