DOI: https://doi.org/10.53350/pjmhs2022161195

ORIGINAL ARTICLE

Effect of Trunk Exercises on Trunk Control, Balance, and Mobility Function in Children with Hemiparetic CP

AFIFA MUNAF[1], SAMIA MEHBOOB[2], MARYAM RAZZAQ[3], MADIHA YOUNAS[4], SAMRA UMAIR[5], IQRA WASEEM[6], HABIBA SHABIR[7], SANA GUL[8]

[1]*Physical Therapist, University of Health Sciences Lahore*
[2]*Lecturer/ Clinical Therapist, Bakhtawar Amin College of Rehabilitation Sciences, BAMDC, Multan*
[3]*Senior Lecturer/ Senior Physiotherapist, Institute: Bakhtawar Amin College of Rehabilitation Sciences, BAMDC, Multan*
[4]*Lecturer, Riphah International University Lahore*
[5]*Physiotherapist, Reem Hospital, Abu Dhabi*
[6]*Assistant Professor*, *University of Lahore*
[7]*Physical Therapist, Bakhtawar Amin Memorial Trust Hospital, Multan*
[8]*Physical Therapist, Riphah International University Lahore*
Correspondence to Dr. Samia Mehboob, E-mail:SamiaMehboob786@gmail.com, Contact: 03200654921

ABSTRACT

Aim: To find the consequences of trunk exercises in addition to the traditional physiotherapy practices for trunk control, mobility, and balance in hemiparetic cerebral palsy children.

Methods: Forty children withhemiparetic cerebral palsy of 10-14 years (without gender discrimination), were included in this randomized controlled trial. Both groups received a conventional physical therapy program, whilethe study group additionally received trunk exercises. Participants were re-evaluated after three months of treatment by using the Trunk Impairment Scale (TIS) for assessment of trunk control, Pediatric Berg Balance Scale (PBS) for balance assessments, and the dynamic gait index scale (DGI) for walking mobility function.

Results: The Mann Whitney 'U' test was used to measure the difference between the 2 groups while Wilcoxon test was used to measure the difference within the group.Results were demonstrated as mean and standard deviations for pre and post-treatmentscores of variables TIS, PBS, and DGI.Comparison of outcome measures of each group before treatment specified no substantial differences. While, comparison of outcome measures after the treatmentwith traditional physiotherapy along with trunk exercises revealed noteworthy increase in the aptitude to maintain trunk stability, balance, and walking mobility function in study group A ($p<0.05$).

Conclusion: The trunk exercise has a beneficial role and can be used in amalgamation with a traditional physiotherapy practiceto increase control of the trunk, and improvement of balance, and walking mobility functions in hemiparetic cerebral palsy individuals.

Keywords: Hemiparetic Cerebral palsy, trunk control, balance, Pediatric Berg Balance Scale, Dynamic Gait Index

INTRODUCTION

Cerebral palsy (CP) is describedas a set of permanent neurodevelopmental disorders, which is non-progressive and is instigated by the insult to the undeveloped brain of the fetus/infant.[(1)]It is usually diagnosed by its clinical features such as an abnormal increase or decrease in the muscle tone, postural imbalance, movement dysfunction, abnormalities of motor skills, weakness of muscles, tremors[2], compromised perception, impaired communication, disturbed sensory discernment, behavioral abnormalities, seizures, or a mixture of above-mentioned features[3].

These postural and movement dysfunctions in cerebral palsy ultimately lead to an activity limitation[4]. However, clinical features of cerebral palsy are evolved gradually and may become identifiable after three to five years of age; while evocative signs and symptoms may appear in the initial years of life. The treatment of cerebral palsy demands a team approach of various healthcare professionals (rehabilitation therapists, medical specialists, psychologists, physiotherapists, occupational therapists, speech and language therapists) targeting the management of numerous abnormalities originating from the debilitating insult to the immature brain[2].

Classification of cerebral palsy (CP) is generally centered on the level of motor impairment of severalbody parts and appendages or by activity restrictions experienced by the affected individuals.[(5, 6)]Hemiparetic cerebral palsy denotes the milder cases of hemiplegic cerebral palsy which is a form of paralysis in which motor aptitudes are affected on only one side of the body compromising the normal muscle tone of the body. The foremost cause of hemiparetic or hemiplegic cerebral palsy is perinatal stroke, causing a lifetime debility[7].

Received on 09-06-2022
Accepted on 19-10-2022

Signs and symptoms of hemiparetic cerebral palsy include, seizures (more frequently in the neonatal period), a priority for using one hand over the other, a baby often keeps the pretentious hand folded into a fist, poor balance, the child demands assistance while crawling and standing, frequent asymmetric movements, delayed milestones (rolling over, sitting upright, crawling, walking, etc.), firm muscles on one side of the body, 44-67% individuals experience epilepsy with hemiparesis, intellectual deficiencies, speech and language disorders, and scoliosis. Though, few individuals with hemiplegic cerebral palsy experience severe paralysis, 88% are categorized as having Gross Motor Function Classification System (GMFCS) level 1[8].

Epidemiologic data regarding the prevalence of cerebral palsy from around the globe reveals that its prevalence range is estimated to be 2-3 individuals per thousand live births[6]. Within a populace, it may ensue more frequently in poorer folks[9]. The frequency of CP is greater in males than in females[10]. Moreover, the literature suggests that about 33–39% of cerebral palsy individuals experience hemiplegic cerebral palsy[6].

Key risk dynamics related to cerebral palsy include premature birth, congenital abnormalities, intra-uterine septicity, growth restriction of the fetus, several gravidities, abnormalities of the placenta, asphyxia at birth, unprocessed hypothyroidism of mother, perinatal stroke, and thrombophilia. Although premature birth is considered a primary risk factor for the development of cerebral palsy (CP), the latest literature suggests that post-term gravidness (at 42 weeks or later) is also linked with an augmented menace of this disorder[11]. Up to date, one to two percent of cases of cerebral palsy (frequently hereditary) had been associated with causative mutations. As far as the hereditary predisposition of cerebral palsy is concerned, clinical risk dynamics and findings might act as prompts to rule out the cause[12]. In addition to that multiple forms of severity and complexity areexperienced by cerebral palsy patients therefore, a team approaches according to the set criteria of (ICF) InternationalClassification of Functioning,

Debility, and Fitness should be used for maximizing the overall function and fitness of individuals affected with cerebral palsy[13].

Despite the trunk being considered the main pillar for the stability of posture and control of alignment[14], the literature on trunk regulationin individuals with cerebral palsy is infrequent as compared to upper and lower limb control[15,16]. However, it is demonstrated by literature, that patients with cerebral palsy commonly demonstrate diminished trunk balance, which ultimately compromises their routine activities and affects their overallperformance[17].

Besides, research suggests that proximal trunk control is anessentialpart ofmovement control of a distal limb, stability, and functional activities[4,18]. The stability of the trunk is considered a significant component of independent and selective movements of appendages and head and trunk muscles contribute greatly to the stabilization process of the spine and trunk.Literature suggests thatcoordination of postural muscles is observed to be poor in cerebral palsy (CP) individuals[19,20] along with poor control of the trunk, and static and dynamic stability, which imposes several difficulties in fulfilling their activities of daily living[21]. Depending upon the part of the trunk moved, abdominal muscles (e.g., muscles of the pelvis, the thoracic muscles, or the central aponeurosis) demand a stable base for efficient performance as compared to thelimb muscles. As balance is considered animportant aspect of performing daily activities such as standing, walking, sitting, standing from a sitting position and rambling activities therefore impaired balance can lead to an augmented threat of deteriorating in the direction of the paretic side. Additionally, balanceis considered to have a strong link with locomotor ability, mobility, and the efficacy of walking[22].

Several previous studies suggest that the core stability exercises have anadvantageousoutcome in refining trunk balance, predominantly posture control in sitting (dynamically)[22] and selective trunk exercises along with neurodevelopmental therapy playa significant role in the improvement of balance, mobility, and trunk control in the chronic patients of stroke[23].

Even though trunk control is considered an essential factor for increased constancy and masssymmetry[14], there is a lack of studies that report the role of exercises and rehabilitation in the management of poor trunk stability in cerebral palsy individuals[22]. The rationale of the currentstudy was to conclude the influence of trunk exercises on mobility, trunk control, and balance, in children with hemiparetic cerebral along with traditional physiotherapy practices[4].

The objective of the current study was to find the consequences of trunk exercises in addition to the traditional physiotherapy practices for trunk control, mobility, and balance in hemiparetic cerebral palsy children.

MATERIAL AND METHODS

Single-Blinded Randomized Controlled Clinical Triali.e., only patients were blinded regarding treatment interventions were conducted at COMPASS (center of mentally and physically affected special students), after the approval from Ethical Review Board. A total of 40 participants meeting the inclusion criteria such as diagnosed children with spastic hemiparetic cerebral palsy with ages between 6-14 years, children with levels of gross motor function between I and II according to Gross Motor Function Classification System/GMFCS, and[(4)], children with grade 1 and 2 of spasticity according to the Modified-Ashworth-Scale,[(4)]were included in the study after taking the informed consent. Participants were then casually dispersed randomly into two equivalent groups by using the lottery method, with 20 children in each group. The Control group received the conventional physiotherapy alone i.e. stretching, Positioning, Bobath, and ND treatment while the experimental group received bonus trunk exercises along with traditional physiotherapy interventions for the improvement of balance, mobility, and gait[4].

Both groups were assessed before (pre-test) and after three months of the training program (post-test) by using the trunk-impairment-scale (TIS) for trunk control, pediatric berg balance scale (PBS) for balance assessment, dynamic gait index scale (DGI) for gait assessment.The trunk impairment scale (TIS) was used to evaluate the trunk stability for the assessment of sitting balance including both static balance and dynamic balance,and trunk coordination, which are scored upto 7, 10, and 6 points, correspondingly[4]. The Pediatric Balance Scale (PBS) was used for the assessment of functional balance capabilities of hemiparetic cerebral palsy individuals[4].

Treatment: Throughout the study duration, subjects did not receive any other physiotherapy intervention other than the planned interventions in the study. Participants of each group were given a conventional physiotherapy exercise plan of one hour, a total 3 sessions/ week, for three months consequently, comprised of neurodevelopmental management, including the approximation of the upper and lower limbs rhythmically and regularly, training for righting facilitation, equilibrium reactions, protective reactions, exercises for improving postural balance along with equivalent weight transfer specifically on the affected side, strength training (including both upper and lower limbs), patterns for reflex inhibition and walk training, andstretching[4].

Whereas, the additional trunk exercise program was given to the study group (30 minutes in a day, for 3 days in a week, and threesequential months), which include exercises of the trunk (upper and lower) in various positions (supine and sitting). Supine exercises include upper trunk rotation by performingthe bridgingexercise with clenched hands on either side, rotation of the lower trunk by maintaining a crook lying position and then moving knees on either side, pelvic bridging, and flexion with rotation of the upper trunk.The sitting exercise plans encompass the careful flexion-extension of the lower trunk, rotation of the upper trunk and lower trunk, and forward and lateral reach[24]. Data analysis was done by using SPSS version 25.00 and results were described in mean and standard deviations. P-value ≤0.05 was considered significant. Group measurements (measured over time) were represented using frequency tables.The MANN WHITNEY 'U' test was used to measure the difference between the 2 groups. The Wilcoxon test was used to measure the difference within the group.

RESULTS

A total of 37 participants were evaluated after three months of treatment.The demographic dataof both groups showed no significant difference betweentheir ages. In Group A-(study group) 9 subjects were male and 9 subjects were female, whereas in Group B- (control group) ten subjects were males and nine were females. Overall frequency of males and females i.e., out of 37 individuals 18 were females and 19 were males.

Table 1: The Mean and Standard Deviation of Age:

Group	N	Mean	StandardDeviation
Group A (Study group)	18	10.50	2.203
(Group B) (Control group)	19	11.21	1.619
Total	37	10.86	1.932

When mean and standard deviation of both groups were analyzed, results demonstrated no visible differences in the age of both groups (Table 1).

Table 2 shows the Wilcoxon Test for comparison of pre and post-treatment results within the Group-B (control group). Results showed improvement in all the outcome measures after the treatment with traditional physical therapy treatment. Results are demonstrated as mean and standard deviations for pre and post-treatment scores of variables TIS, PBS, and DGI (Table 2).

Wilcoxon Test was used measure the comparison of outcome measures of before and after the treatment within Group-A (study group). Results are demonstrated as mean and standard deviations for pre and post-treatment scores of variables TIS, PBS, and DGI). Results showed improvement in all the outcome

measures after the treatment with traditional physical therapy treatment along with Trunk Exercises (Table 3).

Man Whitney U test was used to compare the outcome measures of both groups of TIS, PBS, and DGI after the treatment, and results demonstrated noteworthy improvement in the capability to maintain trunk stability, balance, and walking mobility function in both groups ($p<0.05$). Comparing pre-treatment outcomes of both groups specified no substantial differences. Whereas, a comparison of results after the completion of the treatment protocol of both groups, showed notable improvements in the favor of group A (study group) demonstrating $P< 0.05$ (Table 4).

Table 2: Wilcoxon Test for Group-B (Control Group) Comparison OF TIS, PBS, and DGI within the Group-B

Variables	Mean±SD Pre-Treatment	Mean±SD Post-Treatment	Mean Difference	P-Value
TIS	4.63 ± 1.116	6.26 ± 0.733	1.63 ± 0.383	< 0.001
PBS	18.16 ± 1.214	23.53 ± 1.264	5.37 ± 0.05	< 0.001
DGI	8.37 ± 1.065	12.42 ± 1.017	4.05 ± 0.048	< 0.001

Table 3: Wilcoxon Test for Group-A (Study Group) Comparison of TIS, PBS, and DGI within group A

Variables	Mean±SD Pretreatment	Mean±SD Posttreatment	Mean Difference	P-Value
TIS	4.50 ± 0.985	10.11 ± 1.132	5.61± 0.147	<0.001
PBS	18.33±1.283	26.94 ± 1.552	8.61± 0.269	<0.001
DGI	8.78±1.003	17.50 ± 1.150	8.72± 0.147	<0.001

TIS: Trunk Impairment Scale, PBS: Pediatric Berg Balance scale, DGI: Dynamic Gait Index

Table 4: Man Whitney U Test (Comparison between 2 groups)

Variables	Treatment Group	Mean-value	St. Deviation	Mean Rank	P-Value
TIS (Pre)	Group A	4.50	0.985	18.50	0.776
	Group B	4.63	1.116	19.47	
TIS (Post)	Group A	10.11	1.132	28.50	<0.001
	Group B	6.26	0.733	10.00	
PBS (Pre)	Group A	18.33	1.283	19.83	0.638
	Group B	18.16	1.214	18.21	
PBS (Post)	Group A	26.94	1.552	27.61	<0.001
	Group B	23.53	1.264	10.84	
DGI (Pre)	Group A	8.78	1.003	21.06	0.244
	Group B	8.37	1.065	17.05	
DGI (Post)	Group A	17.50	1.150	28.50	<0.001
	Group B	12.42	1.017	10.00	

TIS: Trunk Impairment Scale, PBS: Pediatric Berg Balance scale, DGI: Dynamic Gait Index

DISCUSSION

The research was accompanied to assess the consequence of trunk exercises along with traditional physiotherapy practices in hemiparetic cerebral palsy children. Deductions of the extant study revealed thattrunk exercises along with traditional exercises have beneficial consequences and can be added to the rehabilitation plan of children with hemiparetic cerebral palsy to increase their stability of the trunk, mobility of gait, and balance.

The current study is in accordance with several studies that have evaluated that poor postural control and impaired trunk balance in hemiparetic individuals withcerebral palsy and emphasized the necessityof further investigations to increase stability and balance in hemiparetic individuals of cerebral palsy such as Ozge-kenis-Coskun reported in a studyconducted for evaluation of postural stability in children with hemiplegic cerebral palsy in year 2016, that people with spastic cerebral palsy show poor control of both static& dynamic balance and thus emphasizing the need for further research to improve their posture and stability[25]. In another study conducted by Pavao et al on posture control of hemiparetic cerebral palsy on sit to stand movements in year 2019, showed that people with hemiparetic cerebral palsy experience higher oscillatory movements during the beginning of the sit-to-stand movement as compared to normal children[21].

In addition to that, the results of this study revealed increased postural balance, stability, and mobility after the completion of traditional physiotherapy treatment protocols along with added trunk exercises at the end of the third month. The remarkableimprovement was noted in Group A (study group) which can be due to the appropriate delivery of treatment protocols for sufficient time and by 18 hours of the trunk, exercises provide throughout the treatment.

The post-treatment improvement noted in the control group in all the mean values of study variables may be due to the effects of traditional physiotherapy services which were based on neurodevelopmental programs, targeted toward improving the normal postural patterns such as exercises to improve righting & equilibrium reactions for balance andprogressinga variety of usual movement patterns of trunk & lower extremity. This concept is in harmony with a study conducted by Sina LABAF in year 2015,which concluded that the neurodevelopmental treatment helps toimprove the overall gross motor tasks in these patients, in multiple dimensions such as lying, sitting, crawling, rolling, standing, and kneeling[26].

Also, the improvement recorded in the control group after the provision of treatment is in accordance with the study conducted by Rosalee Dewaar in year 2016, reported in a systematic review conducted on the role of exercise interventions in cerebral palsy children for the improvement of posture and stability and concluded that exercises and rehabilitation has a significant role in the cerebral palsy patients and helps to improve posture and stability impairments, moreover and Verschuren et al concluded in a study on recommendations of exercise and physical activity in cerebral palsy patients in year2016, that exercise therapy is recommended in the cerebral palsy patients to improve their over health and wellbeing[27,28].

Moreover, current study is in accordance with a study conducted by El Shemy who reported in a randomized controlled trial regarding the consequences of core stability exercise in hemiplegic cerebral palsy individuals for trunk endurance and gait variations in year 2018, that addition of core stability exercises to the management plan of hemiplegic cerebral palsy can efficiently increase their trunk endurance of trunk and gait[29].

CONCLUSION

Deduction of this study suggested that the trunk exercise has a beneficial role and can be used in amalgamation with a traditional physiotherapy practice as it is operative in increasing control of the trunk, improvement of balance, and walking mobility functions in hemiparetic cerebral palsy individuals, then following a conventional physiotherapy program alone.

Limitations: This study has some gaps which the author wants to highlight.

- First, since the study population was taken from one setting COMPASS (center of mentally and physically affected special students) Pakistan due to the shortage of time, it doesn't represent all the centers.
- A second limitation is that the current study is a randomized controlled trial, therefore the possibility of selection bias cannot be ruled out.
- The third limitation is that TIS, PBS, and DGI were the only variables that were used to assess outcomes between the two groups.
- Finally, this study lacks the data of follow-up assessments and only reveals the results of pre-and post-treatment.

Recommendations: Future recommendations include that the quality of the study can be enhanced by using a large sample size to confirm the results, improving study design, and selecting more than one institute/center to make the outcomes more generalized.

Conflict of interest: The authors state that the study is directed in the absence of any profitable or financial associations that could

be interpreted as a possibleclash of concerns. The manuscript of t **Source of Support:** None he research has been read and permitted by the writers.

REFERENCES

1. MacLennan AH, Lewis S, Moreno-De-Luca A, Fahey M, Leventer RJ, McIntyre S, et al. Genetic or other causation should not change the clinical diagnosis of cerebral palsy. Journal of child neurology. 2019;34(8):472-6.
2. Gulati S, Sondhi V. Cerebral palsy: an overview. The Indian Journal of Pediatrics. 2018;85(11):1006-16.
3. Aisen ML, Kerkovich D, Mast J, Mulroy S, Wren TA, Kay RM, et al. Cerebral palsy: clinical care and neurological rehabilitation. The Lancet Neurology. 2011;10(9):844-52.
4. El-Basatiny HMY, Abdel-Aziem AA. Effect of trunk exercises on trunk control, balance and mobility function in children with hemiparetic cerebral palsy. International Journal of Therapies and Rehabilitation Research. 2015;4(5):236.
5. Rethlefsen SA, Ryan DD, Kay RM. Classification systems in cerebral palsy. Orthopedic Clinics. 2010;41(4):457-67.
6. Jonsson U, Eek MN, Sunnerhagen KS, Himmelmann K. Cerebral palsy prevalence, subtypes, and associated impairments: a population-based comparison study of adults and children. Developmental Medicine & Child Neurology. 2019;61(10):1162-7.
7. Kuczynski AM, Dukelow SP, Hodge JA, Carlson HL, Lebel C, Semrau JA, et al. Corticospinal tract diffusion properties and robotic visually guided reaching in children with hemiparetic cerebral palsy. Human brain mapping. 2018;39(3):1130-44.
8. P.C., R.& W. (2017) “Hemiplegic/Hemiparetic Cerebral Palsy,” American Baby & Child Law Centers. Available at: https://www.abclawcenters.com/cerebral-palsy/cerebral-palsy-overview/hemiplegic-hemiparetic-cerebral-palsy/ (Accessed: October 24, 2022).
9. Odding E, Roebroeck ME, Stam HJ. The epidemiology of cerebral palsy: incidence, impairments and risk factors. Disability and rehabilitation. 2006;28(4):183-91.
10. Romeo DM, Sini F, Brogna C, Albamonte E, Ricci D, Mercuri E. Sex differences in cerebral palsy on neuromotor outcome: a critical review. Developmental Medicine & Child Neurology. 2016;58(8):809-13.
11. Stavsky M, Mor O, Mastrolia SA, Greenbaum S, Than NG, Erez O. Cerebral palsy—trends in epidemiology and recent development in prenatal mechanisms of disease, treatment, and prevention. Frontiers in pediatrics. 2017;5:21.
12. MacLennan AH, Thompson SC, Gecz J. Cerebral palsy: causes, pathways, and the role of genetic variants. American journal of obstetrics and gynecology. 2015;213(6):779-88.
13. Trabacca A, Vespino T, Di Liddo A, Russo L. Multidisciplinary rehabilitation for patients with cerebral palsy: improving long-term care. Journal of multidisciplinary healthcare. 2016;9:455.
14. Degelaen M, De Borre L, Buyl R, Kerckhofs E, De Meirleir L, Dan B. Effect of supporting 3D-garment on gait postural stability in children with bilateral spastic cerebral palsy. NeuroRehabilitation. 2016;39(2):175-81.
15. Klingels K, Jaspers E, Van de Winckel A, De Cock P, Molenaers G, Feys H. A systematic review of arm activity measures for children with hemiplegic cerebral palsy. Clinical rehabilitation. 2010;24(10):887-900.
16. Damiano DL, Alter KE, Chambers H. New clinical and research trends in lower extremity management for ambulatory children with cerebral palsy. Physical Medicine and Rehabilitation Clinics. 2009;20(3):469-91.
17. Ko S, Kim Y, Lee S. The Effects of Trunk Stabilization Exercises using a Sling on Motor Development and Balance in Infant with Development Disability. Healthcare and Nursing–Advanced Science and Technology Letters. 2016;132:161-6.
18. Karthikbabu S, John M S, Manikandan N, Bhamini K R, Chakrapani M, Akshatha N. Role of trunk rehabilitation on trunk control, balance and gait in patients with chronic stroke: a pre-post design. Neuroscience & Medicine. 2011;2011.
19. Pavão SL, Silva FPdS, Savelsbergh GJ, Rocha NACF. Use of sensory information during postural control in children with cerebral palsy: systematic review. Journal of motor behavior. 2015;47(4):291-301.
20. Santamaria V, Khan M, Luna T, Kang J, Dutkowsky J, Gordon A, et al. Promoting Functional and Independent Sitting in Children with Cerebral Palsy Using the Robotic Trunk Support Trainer. IEEE Transactions on Neural Systems and Rehabilitation Engineering. 2020.
21. Barbado D, Reina R, Roldan A, McCulloch K, Campayo-Piernas M, Vera-Garcia FJ. How much trunk control is affected in adults with moderate-to-severe cerebral palsy? Journal of biomechanics. 2019;82:368-74.
22. Cabanas-Valdés R, Bagur-Calafat C, Girabent-Farrés M, Caballero-Gómez FM, Hernández-Valiño M, Urrútia Cuchí G. The effect of additional core stability exercises on improving dynamic sitting balance and trunk control for subacute stroke patients: a randomized controlled trial. Clinical rehabilitation. 2016;30(10):1024-33.
23. An S-H, Park D-S. The effects of trunk exercise on mobility, balance and trunk control of stroke patients. Journal of the Korean Society of Physical Medicine. 2017;12(1):25-33.
24. Haruyama K, Kawakami M, Otsuka T. Effect of core stability training on trunk function, standing balance, and mobility in stroke patients: a randomized controlled trial. Neurorehabilitation and neural repair. 2017;31(3):240-9.
25. Kenis-Coskun O, Giray E, Eren B, Ozkok O, Karadag-Saygi E. Evaluation of postural stability in children with hemiplegic cerebral palsy. Journal of physical therapy science. 2016;28(5):1398-402.
26. Labaf S, SHAMSODDINI A, HOLLISAZ MT, SOBHANI V, Shakibaee A. Effects of neurodevelopmental therapy on gross motor function in children with cerebral palsy. Iranian journal of child neurology. 2015;9(2):36.
27. Dewar R, Love S, Johnston LM. Exercise interventions improve postural control in children with cerebral palsy: a systematic review. Developmental Medicine & Child Neurology. 2015;57(6):504-20.
28. Verschuren O, Peterson MD, Balemans AC, Hurvitz EA. Exercise and physical activity recommendations for people with cerebral palsy. Developmental Medicine & Child Neurology. 2016;58(8):798-808.
29. El Shemy SA. Trunk endurance and gait changes after core stability training in children with hemiplegic cerebral palsy: A randomized controlled trial. Journal of back and musculoskeletal rehabilitation. 2018;31(6):1159-67