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ORIGINAL ARTICLE

Effect of Whole Body Vibration Therapy on Spasticity, Balance, Fine and Gross Motor Functions in Patients with Spastic Cerebral Palsy: A Systematic Review of RCTs

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ABSTRACT

Context: Cerebral palsy is condition that is caused by neurological damage, which leads to problems in the somatosensory systems. It can cause spasticity in the involved muscles leading to poor function, limitations in range of motion, poor balance and coordination. Therapeutic use of whole-body vibration therapy for the management of the mentioned symptoms have been reported in the literature. This review study examines the effect of whole-body vibration on spasticity, balance and function and summarizes the effective protocols of whole-body vibration therapy for the cerebral palsy patients.

Methods: Three following databases were searched comprehensively: Pubmed, PEDro and Cochrane. The selection criteria for the research papers were based on; (1) human studies with Patient-Intervention-Comparison-Outcomes-Study design (PICOS) method, according to which, P = spastic cerebral palsy; I = Whole Body Vibration; C = comparison with conventional/traditional physiotherapy; O = dynamic balance, spasticity, functional balance, fine and gross motor hand function, hand grip strength, Balance Quantification and Range of Motion; and S = Randomized controlled trials, (2) Published in English Language (3) Full Text Available (4) The PEDro scale on which the score is greater than 4 out of 10.

Results: Nine RCTs were included based on the inclusion criteria. This systematic review showed that whole body vibration therapy can produce positive therapeutic effects on spasticity, balance, fine and gross motor function, muscle strength and range of motion. This modality can be used independently or in combination with the conventional physical therapy. No harm has been reported in the literature.

Conclusion: It can be concluded that whole body vibration therapy is safe, cost effective and fairly simple therapeutic modality that can be used at home or in clinical settings to produce a significant change in spasticity, static and dynamic balance, motor function and range of motion.

Keywords: Balance, Cerebral Palsy, Motor Function, Spasticity, Whole body vibration therapy

INTRODUCTION

Cerebral palsy (CP) is a permanent neurological condition which results in pathological tone in the muscles and altered kinesthetic sense. This abnormal tone and afferent information lead to activity limitation, postural dysfunction and movement disorders. The main cause of this condition is the damage to the child's brain in the prenatal through neonatal period (1).

Whenever there is any damage or serious pathological condition affecting the central nervous system, the patients develop abnormalities of sensorimotor system. There will be altered sensory information going to the brain. In such patients there can be growth retardation, muscle imbalances, poor postural control, poor coordination of the movements, pathological gait, which affects the quality of life and can result in even noticeable asymmetrical changes in the skeletal system as well. Children affected by such conditions like cerebral palsy, may develop serious orthopedic, neurological and behavioral problems as well (2). Cerebral palsy also affects fine and gross motor functions including speech. The muscular tone in some muscles which are most commonly the antigravity muscle is relatively high as compared to the other muscle. This mismatch between the tone results in poor control of the voluntary movements. Even the most basic movements like head rotation, flexion and extension becomes difficult to perform (3).

Because of mismatch of muscular strength in the muscles the movements are not smooth and of poor quality. It has also been reported that there is delayed onset of muscle activation. This delay is considered to be disturbed proprioceptive feedback to the higher centers. The activities of daily living are also affected in such population (4, 5). Cerebral palsy children are not only affected physical but they are also four times more likely than the children of the same age to develop behavioral and emotional lability. It is important to consider a multidisciplinary or holistic approach while developing the treatment plan for these patients (6)

Cerebral pals can be categorized based on motor disturbances (spastic, dyskinetic, ataxic, hypotonic and hypertonic, among these the spastic cases are almost 80%), extremity involved (monoplegic, hemiplegic, diplegic and quadriplegic), and location of the lesion in the brain (cerebellum, pyramidal tract, extrapyramidal tract and cerebral cortex) (7). In spastic diplegic patients both lower extremities are more involved as compared to the upper extremities, so the ability to walk is affected more (8). Previous studies have indicated that spasticity, Poor balance control and poor muscle strength are known to be an important causative factor that leads to movement dysfunction in CP. There is a progressive muscular atrophy and weakness, this may result in the development of the myogenic and sometime arthrogenic contractures of multiple joints of the upper and lower extremity. The most important factors that contributes to pathological gait are muscle weakness and poor proprioceptive feedback (8-10).

Moreover, numerous factors such as a biomechanical restraint significantly affects the patient's capability to adjust their posture, maintain balance or able to perform different functional tasks. However a poor posture pattern in CP children is the maladaptation and inappropriate recruitments of the antagonist muscles along with the top down control of postural muscles (11). Muscle strengthening training is a substantial strategy to prepare weak muscles which are responsible for debilitated walking capacity similar to quadriceps femoris muscle in the spastic CP. Whole-body vibration (WBV) therapy was recommended as a novel therapeutic modality in rehabilitation for the management of static and dynamic balance, functional performance and gross motor function (12).

WBV is a neuromuscular training technique that was primarily used by elite players to improve their strength and speed (13). WBV therapy is a high frequency, low magnitude modality , with vibrating platform that is extensively used for the improvement of physical fitness (14). The application of this technique is usually applied in standing position on a vertical oscillating platform that changes the gravitational forces on body and displaces the individual. Whereas WBV is used to stimulate the natural stretch reflex of body and subsequently causes the muscle contractions.

Additionally, it was suggested that muscular vibration stimulates the principal endings of the muscle spindle Ia afferent, which cause excitement of alpha motor neurons, motor unit contractions as a results a tonic muscle contraction is produced (15).

The WBV therapy is performed on an oscillating platform with the subject's body in standing position and platform vibrates horizontally between the frequency range of 10 to 25 Hz. This helps to stimulates the muscle spindles primary endings and activation of motor neurons and cause muscle contractions, as same as tonic vibration reflex. In comparison to high frequency 40 Hz which increases the muscle tone, low frequency therapy reduces the muscle tone. Hence, WBV therapy increases the muscle strength and muscle force that cause rapid enhancements in neuromuscular capacities and also have positive effects on the muscle performance (16). WBV therapy improves the intramuscular and intermuscular coordination by producing high-frequency muscle contractions of the both agonists and antagonists in neuro-muscular system. The stretch reflex produce by WBV therapy is effective in improving balance control and muscle endurance. This mainly enhance the power in individuals with motor impairments (10, 17).

A meta-analysis done by Saquetto M et al showed that WBV might improve physical functions and gait speed in cerebral palsy children. They also suggested that this technique could be considered for the inclusion in rehabilitation of CP. Overall focus of this study was on gait speed and standing so it failed to generate a conclusive recommendation because of heterogeneity and less sample size (12). A systematic review done by Duquette SA et al exposed that WBV has the therapeutic effects in symptomatic pain relief in CP patients. They revealed that WBV improves muscle coordination, strength and spasticity. Those studies included in this systematic review clearly focuses on WBV as a primary intervention; this study did not include similar interventions in relation to frequency, interval and duration. This also failed to generate a conclusive recommendation because small sample size and heterogeneity of the population (18).

A systematic review by Alashram AR et al revealed that there was weak evidence on short term effects of WBV on spasticity, posture, balance and mobility. Beside this the long-term positive effects of WBV on mobility in neurological disorders. The optimal WBV therapy parameters in treatment of neurological disorders patients remain unclear (19). Therefore, no strong evidence exists regarding the efficacy of WBV especially on static and dynamic balance, spasticity, hand function and range of motion. This study aimed specifically to discuss the effects of WBV in spastic cerebral palsy in regard to outcome measures of static and dynamic balance, range of motion and spasticity. Thus, this systematic review will summarize the heading of an effectiveness of intervention protocol for patients with spastic CP.

METHODS

Eligibility Criteria: In present review the research study was confined to the (no of RCT should be mentioned) Randomized control trail from the year January 2000 till September 2022. The selection criteria for the research papers were based on; (1) human studies with Patient-Intervention-Comparison-Outcomes-Study design (PICOS) method (20), according to which, P = spastic cerebral palsy; I = Whole Body Vibration; C = comparison with conventional/traditional physiotherapy; O = dynamic balance, spasticity, functional balance, fine and gross motor hand function, hand grip strength, Balance Quantification and Range of Motion; and S = Randomized controlled trials, (2) Published in English Language (3) Full Text Available (4) The PEDro scale on which the score greater than 4 out of 10.

Search Strategy and Quality assessment: An extensive and thorough search was executed using the following databases PubMed, PEDro and Cochrane from the above-mentioned duration. Two reviewers independently (i.e. Dr. Rabia & Dr. Nouman) carried out selection and extraction for paper and data respectively that fit to inclusion criteria. In the case of disagreement between the reviewers, a third reviewer (Dr. Syed Ali) was involved. Preferred Reporting Items for Systematic Reviews (PRISMA) guideline were used to develop the review framework as given in the Figure 1, the searching approach was planned by linking the most suitable scientific key terms along with Boolean operators to review objectives as given in the Table 1.

Critical appraisal of the selected researches was done using the PEDro scale as shown in Table 2 that consists of 11 items encompassing external validity (item 1), internal validity (items 2 to 9), and statistical reporting (items 10 to 11) (21). The scoring was as follows; 0-3= poor, 4-5= Fair, 6-8= Good and 9-10= Excellent.

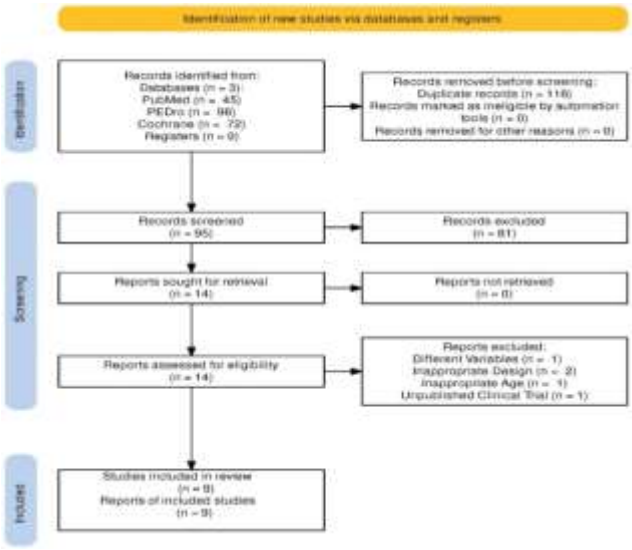

Figure 1: Showing preferred reporting items for systematic review

Table 1: Search Strategies used in the PubMed

Sr. No	Search Terms
1.	Vibration
2.	Vibration OR Whole Body Vibration OR whole body vibration therapy OR whole body vibration training OR vibration training OR vibration therapy OR vibration training therapy OR vibratory OR vibratory stimulation OR vibratory stimulation therapy OR local vibration therapy OR plantar vibration OR weight bearing vibration therapy OR non weight bearing vibration therapy OR palmar vibration
3.	#1 OR #2
4.	Cerebral palsy
5.	Cerebral palsy OR CP OR Little disease OR Little's disease OR Spastic Cerebral Palsy OR spastic hemiplegia OR spastic hemiplegic OR spastic diplegia OR spastic diplegic OR spastic paraplegia OR spastic paraplegic OR infantile palsy OR infantile cerebral palsy OR infantile cerebral palsies OR Spasticity OR Hypertonicity OR Muscle Hypertonicity
6.	#4 OR #5
7.	Balance
8.	Balance OR dynamic balance OR Postural Equilibrium OR Postural balance OR Postural control OR postural control children OR postural balance children OR Musculoskeletal Equilibrium OR Gait OR walking OR Ambulation OR gross motor function OR motor function OR lower extremity function OR Leg function OR fine motor function OR fine motor skills OR fine motor skills children OR hand function
9.	#7 OR #8
10.	#3 AND #6 AND #9
11.	#10 AND [humans]/lim AND [english]/lim [2000–2022]/py.

Table 2: PEDro score of the included studies

Study	2	3	4	5	6	7	8	9	10	11	Total Score	Quality Status
Adaikina (2020)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	8	Good
El-Shamy (2014)	Y	Y	Y	Y	N	Y	Y	N	Y	Y	8	Good
M. M. Ibrahim (2014)	Y	Y	Y	N	N	N	Y	Y	Y	Y	7	Good
Ana Katusic (2013)	Y	N	Y	N	Y	Y	Y	Y	Y	Y	8	Good
Myung-Sook Ko (2016)	Y	N	Y	N	N	Y	Y	Y	Y	Y	7	Good
J. Ruck (2010)	Y	Y	Y	N	N	N	Y	Y	Y	Y	7	Good
Fatih Tekin (2021)	Y	N	Y	N	N	N	Y	Y	Y	Y	6	Good
Teeraporn Tupimai (2016)	Y	N	Y	N	N	N	Y	Y	Y	Y	6	Good
Marianne Unger (2013)	Y	N	Y	Y	N	Y	Y	Y	Y	Y	8	Good

RESULTS

A total of 213 studies (PubMed= 45, PEDro= 96, Cochrane= 72) were identified based on the inclusion criteria mentioned above. The next step was to remove the duplicate studies which identified 118 as duplicate. The first phase of screening removed 95 studies. Only 14 studies were sought to retrieval and were subjected to detailed review in the phase 2. In the second phase of screening 5 studies were removed due to different variables (n=1), inappropriate study designs (n=2), inappropriate age (n=1) and unpublished clinical trial (n=1) Table 3. We included only 9 studies for this systematic review. Each study was analyzed on the aspects of selection, performance and other bias, the characteristics of the studies are shown in Table 4.

Table 3: Reasons for excluding articles following evaluation of full text.

Study	Exclusion Reason
Byoung-Kwon Lee (2013)	Different variables other than the search terms
Myung-Sook Ko (2015)	Non-Randomized control trail
C. Stark (2016)	The age of the participants were different from the current criteria
Punnee (2021)	Unpublished Clinical Trail
S.J. Yun et al (2015)	Cross over design and full text not available

Table 4: Characteristics of studies Included

Study	Study Design	Population	Interventions	Outcomes
Adaikina (2020)	Randomized Clinical Trial	Cerebral Palsy Children 5-12 Years	I1: Two Vibration Frequency Group 20 Hz I2: Vibration Frequency Group 25 Hz C: None	Mobility (6MWT), Body Composition, Muscle Power, Physical Activity, Balance, Gross Motor Function & Quality of Life
El-Shamy (2014)	Randomized Controlled Trial	Diplegic Cerebral Palsy Children 8-12 Years	I: Whole body Vibration C: Control	Knee Extensors Muscle Strength (Biodex Isokinetic Dynamometer), Balance (Biodex Balance System)
M. M. Ibrahim (2014)	Randomized Controlled Trial	Spastic Diplegic Cerebral Palsy Children 8-12 Years	I: Whole Body Vibration C: Control	Knee Extensors Muscle Strength (Hand Held Dynamometer) Spasticity of Hip Adductors, Knee Extensors, Ankle Plantar Flexors (Modified Ashworth Scale) Walking Speed (6MWT) Walking Balance (TUG) Gross Motor Function (GMFM-88)
Ana Katusic (2013)	Randomized Controlled Trial	Spastic Cerebral Palsy Children 4-6 Years	I: Conventional PT + Whole body Vibration C: Conventional PT	Elbow and Wrist Flexors, hip Adductors, Knee Extensors and Ankle Plantar Flexors Spasticity (Modified Ashworth Scale) Gross Motor Function Measure (GMFM-88)
Myung-Sook Ko (2016)	Randomized Controlled Study	Diplegic and Hemiplegic Cerebral Palsy Children 7-13 Years	I: Traditional PT + Whole Body Vibration C: Traditional PT	Knee and Ankle JPS (Tilt meter) Postural Balance Test (Tetrax Interactive Balance System) Gait Analysis 2-D (Opto Gait System)
J. Ruck (2010)	Randomized Controlled Pilot Study	Cerebral Palsy Children 5-12.9 Years	I: Conventional PT + Whole Body Vibration C: Conventional PT	Gross Motor Function Measure (GMFM-88) Walking Speed (10 Meter Walk Test) Bone Densitometry BMD (Dual Energy X-Ray Absorptiometry)
Fatih Tekin (2021)	Randomized Controlled Experiment	Hemiparetic Cerebral Palsy Children 6-18 Years	I: Whole Body Vibration + Conventional PT C: Conventional PT	Gross Motor Function Measure (GMFM-88) Spatio-Temporal Gait Analysis (LEGSys) Balance (Sport KAT 550)
Teeraporn Tupimai (2016)	Randomized Two-Period Cross Over Trial	Spastic Cerebral Palsy Children 6-18 Years	I: Passive Muscle Stretching + Whole Body Vibration C: Passive Muscle Stretching	Hip Adductors, Quadriceps, hamstrings and Soleus Spasticity (Modified Ashworth Scale) Lower Limb Muscle Strength and Balance Ability (Five times sit-to-stand test FTSST) Balance (Pediatric Balance Scale)
Marianne Unger (2013)	Randomized Control Trial (Cross Over Design)	Spastic or Diplegic Cerebral Palsy Children 6-19 Years	I: Exercise on Whole Body Vibration Platform	Functional Ability (1-Minute Walk Test) Postural Analysis (VICON Motion Analysis System) Abdominal Muscle Thickness of External Oblique, Internal Oblique, Rectus Abdominis and Transversus Abdominis (Ultrasound Simens Accusonix X150) Abdominal Muscle Strength (Sit Ups in One Minute)

DISCUSSION

The current review gives a viewpoint of the effectiveness of Whole body vibration therapy on spastic cerebral palsy. Overall, all of the selected researches concluded that WBV was a new, safe and effective therapeutic modality. WBV was recently introduced as a novel way to improve static and dynamic balance, spasticity, muscle strength, motor skills, proprioception, gross motor skills, posture and gait among participants with cerebral palsy. Included studies conclude that WBV was a practical and novel method of improving overall performance of cerebral palsy children (9). In WBV therapy the individual has a full body exposure to mechanical stimulus of low frequency and low amplitude through a vibrating platform. These oscillatory movements stimulate the muscle spindles and also generate nerve impulses which initiate the contraction of muscle same like tonic vibration reflex. WBV is a useful tool in the rehabilitation of the elderly also (12).

Its effects on improvement of balance, posture, gait and muscular strength have been studied; however, little work has done on WBV in children with spastic CP. Therefore, the current review is important because it investigates the WBV as a valuable modality in the rehabilitation of spastic CP children. The findings from different studies incorporated in this review also emphasized that WBV advances the understanding of vibration training as a therapeutic tool in CP children and also explain the ideal parameters of the intervention in term of duration and frequency for the improvement of outcomes (22).

This novel therapy in rehabilitation provides a paradigm shift in rehabilitation. It is of absolute significance that each of the patient's experiences in different health care services need (to) be considered while applying health care related services. Findings of included studies in systematic review addressed the safety, efficacy and feasibility of WBV in CP children. A study showed significant improvement in gait, gross motor function, balance, spasticity in both limbs, related to children's who only received traditional physical therapy treatment. So it was evident that combined WBV with addition of conventional physiotherapy treatment shows relatively more improvement (23).Previous studies have also discussed potential effects of WBV in combination therapy. WBV can improve walking speed, muscle strength, spasticity and gross motor functions related to walking and standing without any negative effects (8, 24).

Previous related studies have reported the favorable effects for the first time addressed the safety, feasibility and efficacy of home based WBV therapy in CP. Studies showed that combination of WBV and passive muscle stretching could increase the muscle strength and balance control and decrease the spasticity in adolescents and children with CP. WBV could be an alternate additional treatment to the muscle stretching for the both home therapy and clinical therapy programs for adolescents and children with CP (25).

The current study review exposed that in the included studies, heterogeneity exists in terms of mode of delivery and outcome measures etc., but there is persistent pattern of encouraging the use of WBV therapy and supporting its effectiveness in rehabilitation. The main point of this systematic review is that (the) evidence has summarized in regards to the utilization of WBV for improvement of spasticity, balance, gross motor function, gait and promoting long term goal of muscle strength in CP children. This review will provide a clear picture for the physiotherapists treating or managing cerebral palsy children to utilize WBV as an alternative or adjunct therapeutic modality. Limitations of the current review are that only studies with English-language were included and unpublished or studies with different designs were excluded. Future research is needed to evaluate the utilization of WBV for specific types of CP and using high-quality research methodologies.

CONCLUSION

Whole body vibration alone or in combination with conventional physical therapy can reduce spasticity, improve static and dynamic balance, fine and gross motor function in the spastic cerebral palsy children. Hence it can be considered as a valuable, low cost and low risk treatment intervention that can be done at home or in the clinical settings. To this point of time, the whole-body vibration therapy has been applied to the lower extremity of the patients.

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Conflict of Interest: None

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REFERENCES

1. Patel DR, Neelakantan M, Pandher K, Merrick J. Cerebral palsy in children: a clinical overview. Translational pediatrics. 2020;9(Suppl 1):S125.
2. Günel MK, Türker D, Ozal C, Kara OK. Physical management of children with cerebral palsy. Cerebral Palsy-challenges for the future: IntechOpen. 2014:29-72.
3. Das SP, Ganesh GS. Evidence-based approach to physical therapy in cerebral palsy. Indian journal of orthopaedics. 2019;53(1):20-34.
4. Wang T-H, Peng Y-C, Chen Y-L, Lu T-W, Liao H-F, Tang P-F, et al. A home-based program using patterned sensory enhancement improves resistance exercise effects for children with cerebral palsy: a randomized controlled trial. Neurorehabilitation and neural repair. 2013;27(8):684-94.
5. El-Basatiny HMY, Abdel-Aziem AA. Effect of backward walking training on postural balance in children with hemiparetic cerebral palsy: a randomized controlled study. Clinical rehabilitation. 2015;29(5):457-67.
6. Gilson K-M, Davis E, Reddihough D, Graham K, Waters E. Quality of life in children with cerebral palsy: implications for practice. Journal of child neurology. 2014;29(8):1134-40.
7. Li N, Zhou P, Tang H, He L, Fang X, Zhao J, et al. In-depth analysis reveals complex molecular aetiology in a cohort of idiopathic cerebral palsy. Brain. 2022;145(1):119-41.
8. Cheng H-YK, Yu Y-C, Wong AM-K, Tsai Y-S, Ju Y-Y. Effects of an eight-week whole body vibration on lower extremity muscle tone and function in children with cerebral palsy. Research in developmental disabilities. 2015;38:256-61.
9. El-Shamy SM. Effect of whole-body vibration on muscle strength and balance in diplegic cerebral palsy: a randomized controlled trial. American journal of physical medicine & rehabilitation. 2014;93(2):114-21.
10. Ibrahim MM, Eid MA, Moawd SA. Effect of whole-body vibration on muscle strength, spasticity, and motor performance in spastic diplegic cerebral palsy children. Egyptian Journal of Medical Human Genetics. 2014;15(2):173-9.
11. Ziab H, Mazbouh R, Saleh S, Talebian S, Sarraj AR, Hadian M-R. Efficacy of Virtual Reality-Based Rehabilitation Interventions to Improve Balance Function in Patients with Cerebral Palsy: A Systematic Review and Meta-analysis of RCTs. Archives of Neuroscience. 2022;9(2).
12. Saquetto M, Carvalho V, Silva C, Conceição C, Gomes-Neto M. The effects of whole body vibration on mobility and balance in children with cerebral palsy: a systematic review with meta-analysis. Journal of musculoskeletal & neuronal interactions. 2015;15(2):137.
13. Rittweger J. Vibration as an exercise modality: how it may work, and what its potential might be. European journal of applied physiology. 2010;108(5):877-904.
14. Högler W, Scott J, Bishop N, Arundel P, Nightingale P, Mughal MZ, et al. The effect of whole body vibration training on bone and muscle function in children with osteogenesis imperfecta. The Journal of Clinical Endocrinology & Metabolism. 2017;102(8):2734-43.
15. Dickin D, Faust K, Wang H, Frame J. The acute effects of whole-body vibration on gait parameters in adults with cerebral palsy. J Musculoskelet Neuronal Interact. 2013;13(1):19-26.
16. Hegazy RG, Abdel-aziem AA, El Hadidy EI, Ali YM. Effects of whole-body vibration on quadriceps and hamstring muscle strength, endurance, and power in children with hemiparetic cerebral palsy: a randomized controlled study. Bulletin of Faculty of Physical Therapy. 2021;26(1):1-10.
17. Han Y-G, Lee S-W, Yun C-K. The immediate influence of various whole-body vibration frequency on balance and walking ability in children with cerebral palsy: a pilot study. Journal of exercise rehabilitation. 2019;15(4):597.
18. Duquette SA, Guiliano AM, Starmer DJ. Whole body vibration and cerebral palsy: a systematic review. The Journal of the Canadian Chiropractic Association. 2015;59(3):245.
19. Alashram AR, Padua E, Annino G. Effects of whole-body vibration on motor impairments in patients with neurological disorders: a systematic review. American journal of physical medicine & rehabilitation. 2019;98(12):1084-98.
20. Eriksen MB, Frandsen TF. The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: a systematic review. Journal of the Medical Library Association: JMLA. 2018;106(4):420.
21. Cashin AG, McAuley JH. Clinimetrics: Physiotherapy Evidence Database (PEDro) Scale. Journal of Physiotherapy. 2020 2020/01/01/;66(1):59.
22. Adaikina A, Hofman PL, Gusso S. The effect of side-alternating vibration therapy on mobility and health outcomes in young children with mild to moderate cerebral palsy: design and rationale for the randomized controlled study. BMC pediatrics. 2020;20(1):1-10.
23. Tekin F, Kavlak E. Short and Long-Term Effects of Whole-Body Vibration on Spasticity and Motor Performance in Children With Hemiparetic Cerebral Palsy. Perceptual and Motor Skills. 2021;128(3):1107-29.
24. Ko M-S, Doo J-H, Kim J-S, Jeon H-S. Effect of whole body vibration training on gait function and activities of daily living in children with cerebral palsy. International Journal of Therapy And Rehabilitation. 2015;22(7):321-8.
25. Tupimai T, Peungsuwan P, Prasertnoo J, Yamauchi J. Effect of combining passive muscle stretching and whole body vibration on spasticity and physical performance of children and adolescents with cerebral palsy. Journal of physical therapy science. 2016;28(1):7-13.