Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Effects of Vestibular Stimulation Techniques on Gross Motor Function of Children with Cerebral Palsy- A Systematic Review

Kumari Ankna[1*] and Singh Sandeep[2]

[1*]Student of Master of Physiotherapy, Dept. of Physiotherapy, Punjabi University, Patiala- 147001, Punjab, INDIA.
[2]Assistant Professor, Dept. of Physiotherapy, Punjabi University, Patiala, Punjab, INDIA.

ABSTRACT

Title: Effects of vestibular stimulation techniques on gross motor function of children with cerebral palsy- A Systematic Review. **Aims and objective**: Systematically review the articles to evaluate the efficacy of vestibular stimulation techniques on gross motor function of children with cerebral palsy. **Methodology**: A systematic review was performed using PRISMA methodology and different electronic databases such as Pub Med, Medline, EMBASE (OVID-Elsevier), Cochrane library, Google scholar, Google and PEDro. The search focused on studies to document the effects of vestibular stimulation techniques on gross motor function of children with CP. **Results**: Total 27 studies were found out of which 11 studies were included in literature review. **Conclusion**: All analyzed studies reported improvement in gross motor function of children with CP through vestibular stimulation. Maximum studies have shown that vestibular stimulation in the age group of 3-10 years given along with conventional physiotherapy seems to be more effective when compared with treatment given with alone conventional physiotherapy.

KEYWORDS: Cerebral Palsy, Brain Injury, Intervention Therapy, Vestibular Stimulation, Vestibular Rehabilitation Therapy; Gross Motor Function.

***Corresponding author**

Dr. Ankna Kumari

Department of Physiotherapy,

Punjabi University Patiala, 147001, Punjab,INDIA.

Email: agarg.ankna@gmail.com, Mob No – 09625537098

BACKGROUND

Many children with cerebral palsy have difficulty in walking which demonstrate poor balance control. Constellations of disorders are observed in children with CP such as cognition and perception impairments, communication and presence of seizures that significantly impair their gross motor function.[6]Gross motor functions are associated with physical activities and functions that develop from birth onwards as children needs to develop their muscles to hold neck upright, to sit, crawl, walk, climb stairs and run.[17]Development of proper gross motor function is major issue in children with cerebral palsy.[12]

Researchers has suggested that better outcomes in cerebral palsy can be attained by comprehensive management of its impaired gross motor function such as sitting, standing, walking.[8]Therefore there needs to be provision of information about most suitable therapy for enhancing their gross motor function.[1]

Vestibular stimulation is often employed in children with cerebral palsy and has been found to be effective in managing their manifestations.[11]Vestibular stimulation helps child to find the optimal arousal sate that develops motor skills and has excitatory as well as inhibitory effects.[5] The studies have suggested that vestibular stimulation contributes to improve motor skills, reflex integration and enhanced verbalization and thus helps in improvement of developing gross motor function.[16]Stimulation of vestibular input has great impact on dynamic balance at almost 65% as compare to static balance therefore fewer portions of visual and proprioceptive inputs. Dynamic balance depends upon vestibular stimulation.[10]

Physiotherapists accentuate the need for evidence-based practice as according to requirements. In earlier reviews administration of various PT interventions and its effects for children with CP has seen which mainly focus only one kind of stimulation such as hippo therapy, modified suit therapy and stimulation on swiss ball, wobble board, sensory integration therapy, horseback riding. Generally, it is difficult to determine owing to the lack of high-quality research in children with CP the efficacy and effects of various physical therapeutic interventions.So, the effects of vestibular stimulation are not consensual in the literature, which deserve some concern. No systematic review has been performed to investigate the effects of vestibular stimulation on gross motor function of children with cerebral palsy.

Present study intends to review the existing literature to have overview of Effects of Vestibular Stimulation techniques on Gross Motor Function of Children with Cerebral Palsy.

METHODOLOGY

This review was planned and conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Mets-Analysis) guidelines. Relevant articles in English were retrieved through a search on electronic databases-Pub Med, Medline, EMBASE (OVID-Elsevier), Cochrane library, Google scholar, Google and PEDro. Key search terms were cerebral palsy; brain injury, intervention; therapy, vestibular stimulation; vestibular rehabilitation therapy, gross motor function. Research studies published in English language, were included in the present study.

RESULTS

Total 27 studies could be retrieved, out of which 11 studies have been included in systematic literature review. Studies retrieved are being presented in tabular form (**table.1**) describing, about study details such as authors/year, title /study design, sample size, Intervention, outcome measures, results and conclusion of studies.

PRISMA

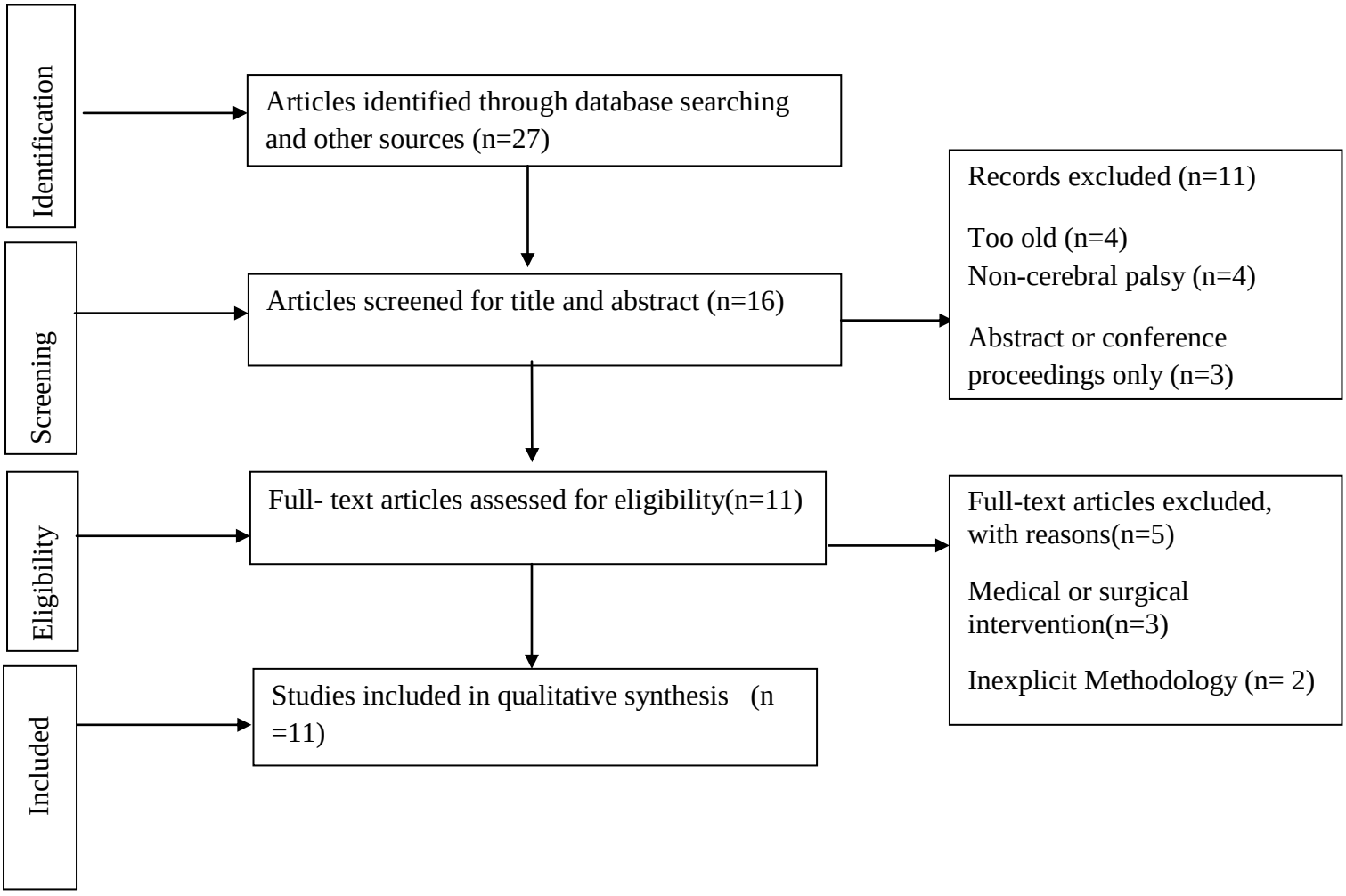

Table1.Studies on various vestibular stimulation techniques

Study details Author/Year	Title/Study Design	Sample size	Intervention	Outcome measures	Results	Conclusion
Asady and Nichols-Larsen (2004)	To study the effect of VST on gross motor functional development of children with cerebral palsy	Children with CP (n=10, aged2.3 to 6.8 yrs.)	Children (n=10) received VST via hippotherapy once a week for 10 weeks.	GMFM and PEDI	Statistically significant improvement in PEDI and total GMFM scores was observed following 10 weeks of VST application	VST given through hippotherapy showed positive effect on the functional motor performance of children with cerebral palsy
Elsahzly and Al-Wahhabi (2005)	To evaluate the effect of VST program on motor function in children with spastic cerebral palsy	Children with spastic cerebral palsy aged between 1-5 yr. N= 30 Group A- 15(male- 10, female- 5) Group B- 15 (male- 8, female- 7)	**Group A-** VST provided on hammock swing, toy horse, scooter board, rocking board for 10 minutes plus traditional physiotherapy. **Group B-** received traditional physiotherapy that includes active and passive ROM exercises; NDT, stretching, mat exercises, balance exercises, stairs climbing, and gait training.	GMFM and PEDI	Significant improvement in the gross motor skills and functional activities of VST group.	Six weeks of VST along with traditional therapy is more effective than traditional physiotherapy alone.
Shamsoddini and Hollisaz, (2009)	Effect of sensory integration therapy on gross motor function in children with cerebral palsy/ Experimental study	24 diplegic CP children, 2-6 yrs.	Sensory integration therapy plus vestibular stimulation	Gross motor function measurement (GMFM 88)	Gross motor function in children of the case group improved significantly better that in the control group.	SIT training significantly had positive effect on gross motor function in the children with diplegic spastic CP
Honkavaara and Rintala, (2010)	The Influence of Short Term, Intensive Hippotherapy on Gait in Children with Cerebral Palsy	3 diplegic CP children, 12-14 yrs.	Hippotherapy along with conventional therapy	Quantitative gait parameters	The results indicated Possibility to improvefunctional gait in children with cerebral palsy through short-term hippotherapy	The long-term effects of hippotherapy are a topic to be studied in the future

Androwis et al, (2013)	To verify the effects of VVS on changes in muscle tone of individuals with neurological disabilities.	A 35-year-old CP male subject	VVS on mechanical chair. **Duration-** 15 min of vertical oscillation with 3 inches amplitude and 2 Hz frequency.	Waternberg Pendulum Knee Drop test (PKD)	The VVS showed noticeable effect on PKD test and decrease in spasticity.	There was improvement in muscle tone of individuals.
Androwis (2014)	Effect of VVS on muscle tone, spasticity and dystonia in individuals with neurological impairments	7 Children with cerebral palsy	VVS with 2 Hz frequency and amplitude of 7.5 cm.	PKD test	VVS showed improvement in children with spastic CP.	The spasticity of CP children gets reduced.
Park et al, (2014)	Effects of Hippotherapy on Gross Motor Function and Functional Performance of Children with Cerebral Palsy, Experimental study	45 spastic CP children, 3-12 yrs.	Hippotherapy for one group and conventional physiotherapy for control group	The GMFM 66 and 88 and the Pediatric Evaluation of Disability Inventory-Functional Skills Scale (PEDI-FSS)	After the 8-weeks of intervention, Mean GMFM-66 and 88 scores were significantly improved in both groups	There was significant improvement in PEDI-FSS scores suggests that hippotherapy may be useful to increase the functional performance of children with CP.
Hosseini et al, (2015)	Investigating the Effects of Vestibular Stimulation on Balance Performance in Children with Cerebral Palsy: A Randomized Clinical Trial Study	20 cerebral palsy spastic children, 3-10 yr.	Vestibular stimulation along with conventional physiotherapy	Centre of pressure parameters	Wilcoxon Test showed significant difference in the velocity parameter; eyes open (P=0.012) and eyes closed	Children with vestibular stimulation were able to change and control COP displacement faster than other.
Kwon et al, (2015)	Effect of Hippotherapy on Gross Motor Function in Children with Cerebral Palsy: A Randomized Controlled Trial	92 children with cerebral palsy, aged 4-10 yrs.	Hippotherapy (30 minutes twice weekly for 8 consecutive weeks)	Gross Motor Function Measure (GMFM)-88, GMFM-66, and Pediatric Balance Scale	GMFM-66 and 88 and GMFM dimensions B, C, D, and E increased significantly in the hippotherapy group.	Hippotherapy positively affects gross motor function and balance in children with CP of various functional levels.
Shahanawaz et al, (2015)	Effect of Swiss Ball on Balance in Children with Spastic Diplegia/ Case study	1 male diplegic CP child, 5 year	The Vestibular stimulation exercises using Swiss ball	GMFM-88, PBS	There was increase in GMFM-88 scoring after vestibular stimulation exercises	The study was analyzed on gross motor components which shows improvement in the Measured by using the GMFM-88

Kim et al, (2017)	To observe the effects of VST provided through exercises on swiss ball on static and dynamic balance of children with CP	Children with cerebral palsy aged between 3-14 years. N=7	All children received VST in form of swiss ball in sitting (up-down, to-fro and spinning movements) and in prone position (to and fro sway) with extension of upper limbs for 5 min. **Duration:** One treatment session for 20 minutes.	ID Standing Time test and Modified TUGT	Significant improvement in the ID standing and modified TUGT of all the participants after VST.	Vestibular stimulation administered through Swiss ball had positive effects on both static and dynamic balance of children with CP

Abbreviations: COP, center of pressure; CP, cerebral palsy; THR, therapeutic horse riding; GMFM, gross motor function measure; PEDI, pediatric evaluation of disability inventory; PBS, pediatric balance scale; TUG, time up and go; PEDI-FSS, Pediatric Evaluation of Disability Inventory-Functional Skills Scale; ID standing, independent standing; Modified TUGT, modified time up and go test; VVS, vertical vestibular stimulation.

DISCUSSION

This systematic review analyzed 11 articles and searched those databases that include relevant articles between the years of 2004-2016. Different studies of this review focused on benefits of different vestibular stimulation techniques on gross motor function of children with cerebral palsy. In this systematic review most of the studies used GMFM-66 and 88 as outcome measure and showed positive results of GMFM 88 and its dimensions, rest studies used different gait parameters as outcome measure. PKD and PEDI FSS score also showed good results.

Studies related to hippo therapy found significant improvement in PEDI FSS score and on GMFM which suggest that hippo therapy is useful in increasing functional performance, gross motor function and balance performance in children with cerebral palsy.[7,9,13] Studies of vertical vestibular stimulation demonstrated reduction in spasticity and muscle tone but few concepts related to duration of stimulation, its frequency and age range were not much clear.[2,3,4]

Shamsoddini and Hollisaz, 2009, Shahanawaz et al., 2015 stated that sensory integration therapy and exercises on therapy ball had significant improvement on gross motor function in children with cerebral palsy.

In study of Hosseini (2016) and Elsahzly and Al-Wahhabi (2005), when vestibular stimulation was applied on balance and gross motor function of cerebral palsy children it seems that those children were able to maintain stability and control COP displacement faster and easily than others. The significant improvement was found on gross motor function of children with cerebral

palsy when vestibular stimulation was applied with traditional physiotherapy. Whereas Kim et al (2017) observed that vestibular stimulation when applied through therapy ball showed positive improvement on static and dynamic balance of children with cerebral palsy.

CONCLUSION

All analyzed articles reported improvement in gross motor function and gait parameters of children with cerebral palsy through vestibular stimulation. Maximum studies have shown that vestibular stimulation in the age group of 3-10 yrs. given along with conventional physiotherapy seems to be more effective when compared with treatment given with alone conventional physiotherapy. Most of the studies were done on small sample size but some studies showed that treatment sessions were less to show their effects on children with cerebral palsy and were done in multidisciplinary environment. The duration of stimulation was also not much understood as in mechanical stimulation. Future research is required to done on large sample size to show effects of vestibular stimulation techniques on gait parameters and to see its effects on muscle tone of children with cerebral palsy and to recruit this therapy as a part of intervention.

REFERENCES

1. Azubuike J C and Egbuonu I, "Socio-cultural and other Determinants of Health and Disease in the Tropics: Paediatrics and Child Health in a Tropical Region". (2nd Edn), African Educational Services, Owerri, Nigeria. 2007.
2. Androwis, G. J., Michael, P. A., Strongwater, A. and Foulds, R.A. "Evaluating the effect of mechanical vestibular stimulation on muscle tone and spasticity in Stroke survivors: A Pilot Study" *https://www.researchgate.net/publication/ 265376418.*2014
3. Androwis, G.J, Michael, P. A, Strongwater, A. and Foulds, R.A. "Alterations of neuromuscular signals as a result of vestibular stimulation". *In 6th International IEEE/EMBS conference on neural engineering (NER),* 2013; 1238-41.
4. Androwis, G.J, Foulds, R. A, Strong water, A and Stone, D. "Quantifying the effect of mechanical vestibular stimulation on muscle tone and spasticity", 2014; NEBEC IEEE 39th.
5. Bar-shalita, T., Goldstand, S., Hahn-Markowitz, J. and Parush, S. "Typical Children's Responsivity pattern of the Tactile and Vestibular systems". *American Journal of Occupational Therapy* .2005; 59(2): 148-156.
6. Bax, M., Goldstein, M. and Rosenbaum, P. " Proposed definition and classification of cerer alpalsy". Dev Med Child Neural; 2005; 47: 571-576.
7. Cherng, R., Liao, H., Leung, H. W. C. and Hwang, A. " The effectiveness of the rapeutichore

backridingin children with spastic cerebral palsy". Adapted Physical Activity Quarterly, 2004;21: 103-121.

8. Duggan, M. B. and Onalo, W."Cerebral Palsyin Nigeria-are port from Zaria". Ann Trop Paeatr; 1987; 2: 7-11.
9. Honkavaara M .and Rintala, P." Thein fluence of short term, in ten sive hippo the rapyonga in children with cerebral palsy". European Journal of Adapted Physical Activity, 2010; 3(2): 29-36.
10. Hosseini, S. A., Ghoochani, B. Z., Talebian, S., Pishyare, E., Haghgoo, H. A., Meymand R. M. and Zeinalzadeh. "Investigating the Effects of Vestibular Stimulation on Balance Performance in Children with Cerebral Palsy: A Randomized Clinical Trial Study". *Journal of Rehabilitation Sciences and Research*, 2015; 2: 41-46.
11. Jobling, A. and Cuskelly, M."Young people with Down syndrome: a preliminary in vestigati on of health knowledge and associated behavior". Journal of Intellectual and Developmental Disability, 2006; 31(4): 201-8.
12. Molnar G E and Goldon S V."Predictive Value of clinical signs for early prognostication of Motor Function in Cerebral Palsy". *Arch Phys Med Rehabil*, 1974; 57: 153-158.
13. Park, E. S., Rha, D., Shin, J. S., Kim, S. and Jung, S. "Effect so fhippo the rapyon gross moto rand functional performance of children with cerebral palsy". Yonsei Med Journal, 2014; 55 (6):1736-42.
14. Shahanawaz S.D., Tushar J., "Effect of swiss ball on balance in children with spastic diplegi". *International journal of Research in Paediatrics*, 2015; 1:8-11.
15. Shamsoddini A. R., Hollisaz M. T., "Effect of sensory Integration therapy on gross motor function children with cerebral palsy*". Iran J child Neurology*; 2009; 43-48.
16. Uyanik M, Bumin G and Kayihan H. "Comparison of different therapy approaches in children with Down syndrome". *Pediatrics International*.; 2003; 45: 68-73.
17. Williams, H. G., Pfeiffer, K. A., O'Neill, J. R., Dowda M., Mclver K. L., Brown W. H. and Pate R.R. June. "Motor Skills Performance". *Physical Activity in Preschool Children*. 2008; 16(6) : 1421-1426.