Research Article

Effects of additional functional strength training on mobility in children with hemiplegic cerebral palsy

Mamoona Tasleem Afzal[1]*, Saad Tariq[2], Muhammad Shakir Khan[3]. Zainab Tariq[2], Hadia Anjum[1], Sairish Sairien[1]

ABSTRACT

Background: Cerebral palsy (CP) affects the mobility and functional strength of children which leads to a decline in the quality of life of children. Functional strength training may considered objective-oriented to achieve some specific activity level and improve the overall performance of children.

Objective: To determine the effects of additional functional strength training on mobility in Children with Hemiplegic Cerebral Palsy (HCP).

Method: A single-blind randomized control trial (NCT05878756) was conducted on (n=40) children with hemiplegic cerebral palsy (HCP) at the National Institute of Rehabilitation Science, Islamabad. Children who can follow commands, not using assistive devices, and are not being treated in any other rehabilitation services were included. Children aged 4-12 years were recruited through a non-probability convenient sampling technique and a total of n=40 participants were randomly divided into Group A (n=20) which received conventional therapy along with functional strength training for 4 weeks, while Group B (n=20) only received conventional physical therapy. Both groups received intervention for 4weeks. The tools, Gross Motor Function Measure (GMFM) used for the severity of mobility and, five times sit-to-stand (FTSTS) to assess functional lower extremity strength, transitional movement balance, and fall risk in older adults, were used at baseline and post-treatment assessment.

Results: Both groups had improvements in strength and mobility but there was significant improvement in strength and mobility in Group A after 4th week ($p \leq 0.05$). However, no significant increase in the dimension of lying and kneeling was observed. Comparison within both groups for dimensions of walking, running, and jumping in both groups showed significant improvement ($p=0.045$). According to the result of GMFM scoring, a significant improvement in the interventional group (A) as compared to Group B ($p=0.003$).

Conclusion: It is concluded that additional functional therapy has a better outcome as compared to conventional therapy on mobility and strength of children with CP

Keywords Cerebral palsy; functional strength training; mobility; gross motor function measure; gross motor function classification system

Clinical Trials.gov Identifier: NCT05878756

Designation & Affiliation

1. Senior Lecturer, Institute of Rehabilitation Sciences, SZABMU, Islamabad, Pakistan
2. Lecturer, Yusra Institute of Rehabilitation Sciences, Islamabad, Pakistan
3. Physiotherapist, Riphah College of Rehabilitation Sciences, Islamabad, Pakistan

Citation

Afzal MT, Tariq S, Khan MS, Tariq Z, Anjum H, Sairien S. Effects of additional functional Strength Training on mobility in Children with Hemiplegic Cerebral Palsy. T Rehabili. J. 2023:07(04); 14-19 doi: 10.52567/trehabj.v7i04.8.

Article History

Received on: 05-07-2023
Revision on: 20-12-2023
Published on: 21-12-2023

Correspondence*

Mamoona Tasleem Afzal, Institute of Rehabilitation Sciences, SZABMU, Islamabad, Pakistan
E-mail: moona.dpt@gmail.com

INTRODUCTION

Cerebral palsy (CP) is a group of everlasting movement disorders [1]. In HCP; patients have unilateral impairment including, decreased ROM, strength, coordination, and sensation often affecting their bimanual activities and limiting their participation[2]. Moreover, infants with cerebral palsy may face difficulty in rolling over, sitting, crawling, or walking and might be labeled as delayed until or unless no prominent sign or symptom is observed[3]. In addition to this, children with cerebral palsy also have weak and stiff muscles and tremors[4].

strength training is important for children with cerebral palsy, which improves flexibility, postures, strength, and walking in children with cerebral palsy so that they can perform their ADLS and IADLs more easily and improve appearance, health, overall function, and general well-being[5,6]. Functional physical therapy is based on the supposition that an increase in motor impairments causes participation restrictions and a decrease in activity limitation[7,8,9]. Functional activities are learned by the repetitive practice of goal-oriented tasks in each functional situation. This approach instead of focusing on normality, it focuses on functionality[10]. In this way, the child must practice a given task functionally rather than normally[9, 10].

It is vital to research functional strength training in children with hemiplegic cerebral palsy. Since their motor deficiencies interfere with their day-to-day functioning, strength training, focuses on certain weaknesses and offers a comprehensive approach to recovery. Customized treatment regimens and an enhanced quality of life may result from this, supporting evidence-based therapies and more successful rehabilitation techniques. It was hypothesized that additional functional training significantly improves symptoms associated with hemiplegic spastic CP. So, the purpose of this study was to determine the effects of additional functional strength training on mobility in Children with Hemiplegic Cerebral Palsy (HCP).

METHODOLOGY

It was a single-blinded randomized control trial RCT conducted NCT05878756) at the National Institute of Rehabilitation Medicine Islamabad from April 2020 to September 2020 after the approval from the Yusra research ethical committee (Ref no: YIRS/02/20).

Children aged 4 -12 years, who can follow commands, not using assistive devices (GMFCS Level I & II), and not being treated in any other rehabilitation centre, were included. The children having fixed contractures underwent surgery, received Botulinum Toxin diagnosed cases of mental retardation due to seizure, and having acute illness and inflammation were excluded.

The participants were recruited through a non-probability convenient sampling technique. A total of n=40 samples was calculated by G*Power with the effect size small (0.273), with α error margin at 0.05. To avoid β error probability, the power (1- β) was set at 0.80% [6].

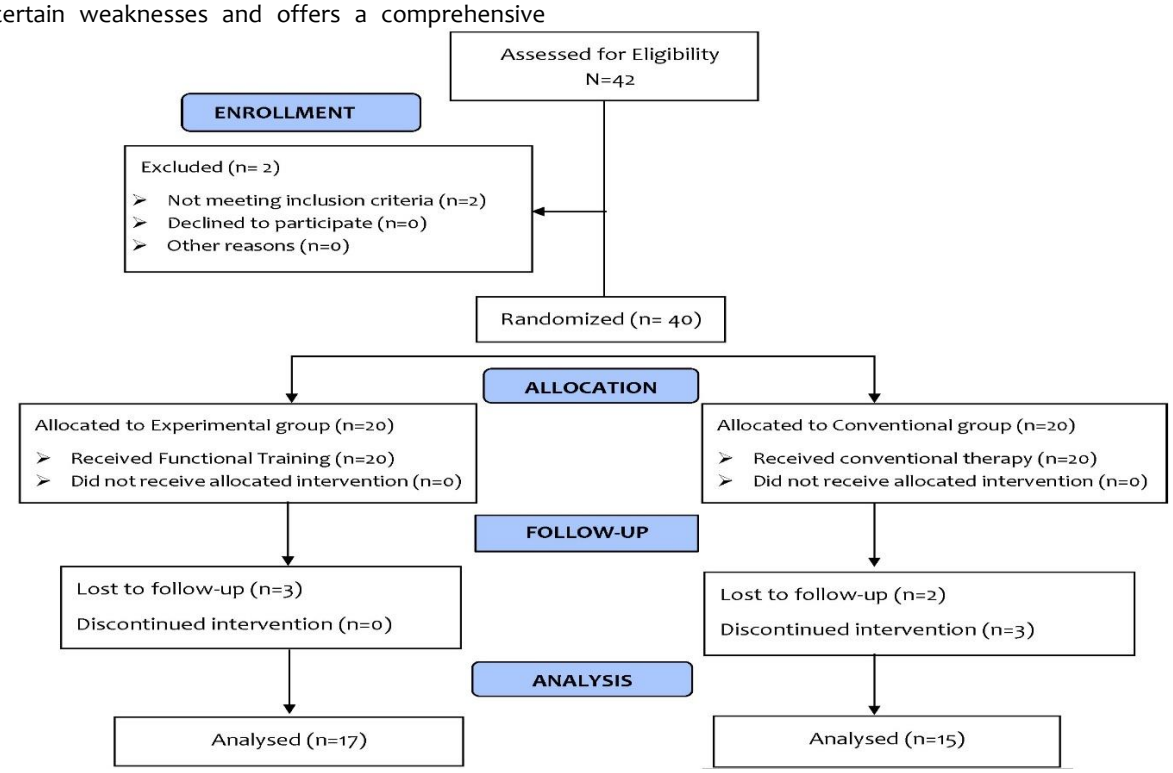

Figure 2: CONSORT diagram

https://doi.org/10.52567/trehabj.v7i04.8

Patients with HCP were randomly allocated to Group A (n=20) which received functional strength training in addition to conventional therapy and Group B (n=20) only received conventional physical therapy. In Group B n=5 children did not continue the treatment plan due to parent's problems while in group A n=3 children left the treatment due to seizures and unstable health conditions. A total of n=32 participants were included in the data analysis. (Figure 1).

The parents of all participants signed the informed consent form. The assessment was done two times at baseline and after 4th week of intervention. The tools used in this study were a Gross Motor Function Measure (GMFM) and Five time sit to stand test (FT-STS).

GMFM is used to determine gross motor function capacity and has five dimensions that are A, B, C, D, and E. Dimension A measures lying and rolling, Dimension B measures sitting, dimension C measures kneeling and crawling, Dimension D measures standing and dimension E measures walking along with running and jumping [13]. The FTSTS is used to measure the time needed by participants to complete consecutive STS cycles as fast as possible[14]. At the start, every participant in both groups was assessed for lower limb strength through FTSTS. The total time in seconds taken by the child to complete the task was noted at baseline and 4th week.

Both groups received a total of 30-minute sessions of conventional therapy (stretching exercises). In addition to conventional therapy, Group A was also given a functional strength training program. Functional strength training was given as a home program consisting of ten tasks. Before giving the functional strength training program at home, it was elaborated on in detail. All ten tasks were applied to participants of Group A at baseline week. For the convenience of parents of children with hemiplegic cerebral palsy; the tasks were given in printed form. The printed form of tasks was both in Urdu and English version with the pictures given in front of each task. The number of repetitions and days on which tasks were to be performed were mentioned on the form. The ten tasks were sit-to-stand (STS), one-leg standing, weight shifting (from one side of the body to the other), step-ups, lateral step-ups, squatting against a wall, picking an object from a standing position, walking forward, walking backward, and kicking the ball. The data was collected from participants during the baseline week and after 4th week. (Table 1)

SPSS 21 was used to analyze the data. The test of normality was applied to all variables to assess the homogeneity of a sample at baseline. The decision to apply a parametric or non-parametric test was made based on the Shapiro-Wilk test. which suggested the use of a parametric test, and an independent sample T-test for the between the group differences, while a paired sample t-test was used for within-group changes during the baseline week and after the 4th week of training.

Table 1: Intervention Protocols

	Group A (FST+CPT)	Group B (CPT)
1st and 2nd week	• In this group stretching exercises are performed for 4 weeks. • Static stretching exercises such as trunk rotation, flexion, and extension; hip flexors stretch, standing hamstring stretch; plantar flexors stretch, shoulder, elbow and wrist flexors and supinator. • Stretching applied for 30 sec holds with 30 sec rest. 5 times for each muscle group.	
3rd week	• STS (5 minutes), one leg standing (5 minutes), weight shifting (5 minutes), step-ups (5 minutes), lateral step-ups (5 minutes) • 1-minute rest between each task.	-
4th week	• squatting against wall (5 minutes), picking an object from standing position (5 minutes), walking forward (5 minutes), walking backward (5 minutes), kicking the ball (5 minutes) • 1-minute rest between each task.	-

STS-Sit to stand.

RESULTS

A total of n = 32 children with HCP, including n=23 males and n = 9 females participated in this trial and successfully received the intervention. Group-wise gender distribution was n=11 males and n=6 females in Group A and n=12 males and n=3 females in Group B. There were n=10 cases of right hemiplegic cerebral palsy and n=7 cases of left HCP among the patients in Group A. In contrast, there were n = 8 cases of right HCP and n = 7 cases of left HCP in the Group B group. Within-group analysis regarding STS, GMFM mentioned. (Table 2)

A comparison between Group A which received conventional therapy along with task-oriented functional training given as a home program and Group B which received only conventional therapy was made. In Group A group time taken to complete STS was comparatively more decreased than in Group B. In Group A, the mean STS was decreased at post-training. While in Group B, mean STS decreased very little in the 4th week (Table 3).

https://doi.org/10.52567/trehabj.v7i04.8

Table 2: Within group changes in STS, & GMFM

Variables		Group A		Group B	
		Mean ± SD	p-value	Mean ± SD	p-value
STS	Baseline	17.04 ± 8.32	0.00***	17.20 ± 8.32	0.00***
	After 4th week	12.3 ± 4.29		16.01 ± 4.29	
GMFM	-	-	-	-	-
Lying and rolling	Baseline	43.80 ± 6.97	0.00***	42.18 ± 5.08	0.00***
	After 4th week	44.60 ± 6.28		48.47 ± 4.45	
Sitting	Baseline	46.53 ± 5.54	0.00***	47.00 ± 6.33	0.00***
	After 4th week	49.60 ± 5.91		54.11 ± 6.47	
Crawling and Kneeling	Baseline	33.26 ± 6.63	0.00***	33.82 ± 4.29	0.00***
	After 4th week	35.13 ± 5.02		38.00 ± 2.59	
Standing	Baseline	23.00 ± 6.02	0.00***	23.17 ± 5.63	0.00***
	After 4th week	24.86 ± 5.82		28.88 ± 5.01	
Walking, running and jumping	Baseline	47.26 ± 9.24	0.00***	47.64 ± 6.28	0.00***
	After 4th week	49.53 ± 9.65		56.23 ± 8.39	

Significance level: p<0.05, p<0.01**, p<0.001****

Table 3: Difference of Group A and Group B regarding STS, GMFM

Variables		Group A	Group B	P –value
		Mean ± SD	Mean ± SD	
STS	Baseline	17.04 ± 8.32	17.20 ± 8.32	0.946
	After 4th week	12.3 ± 4.29	16.01 ± 4.29	0.041*
GMFM	-	-	-	-
Lying and rolling	Baseline	43.80 ± 6.97	42.18 ± 5.08	0.454
	After 4th week	44.60 ± 6.28	48.47 ± 4.45	0.052
Sitting	Baseline	46.53 ± 5.54	47.00 ± 6.33	0.827
	After 4th week	49.60 ± 5.91	54.11 ± 6.47	0.049*
Crawling and Kneeling	Baseline	33.26 ± 6.63	33.82 ± 4.29	0.285
	After 4th week	35.13 ± 5.02	38.00 ± 2.59	0.048*
Standing	Baseline	23.00 ± 6.02	23.17 ± 5.63	0.932
	After 4th week	24.86 ± 5.82	28.88 ± 5.01	0.045*
Walking, running and jumping	Baseline	47.26 ± 9.24	47.64 ± 6.28	0.89
	After 4th week	49.53 ± 9.65	56.23 ± 8.39	0.044*

Significance level: p<0.05, p<0.01**, p<0.001****

DISCUSSION

The objective of a recent study was to determine the effects of additional functional strength training on mobility in Children with Hemiplegic Cerebral Palsy (HCP). According to the results, combined therapy i.e. functional therapy along with conventional therapy proves to be beneficial for mobility and strength among children with hemiplegic cerebral palsy, so an alternate hypothesis was accepted.

In 4th week of the training session, there was a decrease in time taken by the participants of both groups to complete FTSTS. However, Group A showed a greater decrease in the time taken to complete FTSTS as compared to Group B. However, the P value is not significant as the duration of training was just 4 weeks. A study was conducted, to see the effect of FTSTS on lower limb strength in CP children at pre and post-training. The training was for six weeks. The median of time spent for FTSTS in participants was considerably decreased from 21.8 at pre-training to 14 sec at post-training. The *P* value was 0.03[17].

After the completion of the four-week training session, no significant p-value was seen for dimensions A (lying and rolling) and C (kneeling). However, an increase in dimensions B (sitting), D (standing), and E (walking, running and jumping) was seen. A study was conducted to check the effect of physical activity on CP children. The dimensions A and C showed a significant difference. so the findings of dimension C are in line with recent research while that of dimension A contradicts[18].GMFM was used to evaluate standing and walking ability in HCP children in the present research. Dimensions D and E were slightly increased. A study was conducted to assess dimensions D and E only in children with cerebral palsy. The duration of the study was ten weeks. The walking ability was assessed by a 6-minute walk test. There was a highly significant difference of p=0.005 seen at the end of a training session in GMFM, dimensions D and E. In the present study, there was a less significant increase in p-value. However, it can be improved by increasing the number of weeks as reported by Anderson[19].

The results of the recent study are also supported by the results of a study done by Eun-YoungParka1 et.al. They performed a meta-analysis to check the effect of strengthening exercises in children with CP. A total of 13 studies were chosen and all showed a positive increase in muscular strength provided if a session is given three

https://doi.org/10.52567/trehabj.v7i04.8

times/day for at least forty to fifty min. There was an improvement in the GMFM score was also seen[20]. According to a study, a total of 10 adults participated in the research. Out of ten adults, seven were male and three were female. The strength training program was often weeks. There was an improvement in lower limb strength with improvement in STS. So, the results were in favor of the implication of s strength training program for CP children[20].

This study showed an increase in strength and mobility after a four-week training session.in dimension D (standing) and E (walking) of the GMFM. This finding was in line with the study to check the effect on mobility in CP children through task-oriented training. The training session was of five weeks. Dimensions D and E were improved[21]. In this research, the effect of functional strength training on GMFM total percentage score was considerably increased. However, the mean for GMFM total score percentage in Group A was increased in 4th week. This finding was related to the study to check the effect of strength training in cerebral palsied children pre and post-training. The training was of eighteen weeks. Three readings were taken i.e. at baseline, 6 weeks, and 18th week. The total mean score for GMFM percentage was increased in both groups[22].

This study has some limitations that need consideration, it was not convenient for the patient to come daily so a home program was given to groups. Due to lack of follow-up, unable to take assessments after six weeks.

CONCLUSION

The study concluded that combined therapy including functional therapy along with conventional therapy proves to be beneficial on mobility and strength among children with HCP. It makes children more independent in managing daily tasks and enhances the functional status to achieve the optimal goals.

DECLARATIONS & STATEMENTS

Author's Contribution

The following format should be used for author's contribution.
MT: substantial contributions to the conception and design of the study.
SS and ST: acquisition of data for the study.
MS: interpretation of data for the study.
ZT: analysis of the data for the study.
HQ: drafted the work.
MA, ST, MS, ZT, HQ and SS: revised it critically for important intellectual content.
MA, ST, MQ, ZT, HQ and SS: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted from January 2020 to December 2020 in the department of physiotherapy, National Institute of Rehabilitation Medicine, Islamabad. (Ref No: NIRM/ADM/20). Ethical approval was taken from Research Ethical Committee of Yusra Institute of Rehabilitation Sciences, Islamabad (Ref No: YIRS/02/20).

Consent Statement

Informed consent was obtained from attendants and parents of children involved in the study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Acknowledgments

None to declare.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

None to declare.

REFERENCES

1. Flanagan D, Gaebler D, Bart-Plange EB, Msall ME. Addressing disparities among children with cerebral palsy: Optimizing enablement, functioning, and participation. J Pediatr Rehabil Med. 2021: 14(2):153-159 [CrossRef] [PubMed]
2. Elnaggar RK. Effects of plyometric exercises on muscle-activation strategies and response-capacity to balance threats in children with hemiplegic cerebral palsy. Physiother Theory Pract. 2022. 38(9):1165-1173. [CrossRef] [PubMed]
3. Shilesh K, Karthikbabu S, Rao PT. The Impact of Functional Strength Training on Muscle Strength and Mobility in Children with Spastic Cerebral Palsy - A Systematic Review and Meta-Analysis. Dev Neurorehabil. 2023. 26(4):262-277. [CrossRef] [PubMed]
4. Garib B, Ibraheem B, Ahmed D. Dental and maxillofacial findings in cerebral palsy children from Sulaimani City: assessment for unmet dental needs. Sulaimani Dent. J. 2020.;7(1):10. [CrossRef]
5. Yi YG, Jung SH, Bang MS. Emerging Issues in Cerebral Palsy Associated With Aging: A Physiatrist Perspective. Ann Rehabil Med. 2019. 43(3):241-249 [CrossRef] [PubMed]
6. Rai N, Rai N, Gogia VS, Shukla DK. Cerebral Palsy in Children-an indicator of maternal care in pregnancy-How far are we from attaining continuum of care. Asian J. Med. Sci. 2022.1; 13(9):207-. [CrossRef]
7. Rafique A. The burden of cerebral palsy in Pakistan: an insight into demographic and preventive plan. Çukurova med. j. 2022. 12;47(4):1759-60. [CrossRef]
8. Xu H, Zhang L, Xuan XY, Zhu M, Tang J, Zhao XK. Intrauterine cytomegalovirus infection: a possible risk for cerebral palsy and related to its clinical features, neuroimaging findings: a retrospective study. BMC Pediatr. 2020. 20(1):1-9. [CrossRef] [PubMed]
9. Delin S, Bošnjak Nađ K, Martinec S, Čokolić Petrović D, Šimic Klarić A, Mejaški Bošnjak V. Prognostic value of

cranial ultrasonography in comparison with magnetic resonance imaging in children with cerebral palsy: a population-based study. Acta Clin Croat. 2020. 59(2):260. [CrossRef] [PubMed]

10. Sørensen K, Vestrheim IE, Lerdal B, Skranes J. Functional Skills among Preschool Children with Cerebral Palsy - Assessment before and after Early Intervention. Dev Neurorehabil. 2020. 16;23(8):519-25. [CrossRef] [PubMed]
11. Chen S, Nanbert Z. Current progress of genetic and epigenetic studies of cerebral palsy. Obstet. Gynecol. 2019. 15(6):94-101. [CrossRef]
12. Prieto A, Martins Almeida Ayupe K, Nemetala Gomes L, Saúde AC, Gutierres Filho P. Effects of equine-assisted therapy on the functionality of individuals with disabilities: systematic review and meta-analysis. Physiother Theory Pract. 2022; 38(9):1091-106. [CrossRef] [PubMed]
13. Lundkvist Josenby A, Jarnlo GB, Gummesson C, Nordmark E. Longitudinal construct validity of the GMFM-88 total score and goal total score and the GMFM-66 score in a 5-year follow-up study. Phys Ther. 2009. 1;89(4):342-50. [CrossRef] [PubMed]
14. Tofani M, Candeloro C, Sabbadini M, Field D, Frascarelli F, Lucibello L, et al. A study validating the Italian version of the Level of Sitting Scale in children with cerebral palsy. Clin Rehabil. 2019. 33(11):1810-8. [CrossRef] [PubMed]
15. Towns M, Rosenbaum P, Palisano R, Wright FV. Should the Gross Motor Function Classification System be used for children who do not have cerebral palsy? Dev Med Child Neurol. 2018. 60(2):147-54. [CrossRef] [PubMed]
16. Ferre-Fernández M, Murcia-González MA, Barnuevo Espinosa MD, Ríos-Díaz J. Measures of Motor and Functional Skills for Children With Cerebral Palsy: A Systematic Review. Pediatr Phys Ther. 2020; 32(1):12-25. [CrossRef] [PubMed]
17. Naz A, Ahmad U, Arshad N, Shabbir M, Javed MA. Comparison of constraint induced therapy with vibration therapy on hands function in hemiplegic cerebral palsy. Rawal Med. J. 20222; 47(3): 689-692.
18. Jung Y, Chung EJ, Chun HL, Lee BH. Effects of whole-body vibration combined with action observation on gross motor function, balance, and gait in children with spastic cerebral palsy: a preliminary study. J Exerc Rehabil. 2020. 16(3):249. [CrossRef] [PubMed]
19. Singh N, Qureshi MI, Damke S, Bele A, Wane M. Combined effect of spiral suit and physical therapy in rehabilitation of quadriplegic cerebral palsy patients in rural areas. J. Datta Meghe Inst. Med. Sci. Univ. 2020;15(4):626-32. [CrossRef]
20. Myrhaug HT, Odgaard-Jensen J, Jahnsen R. The long-term effects of conductive education courses in young children with cerebral palsy: a randomized controlled trial. Dev Neurorehabil. 2019. 17; 22(2):111-9. [CrossRef] [PubMed]
21. Das SP, Ganesh GS. Evidence-based Approach to Physical Therapy in Cerebral Palsy. Indian J Orthop. 2019;53(1):20-34 [CrossRef] [PubMed]
22. Johnson RW, Williams SA, Gucciardi DF, Bear N, Gibson N. Can an online exercise prescription tool improve adherence to home exercise programmes in children with cerebral palsy and other neurodevelopmental disabilities? A randomised controlled trial. BMJ Open. 2020. 10(12):e040108. [CrossRef] [PubMed]

https://doi.org/10.52567/trehabj.v7i04.8