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Impact of mental practice training on balance and trunk endurance in children with hemiparesis: A randomized controlled trial

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ABSTRACT

Children with hemiparesis experience poor balance due to a combination of underdeveloped neural motor control mechanisms and secondary musculoskeletal issues, which lead to atypical body posture. The aim of this randomized controlled trial was to investigate the impact of mental practice (MP) training on balance and trunk endurance in children with hemiparesis. Forty hemiparetic children (16 boys and 24 girls), aged 7 to 10 years, were randomly assigned to two groups of equal size (20 children per group): control group (Group A) and study group (Group B). The study was conducted at the outpatient clinic of the Pediatric Physical Therapy Department at Mansoura International Hospital and Mansoura Specialized Hospital. Participants were assessed for balance and trunk muscle endurance at baseline and after 3 months of intervention using the modified Clinical Test of Sensory Integration of Balance (mCTSIB) and trunk endurance tests, respectively. Both groups received the same selected physical therapy program, with Group B additionally receiving MP training three times per week for three months. The Statistical Package for the Social Sciences (SPSS) (version 28) was used to conduct all of the statistical analyses. Significant differences were observed between the two groups post-treatment regarding mCTSIB scores and trunk endurance tests, favoring the study group ($p < 0.05$). MP training emerges as a promising intervention to enhance balance and trunk endurance in children with hemiparesis. Healthcare professionals and therapists working with these children should consider integrating the MP program as a valuable component of their therapeutic strategies.

KEYWORDS

Balance; Hemiparesis; Mental Practice; Motor Imagery; Trunk Endurance

1. INTRODUCTION

Cerebral palsy (CP) is a spectrum of disorders featured by activity limitation and postural development restriction that is caused by non-progressive lesion of the developing fetus or infant brain (Allen et al., 2021). The majority of children with CP suffer from one or more of the following impairments: lack of selective motor control; spasticity; muscular weakness; co-contraction as well as contractures. Subsequently, these problems might make it challenging to perform independent activities such as walking and taking steps on uneven surfaces in addition to activities of daily living (Mackey et al., 2014; Stavsky et al., 2017).

As for children with hemiparesis, it is a reduction in the ability to generate a normal level of muscle strength in the side of the body contralateral to the brain damage (Lima et al., 2023). The neonatal prevalence of unilateral spastic CP is estimated to be between 0.6 and 0.9 per 1000 live births (Odding et al., 2006). Many children with hemiparesis suffer from poor balance and delayed postural responses involving atypical body posture, brought on by asymmetry in alignment (Schmit et al., 2016). Subsequently, the recovery of stability after a sudden external perturbation result from delays in the initiation of postural muscle activity and disruptions in the temporal as well as spatial aspects of postural muscle responses (Dewar et al., 2015).

Furthermore, children with hemiparesis have difficulty regulating redundant sensory information for posture control, and they also have difficulty sequencing multiple muscle actions, leading to a high amount of co-contraction of both agonist as well as antagonist muscles at a joint (Santamaria et al., 2016). To get around, they frequently use a variety of compensating movements; greater segmental sway necessitates corresponding compensatory motions for maintaining balance. All of these disorders make it difficult to maintain balance and walk normally, which can restrict participation in many activities (Sim et al., 2015).

Muscular endurance refers to a child's resistance to exhaustion and/or their capacity to keep working out for an extended period of time. It is the ability to repeatedly contract a muscle group at a moderate intensity for a set period of time. It is one of the cornerstones of muscular performance because it is closely linked to physical activity. Children with hemiparesis are more likely to get muscle fatigability, a serious movement disorder that has been linked to less activity, worse motor skills, and less well-being (Eken et al., 2013).

It has been proposed that impairments in motor competence and neuro-visual skills may hinder the development of higher-order cognitive processes in hemiparetic children. Among them, cognitive flexibility, abstract thinking, rule acquisition, initiating suitable behaviours and stopping improper actions, picking relevant sensory information, and planning may be impaired (Jeannerod, 2006). Motor planning is the capacity to visualize the outcome of an action when organizing a movement to reach an object (Johnson-Frey et al., 2004). It has been suggested that action planning benefits greatly from mental rehearsal. Moreover, it can potentially improve motor planning in children with hemiparesis because it targets the more "cognitive" parts of motor activity (Deconinck et al., 2009).

Mental practice (MP) can be assumed as an umbrella term that incorporates different mental training techniques. Researchers have begun to use the term motor imagery (MI) to refer to the imagining of moving certain body components. Mental practice, often known as "motor imagery," is a strategy for cognitively rehearsing physical performances in a safe and repetitive manner (Schuster et al., 2011).

Mental practice is the mental representation of movement that occurs in the absence of real body movement. It is a mental activity in which a person imitates or rehearses a specific action. It is usually used in sports training and neurological rehabilitation. Mental practice is expected to promote more cognitive components of motor activity and as a result, may be beneficial in enhancing motor planning in children hemiparesis (Coslett et al., 2010). The kinesthetic mode, which involves the actual experience of performing the motor act, or the visual mode, which involves simply visualizing the movement, can both be used to mentally stimulate practice (Féry, 2003). Typically, the individual will also differentiate between internal and external perspectives. The term "internal perspective" refers to the mental process of visualizing a motion in the first person, as if one were actually observing a particular body part in motion. On the other hand, the external perspective is a third-person view of oneself (Callow et al., 2013).

Upon the benefits of this type of training, there was not enough evidence to figure out how MP affects children with hemiparesis in terms of their ability to walk and balance compared to other traditional methods. However, most researchers agreed that MI effectively improves motor performance (Steenbergen et al., 2009; Behrendt et al., 2021). Therefore, the aim of the study is to identify the impact of MP on balance and trunk endurance in children hemiparesis. It was hypothesized that MP had no effect on balance and trunk endurance in children with hemiparesis.

2. METHODS

2.1. Study design and participants

A randomized controlled trial was conducted at the outpatient clinic of the Pediatric Physical Therapy Department at Mansoura International Hospital and Mansoura Specialized Hospital between March 2021 and July 2022.

Forty children of both genders diagnosed with hemiparesis were enrolled in this study. PS Power and Sample Size Calculations version 3.0.11 for Microsoft Windows was utilised to identify the sample size, and the results indicated that 14 children in each group would be sufficient to accomplish 80% power at the = 0.05 level when utilizing the student's t-test for independent samples. The sample size was expanded to 40 children to counteract any dropouts. The children were between 7 and 10 years when they participated in this study. Their motor function was at a level I based on the Gross Motor Function Classification System (GMFCS) (Palisano et al., 2008), while the degree of spasticity was grade 1 to 1+ according to the Modified Ashworth Scale (Meseguer-Henarejos et al., 2018).

They had appropriate level of cognition, working memory, no significant perceptual defects and were capable of following instructions throughout the evaluation and treatment procedures; as it needed a good comprehension in order to follow motor imagery task's procedure and complete the training (Gözaçan Karabulut et al., 2022). Participants were excluded from the study if they had visual or hearing loss, mental retardation, seizures, cardiovascular or respiratory disorders, received a botulinum toxin injection in the previous six months, underwent lower extremity surgery, or had musculoskeletal disorders or structural deformities in the spine and/or lower limbs.

2.2. Randomization

Fifty-five children with hemiparesis were approached about participating in this study. Eligibility, inclusion, as well as exclusion criteria, were initially determined by screening and evaluation. Ten of the 55 children selected for this study failed to fulfill the inclusion criteria, whereas the parents of another five rejected to participate. Forty children participated in the study (16 boys and 24 girls). As highlighted in the study's flowchart (Figure 1), a blind individual selected sealed opaque envelopes from a box in numerical order to randomly assign the children into two groups of twenty; each envelope included a letter identifying whether or not the child was part of the study group or the control group.

Children in the control group underwent a selected physical therapy program for 1 hour, 3 sessions a week for 3 sequential months, while children in the study group got the same selected physical therapy program of the control group for 30 minutes as well as a 30-minute mental practice training, according to the protocols of Amjad et al. (2019); Gupta (2017); Shah et al. (2016).

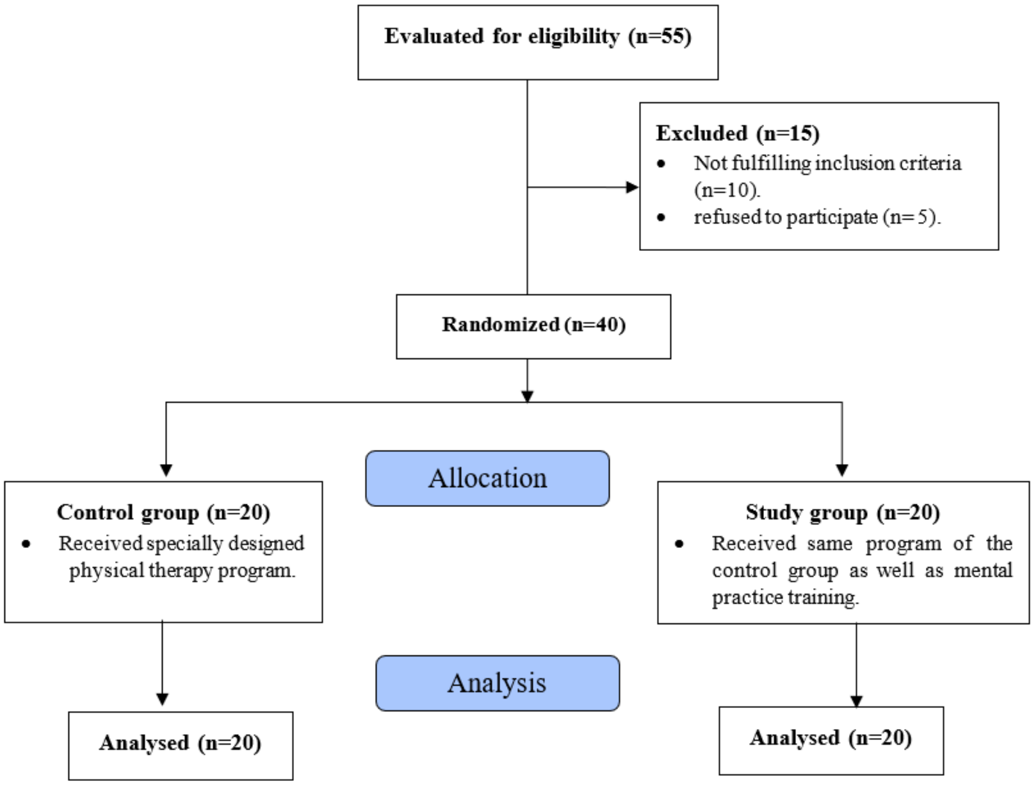

Figure 1. Flow chart of study participants

2.3. Ethical considerations

The research was conducted in accordance with a protocol permitted by the Research Ethical Committee at the Faculty of Physical Therapy, Cairo University with number (P.T.REC/012/003024) and was recorded on ClinicalTrials.gov with the number (NCT04765917). All children and their parents were given a thorough explanation of the study's goals and protocols before participation, and all parties signed an informed consent form.

2.4. Outcome measures

At baseline, as well as 3 months post-treatment, all children were assessed for balance by using the HUMAC balance system. This way of testing balance is valid and reliable (Koltermann et al., 2017). The isometric tests reported for testing trunk endurance were the back extensor endurance test, the abdominal flexor endurance test, as well as the lateral bridge endurance test. These tests are easy to apply and safe when utilized in clinical settings, where performance is measured by how long an individual can maintain a specific position on the test (Evans et al., 2007).

2.5. Procedures for Evaluation

2.5.1. Modified Clinical Test of Sensory Integration and Balance (mCTSIB):

The purpose of this test was to evaluate the sensory integration of balance in both open and closed eye conditions, on both firm and foam surfaces including (EOFS=Eyes Open Firm Surface, ECFS=Eyes Closed Firm Surface, EOSS=Eyes Open soft Surface, ECSS=Eyes Closed soft Surface). Once the child's feet were located on the platform, he was told to stare at a mark on the wall that was placed at eye level for 30 seconds before being told to close his eyes for an additional thirty seconds. On a foam surface, the method was performed two times, one with the eyes open and another time with them closed. Each condition was tested three times, and the best value from each set of results was used (Lotfi et al., 2018).

2.5.2. Assessment of trunk muscular endurance

Three endurance tests were used to determine the isometric endurance of the trunk muscles:

2.5.2.1. Trunk Flexor Endurance test

The procedure began with the child seated, using a wedge for supporting his trunk at an angle of 60° flexion, with their knees and hips bent to 90 degrees, their arms crossing over their chest, and their feet fastened by a strap. The "wedge" that supports the child's trunk will be retracted 10 centimeters, and the child will stay in that posture for as much as possible. The test was over when the back of the child touched the wedge again, or after 300 seconds had passed (Willson et al., 2005).

2.5.2.2. Trunk Extensor Endurance test

The child was asked to lie flat on an examination table with his or her hips parallel to the edge. The upper extremities were crossed over the chest, whereas the pelvis, hips, as well as knees, were strapped to the table. The child was kept horizontal with his or her arms folded over his or her chest for as long as possible. When the child reached 300 seconds or was unable to stay horizontal, the test was over (Moreau et al., 2001).

2.5.2.3. Lateral Trunk Endurance test (for the affected side)

It started with the child lying on a side-lying position on the affected side with their knees extended and the upper foot in front of the lower foot. They crossed their upper arm over their chest and rested their hand on their opposite shoulder. In this position, the child rested his or her weight just on his or her lower elbows as well as feet, with the hips raised off the treatment table to create a long, straight line. The test was considered complete when the child either stopped maintaining the side-lying position, lowered his or her hips to the treatment table, or after 300 seconds (McGill et al., 1999).

2.6. Intervention

2.6.1. The Selected Physical Therapy Program

This involved neurodevelopmental therapy for both the lower extremities, stretching exercises for short muscles including hip flexors and adductors, knee flexors, and ankle plantar flexors, strengthening exercises for the trunk as well as both lower extremities, proprioceptive and balance training in every direction from a standing position, in addition to gait training (Verschuren et al., 2011; Page, 2012; Macias-Merlo et al., 2015).

2.6.2. The Mental Practice Training

Based on the treatment protocol described by Amjad et al. (2019); Gupta (2017); Shah et al. (2016), each child in the study group watched a film of five minutes of a typical child in a quiet room as a preparation. They were seated in a manner that allowed them to relax. The screen is within the range of the child's vision. Children were instructed to close their eyes and visualize themselves carrying out the physically rehearsed task for 10 minutes in a manner like that depicted in the video; they were encouraged to imagine themselves from a first-person perspective and to feel their trunk, legs, hands, and feet to focus on their movements. The assignment was verbally explained to the child to help him or her remember the sensations in his or her muscles during the exercises. Throughout the entire program, the child was guided to pay close attention to the position and movement of their body. The child was then instructed to carry out the sequence of actions that he or she had mentally practiced for 20 minutes. They were instructed to perform five to ten repetitions of each exercise, depending on their current fitness level. In the end, the children were instructed to calm down.

2.7. Statistical Analysis

Children's demographic characteristics were analyzed between groups using unpaired t-tests. The chi-squared test was adopted to compare the gender, affected side, and spasticity grade distribution among groups. The Shapiro-Wilk test was employed to identify whether the data were normally distributed. Homogeneity between groups was checked using Levene's test for variance homogeneity. A mixed design 2 x 2 MANOVA test was employed to compare between- and within-group impacts on (mCTSIB) and trunk endurance tests. For subsequent multiple comparisons, post hoc tests with the Bonferroni correction were conducted. All statistical tests had a significance level of p-value less than 0.05. The Statistical Package for the Social Sciences (SPSS) version 28 for Windows (IBM SPSS, Chicago, IL, USA) was used to conduct all of the statistical analyses.

3. RESULTS

3.1. Participant characteristics

The demographic data of children in both groups are displayed in Table 1. Age, weight, height, distribution of gender, affected side, and spasticity grades were not statistically different among groups (p > 0.05).

Table 1. General characteristics of children in both groups

	Control group $\bar{X} \pm SD$	Study group $\bar{X} \pm SD$	MD	t-value	*P*- value
Age (Years)	8.42 ± 1.08	8.70 ± 1.14	- 0.28	-0.783	0.438^{NS}
Height (cm)	122.20 ± 11.48	125.20 ± 10.63	- 3.0	-0.857	0.397^{NS}
Weight (kg)	27.46 ± 8.70	27.20 ± 7.02	0.27	0.109	0.914^{NS}
Gender (n & %)					
Boys	7 (35 %)	9 (45 %)	X^2= 0.417		0.748^{NS}
Girls	13 (65 %)	11 (55 %)			
MAS (n & %)					
Grade 1	3 (15 %)	6 (30 %)	X^2= 1.29		0.451^{NS}
Grade 1+	17 (85 %)	14 (70 %)			
Affected side (n & %)					
Right side	14 (70 %)	11 (55 %)	X^2= 0.960		0.514^{NS}
Left side	6 (30 %)	9 (45 %)			

*Note: $\bar{x}$ = Mean; SD= Standard deviation; MD= Mean difference; X^2= Chi-squared test; P-value: probability value; *Significant at P<0.05; NS=non-significant; MAS= Modified Ashworth Scale*

3.2. Pre-treatment comparison between both groups

There were no statistically significant differences between both groups prior to the study intervention in any of the measured variables (p > 0.05), as shown in Table 2.

Table 2. Pre-treatment comparison between both groups

	Variable	Control group $\bar{x} \pm SD$	Study group $\bar{x} \pm SD$	*MD*	*f-value*	*P*- Value
Modified clinical test of sensory integration of balance (mCTSIB)	**Eyes open firm surface (EOFS) (%)**	74.60 ± 3.70	73.50 ± 4.51	1.10	0.679	0.413
	Eyes closed firm surface (ECFS) (%)	71.15 ± 7.32	73.00 ± 4.09	-1.85	0.974	0.327
	Eyes open soft surface (EOSS) (%)	69.55 ± 8.69	70.90 ± 4.59	-1.35	0.570	0.453
	Eyes closed soft surface (ECSS) (%)	65.45 ± 9.25	63.70 ± 4.50	1.75	0.885	0.350
Trunk endurance tests (sec)	**Trunk flexion endurance test (sec)**	57.60 ± 1.81	58.50 ± 3.67	-0.90	0.997	0.321
	Trunk extension endurance test (sec)	60.90 ± 4.31	61.25 ± 4.24	-0.35	0.081	0.776
	Lateral trunk endurance test (Affected side) (sec)	15.90 ± 1.61	17.30 ± 3.71	-1.40	2.30	0.134

*Note: $\bar{x}$: Mean; SD: Standard deviation; MD: mean difference; f-value: MANOVA test; *Significant at P<0.05*

3.3. Within group comparison

A statistically significant improvement in all tests of mCTSIB has been detected in both study and control groups, including (EOFS, ECFS, EOSS, and ECSS) post-treatment in comparison with those levels pre-treatments (p > 0.05) as displayed in Table 3. In both groups, there were statistically significant improvements in the trunk endurance tests including (trunk flexion endurance test, trunk extension endurance test and lateral trunk endurance test) post-treatments when compared to the pre-treatments (p > 0.05) (Table 3).

Table 3. Pre and post-treatment comparison between both groups

	Variable	Time	Control group $\bar{x} \pm SD$	Study group $\bar{x} \pm SD$	*MD*	*f-value*	*P*- Value
clinical test of sensory integration of balance	**Eyes open firm surface (EOFS) (%)**	Before	74.60 ± 3.70	73.50 ± 4.51	1.10	0.679	0.413
		After	79.80 ± 5.23	83.70 ± 3.13	-3.90	8.53	0.005*
		% of change	↑ 6.97	↑ 13.87			
		P Value	0.001*	0.001*			
	Eyes closed	Before	71.15 ± 7.32	73.00 ± 4.09	-1.85	0.974	0.327

	firm surface (ECFS) (%)	After	77.20 ± 7.61	82.00 ± 3.50	-4.80	6.55	0.012*
		% of change	↑ 8.50	↑ 12.33			
		P Value	0.005*	0.001*			
	Eyes open soft surface (EOSS) (%)	Before	69.55 ± 8.69	70.90 ± 4.59	-1.35	0.570	0.453
		After	75.00 ± 4.33	80.70 ± 3.52	-5.70	10.164	0.002*
		% of change	↑ 7.83	↑ 13.82			
		P Value	0.006*	0.001*			
	Eyes closed soft surface (ECSS) (%)	Before	65.45 ± 9.25	63.70 ± 4.50	1.75	0.885	0.350
		After	71.80 ± 4.80	77.25 ± 3.05	-5.45	8.58	0.004*
		% of change	↑ 9.70	↑ 21.27			
		P Value	0.016*	0.001*			
Trunk endurance tests (sec)	**Trunk flexion endurance test (sec)**	Before	57.60 ± 1.81	58.50 ± 3.67	-0.90	0.997	0.321
		After	61.40 ± 1.50	65.50 ± 3.66	-4.10	20.68	0.001*
		% of change	↑ 6.60	↑ 11.97			
		P Value	0.001*	0.001*			
	Trunk extension endurance test (sec)	Before	60.90 ± 4.31	61.25 ± 4.24	-0.35	0.081	0.776
		After	66.00 ± 3.11	71.35 ± 3.73	-5.35	19.01	0.001*
		% of change	↑ 8.37	↑ 16.49			
		P Value	0.001*	0.001*			
	Lateral trunk endurance test (Affected side) (sec)	Before	15.90 ± 1.61	17.30 ± 3.71	-1.40	2.30	0.134
		After	18.55 ± 1.79	24.60 ± 3.80	-6.05	42.94	0.001*
		% of change	↑ 16.66	↑ 42.20			
		P Value	0.001*	0.001*			

x̅: Mean; SD: Standard deviation; MD: mean difference; f-value: MANOVA test P-value: probability value; *Significant at P<0.05

3.4. Post-treatment comparison between both groups

A comparison of the study group and control groups post-treatment demonstrated a statistically significant increase in mCTSIB, including (EOFS, ECFS, EOSS, and ECSS) in the study group when compared to the control group (p > 0.001). Also, the trunk endurance tests of the study group were statistically significantly higher post-treatment when compared to those of the control group (p > 0.001), as shown in Table 4.

Table 4. Post-treatment comparison between both groups

Variable		Control group x̅ ± SD	Study group x̅ ± SD	*MD*	*f-value*	*P*- Value
Modified clinical test of sensory integration of balance (mCTSIB)	**Eyes open firm surface (EOFS) (%)**	79.80 ± 5.23	83.70 ± 3.13	-3.90	8.53	0.005*
	Eyes closed firm surface (ECFS) (%)	77.20 ± 7.61	82.00 ± 3.50	-4.80	6.55	0.012*
	Eyes open soft surface (EOSS) (%)	75.00 ± 4.33	80.70 ± 3.52	-5.70	10.164	0.002*
	Eyes closed soft surface (ECSS) (%)	71.80 ± 4.80	77.25 ± 3.05	-5.45	8.58	0.004*
du ra nc e	**Trunk flexion endurance test (sec)**	61.40 ± 1.50	65.50 ± 3.66	-4.10	20.68	0.001*

Trunk extension endurance test (sec)	66.00 ± 3.11	71.35 ± 3.73	-5.35	19.01	0.001*
Lateral trunk endurance test (Affected side) (sec)	18.55 ± 1.79	24.60 ± 3.80	-6.05	42.94	0.001*

*Note: $\bar{x}$: Mean; SD: Standard deviation; MD: mean difference; f-value: MANOVA test; *Significant at p<0.05*

4. DISCUSSION

To avoid any confounding factors, both groups were matched regarding demographic data and baseline data (e.g., age, sex, BMI, degree of spasticity (MAS), and affected side). There were no statistically significant differences between the groups in pre-intervention data (mCTSIB and trunk endurance tests, p>0.05). Our study results revealed statistically significant differences between groups in all tests of mCTSIB, including EOFS, ECFS, EOSS, and ECSS, post-treatment, in favor of the study group (p<0.05).

It was thought that the motor problems facing children with hemiparesis have been caused by both problems with executing movements and problems with planning movements. However, there are redundant of rehabilitation methods that have been directed at assisting with the motor execution part of action performance. They haven't really focused on either motor planning or preparation processes. Motor imagery is a promising approach for improving the more "cognitive" parts of motor behavior, so it may help hemiparetic children in planning their movements. Limited research studies have investigated the efficacy and validity of mental practice programs and techniques for treating children with hemiparesis (Steenbergen et al., 2009; Steenbergen et al., 2013).

Although there's no cure for hemiplegia, neuro-rehabilitative methods can help to decrease its effects. MP is when a person imagines doing a simple or complicated movement without moving their body. Therefore, MP is a cognitive procedure in which the action is represented in the working memory without being carried out (Jeannerod, 1995; Decety, 1996). This is similar to what happens when the subject really moves. Additionally, it was thought that MP could be utilized for accessing the motor system or neural representation of motion (Sharma et al., 2006).

The selection of the age of the children who participated in the current study was consistent with prior studies that determined the age at which children's motor imagery ability is fully developed. According to Molina et al. (2008), motor imagery ability in children develops around the age of seven. This also comes in agreement with Gözaçan Karabulut et al. (2022), who explore motor imagery profiles of children with hemiplegic cerebral palsy (HCP) based on gender and affected side and age range of 7 to 18 years.

There are two opposing views on motor imagery in cerebral palsy; according to some studies, children with left hemisphere impairment are more likely to have impaired motor imagery (Chinier et al., 214; Molina et al., 2015); while other sources, have been emphasized the performance of motor imagery in HCP is not dependent on the affected side (Williams et al., 2011; Williams et al., 2012). Based on these results, we can suggest that the motor imagery skills of hemiparetic children with either the right or the left extremities are affected at the same level. In addition, when the effect of gender differences on motor imagery ability was evaluated; it was determined that there was no difference (Campos, 2014; Subirats et al., 2018).

Our results are consistent with number of studies (Steenbergen et al. 2013; Oh & Choi 2021) who demonstrated that MI techniques were helpful in increasing the static and dynamic balance, postural stability, endurance and walking capacity in children with hemiparesis and could be a valid and helpful tool to improve rehabilitation in children with CP. These findings are supported by Ferraye et al. (2014) who utilized MI protocol to study the brain regions responsible for balance, as they indicate that MI stimulated more cortical and subcortical parts of the motor system, such as the frontal cortex, basal ganglia, cerebellum, as well as mesencephalic locomotor region, which showed more effective connections with the supplementary motor area.

Motor imagery may additionally be utilized as a means of rehabilitation to enhance physical execution. This is called the "mental imagery practice process," and it involves imagining motor acts over and over to improve the way they move. Mental imagery practice can be utilized to learn difficult motor skills including sports or to re-learn motor abilities and improve motor recovery of motor performance for individuals with neurological disorders (Jackson et al., 2001). It has been shown that MI makes the corticospinal tract in stroke patients more active. There is evidence that mental imagery practice can help patients with stroke as well as children with developmental coordination problems (Maruff et al., 1999).

The results reflected that practicing a task is an essential part of learning and mastering a motor task, for the purpose of improving the skill itself and for making sure the procedural memory stays stable. MP of motor gestures generates cortical representations as well as neural substrates that are similar to those created by real practice. This makes MI a useful motor learning strategy (Cuenca-Martínez et al., 2020). Based on these adult post-stroke beneficial effects, it could be hypothesized that children with HCP might also benefit from a rehabilitation program involving the use of MI (Souto et al., 2020).

Trunk stability is influenced by muscle power, neural regulation, and accurate proprioception. Children with hemiparesis frequently have trunk muscle weakness. They have less endurance, limiting their movements. Trunk imbalance and its associated pelvic obliquity, unequal weight bearing, and increased postural sway can impact either standing or walking. As a result, the dysfunctional movement patterns of these children result in excessive energy expenditure. Trunk muscles assist in maintaining the trunk in an erect posture and allow for successful weight shifts throughout dynamic postures (Tsirikos & Spielmann, 2007). So, trunk exercise became a part of the treatment of hemiparetic children.

The current study showed a statistically significant improvement in trunk endurance. It was proved that trunk motor imagery practice, combined with routine trunk rehabilitation, is a clinically important early rehabilitation strategy for improving trunk performance, functional balance as well as activity of daily living in patients with acute stroke. Improved trunk proprioception and trunk muscle activation using motor imagery training can assist in the prevention of falling and have an essential role in daily activities as well as balance. The rationale regarding the effectiveness of MP for recovery after a stroke is that activating motor areas via imagery will improve brain plasticity. On another level, the results could be due to an indirect impact of neuroplasticity, in which mental practice reactivates previously utilized motor representations, making the physical practice have a greater impact (Santhosh Kumar et al., 2023). When you mentally practice a movement to improve it, you are engaging in what is known as a mental rehearsal. Using MI activates corticospinal facilitation and cortical reorganization by stimulating the mirror neuron structure in the primary motor cortex (Shah et al., 2016).

Many investigations showed that MI training for trunk motions could effectively improve trunk muscle activity as well as proprioception in stroke patients (Oh & Choi, 2017). Also, it added benefits to improve paretic muscle strength. Neural adaptation is an essential part of strength gaining through voluntary training of the skeletal muscles. Previous research on MI training and muscle strength showed that MP combined with MI actively alters central programming processes like motor planning, improving neural adaptation regarding maximal voluntary contraction, as well as that kinesthetic imagery training might alter higher activation in motor units, and this might explain our current findings (Yao et al., 2013).

Additionally, activating the visual cortex of the brain using imagery training causes muscle tension by means of either voluntary or involuntary motions of the eyes and brain whenever an object moves or a quick change in eye direction happens (Zwergal et al., 2012). The mental practice could be extremely effective in stimulating the unconscious processes that are part of muscle training. Subsequently, it makes individuals feel self-confident because they are able to utilize MP techniques prior to doing any task. This gives them more confidence to control their task performance (Kumar et al., 2016).

Motor imagery along with physical exercise appears to be an efficient method for eliciting brain plasticity and enhancing motor function. It is also believed that for certain motor tasks, imagined movement can lead to higher performance gains than those observed with physical practice (Allami et al., 2008). It had better effects on motor function in hemiparetic children than conventional rehabilitation therapies, which may be helpful in increasing balance and gross motor function of children with CP.

5. LIMITATIONS

The generalizability of these results is subject to certain limitations. First, there is no long-term follow-up of the children to find out if the improvement seen in the short term was kept over time. Subsequently, additional studies with longer treatment periods are suggested for an optimum generalization of the results. Second, the potential difficulty in differentiating between children with right and left hemiparesis in the results. Additional studies utilizing functional magnetic resonance imaging as well as positron-emission tomography scans in children are recommended to differentiate between the effects of MP training on right and left hemiparesis.

6. CONCLUSIONS

Based on the results of this study, the MP program is recommended to be included in training programs for children with hemiparesis to improve their balance and trunk muscle endurance. Incorporating the MP program into regular training regimens could lead to improved overall physical stability. This approach not only supports the physical development of these children but also enhances their overall well-being and quality of life. Therefore, healthcare professionals and therapists working with children with hemiparesis should consider integrating the MP program as a valuable component of their therapeutic strategies.

7. REFERENCES

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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