

Effect of Mirror Intervention Program on Hand Activity, Mastery Motivation and Self-Esteem among Children with Cerebral Palsy

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Abstract

Background: Mirror therapy is a type of intervention aimed at paying the child's attention to perform the physical exercises of the non-affected side by visually stimulating the child's perception. Children with cerebral palsy need to learn strategies and techniques leading to learned non-use of the affected hand. **The aim of the study** is to assess the effect of a mirror intervention program on hand activity, mastery motivation, and self-esteem among children with cerebral palsy. **Research design:** A quasi-experimental design was used in this study. **The study subjects** consisted of 50 children suffering from unilateral spastic cerebral palsy aged 6-12 years old. **Setting:** The study was conducted at the specialized outpatient department in Children's Hospital affiliated to Ain Shams University Hospitals, Cairo, Egypt. **Tools:** The data was collected using 1) Demographic characteristics of the studied children and their parents; 2) Upper Extremity Functional Index; 3) Activities of Daily Living Checklist; 4) Box and Block Test; 4) Dimensions of Mastery Questionnaire; 5) Coopersmith Self-Esteem Inventory. **Results:** The present study revealed that there was a statistically significant difference pre-, post, and follow-up of the mirror intervention program regarding upper extremity functional index, activity of daily livings, and box and block test with (F test = 48.54, 7.29, 8.51 respectively with P value \leq 0.05). The study also revealed statistically significant differences in the dimensions of mastery scores, especially during the follow-up assessment after implementing the mirror intervention program (F test = 54.87 with P value \leq 0.05). Meanwhile, a non-statistically significant difference was noted regarding the Coopersmith self-esteem inventory (F test= 54.87 with P value $>$ 0.05). There were strong positive correlations between study variables. **Conclusions.** The mirror intervention program had significant changes in hand activity and mastery motivation among children with cerebral palsy, while it did not have a significant effect on children's self-esteem. **Recommendation:** A longitudinal study should be conducted to assess the impact of a mirror intervention program on a large sample of children with special disabilities related to hand activity, self-esteem, and other psychological aspects.

Keywords: Mirror, intervention program, hand activity, mastery motivation, self-esteem, children, cerebral palsy.

Introduction

Cerebral palsy (CP) is "a cumulative and irreversible sensory and motor deterioration as and dysfunction caused by brain injury happened pre, at or post-delivery". Worldwide, the incidence of CP is 2 – 2.5 /1,000 child and more than 30% has spastic hemiplegia (Elsepae et al., 2016; Narimani et al., 2019). In unilateral CP, upper limb dysfunctions are the main cause of dependence and activity participation restriction, Children with CP are faced with neurodevelopmental problems in the form of spasticity, inability to initiate muscle

activity, poor coordination, and poor balance. Many children also experience health, sensory, and perceptual problems, and may have complex limitations in self-care activities such as feeding, dressing, bathing, and mobility (Mohammed et al., 2022).

Cerebral palsy remains the most common cause of disability during childhood. Children with CP encounter many physical and psychological challenges including upper/ lower limb impairment, dependency in performing their daily living activities, as well as negative effects on the function of hand activity.

Anxiety, depression, disfigurement, and negative self-concept are also affected. Furthermore, children with CP have more difficulties with their behaviors, attention, and social interactions compared to their peers in the same age group (Rudebeck, 2020). Children with movement disorders and disabilities also are more likely to face discrimination in terms of decreased opportunities to participate in activities that negatively affect their self-esteem (Bates et al., 2021).

Mastery motivation is an inner psychological driving force that enables individuals with incentive and encouragement to independently discover, act, persist, and try to solve problems and challenging tasks. Motivation leads to more confidence, creativity, and tendency while participating in different tasks and activities (Salavati et al., 2018a). Children's motivation especially in children with disabilities such as cerebral palsy can affect the level of dependency and functional abilities. They had lower mastery motivation compared to typically developing children (Salavati et al., 2018b).

Mirror intervention is a non-invasive approach that focuses on visual stimulation and the movement of limbs through visual feedback. In this intervention, the children place their both hands (affected and non-affected) on both sides of the mirror, so the unaffected hand is in the frontal of the mirror and the affected one is in the back. Thus, the children understand the reflection of their unaffected hands in the mirror as affected (Narimani et al., 2019). Mirror therapy has a positive effect on hand strength, movement speed, muscle activity, and accuracy of hand matching by motivating the child to be compliant with performing regular hand exercises and activities (Park et al., 2016).

Significance of the study:

Children with unilateral cerebral palsy experience difficulties with unimanual and bimanual upper limb function, impacting independence in daily life such as reaching, pointing, taking, releasing, and manipulating objects (Elanchezhian & Swarna, 2019). The prevalence of cerebral palsy in Arabic-speaking countries was 1.8/1000 live births in which spastic cerebral palsy was the most common

motor type, representing 59.8% (Mushta et al., 2022).

The mirror intervention program focuses on helping the child to maximize his /her mastery motivation. A systemic analysis study of the effects of mirror rehabilitation techniques on hand activities revealed that the mirror image of a child's active hand increased the excitability of neurons in the primary motor cortex. Therefore, mirror intervention seems to be effective for hand function recovery (Miryutova et al., 2021; Tofani et al., 2022). Furthermore, there are minor studies that assessed the effect of mirror intervention on a child's psychological aspects. So, based on several studies that applied to post-stroke patients and have significant positive results in relieving psychological problems (Zhang et al., 2021; Polamraju, 2022). The current study was conducted to evaluate whether the mirror intervention is a feasible intervention for children with CP and may improve the children's psychological aspects in the form of mastery motivation in performing tasks and daily activities independently as well as increasing their self-esteem and consequently promoting their positive self-concept. Therefore, the current study aimed to assess the beneficial effect of a mirror intervention program on a group of children suffering from unilateral spastic CP.

Aim of the study:

To assess the effect of the mirror intervention program on hand activity, mastery motivation, and self-esteem among children with cerebral palsy.

The study objectives:

1. Assess the hand activity of children with CP before program implementation.
2. Assess the mastery motivation and self-esteem of children with CP before program implementation.
3. Plan and implement the mirror therapy intervention program sessions based on the child's condition and developmental stage.
4. Evaluate the effect of the mirror intervention program on hand activity, mastery motivation, and self-esteem among children

with CP after program implementation and follow-up.

Research hypothesis:

H1: The mirror intervention program may improve hand activity and independence among children with CP.

H2: The Mirror intervention program may improve mastery motivation and self-esteem among children with CP.

Subject and Methods

Study design

A quasi-experimental research design was utilized in this study (One group pre, post, and follow up).

Study setting

The study was carried out in the pediatric specialized outpatient department, at children's hospital affiliated to Ain Shams University because this setting accommodates diagnosis, specific treatment, and follow-up care for a large number of children with CP. The pediatric neurology clinic is located in the first floor for two days /week (Sunday, and Wednesday; 9.00 am to 12.00 pm).

Study subjects

A purposive sample of 50 children diagnosed with either left or right unilateral spastic hemiplegic CP with regular follow-up from the previously mentioned setting.

Inclusion criteria:

- Age from 6-12 years.
- Children with IQ $\geq 70\%$.
- Able to verbally communicate.
- Children without hearing and visual impairment.
- Not received previously mirror intervention.
- Children attend more than two consecutive sessions to participate in the program.

Sample size:

As based on the total number of children with CP who attended the previously mentioned

setting during the year 2021 was about 400 as well as a Power Analysis of 95% that achieving the level of significance of 5%, the total sample size was calculated as follows:

$$n = \frac{t^2 \times P(P-1)}{m^2}$$

n= the required sample size.

t = the confidence level at 95% (standard value of 1.96).

p = estimated prevalence of unilateral spastic cerebral palsy.

m = the margin of error at 5% (standard value of 0.05). So, the total number of children was 50.

Tools for data collection

Data was collected by using the following tools and translated into simplified Arabic Language by a language expert:

I. Interview questionnaire format

It was composed of two parts:

The first part: (Characteristics of the studied subjects)

- a. Characteristics of the studied children including child's name, age, sex, educational level, child's ranking, residence, and affected limb.
- b. Characteristics of primary caregivers including age, sex, educational level, relationship to the child, number of children in the family, and employment status.

The second part: (The Activities of Daily Living Checklist (ADLs),

was adopted from Blank et al., (2009). Activities of daily living are a series of basic activities necessary for independent living at home or in the community. They are performed daily. It is used to measure the level of independence and estimate the level of assistance needed based on whether the child can perform these activities on their own or they need help from a family caregiver.

The tool description and scoring system are as follows.

ADLs	Description	Scoring system		
		Dependent 0	partially dependent 1	Independent 2
1. Personal hygiene	“Bathing/showering, washing face, washing hands, nose cleaning with tissue and water, combing hair, nail care, mouth washing, and brushing teeth”.			
2. Dressing	“Able to dress and undress oneself including wearing and taking off a shirt, wearing and, taking off trousers, wearing and taking off socks, wearing and taking off shoes”.			
3. Eating and drinking	“The ability to feed oneself, though not necessarily the capability to prepare food”.			
4. Maintaining continence	“Being able to use a restroom mentally and physically. This includes the ability to get on and off the toilet and cleaning oneself”.			
5. Transferring/Mobility	“Being able to stand from a sitting position, as well as get in and out of bed. The ability to walk independently from one location to another”.			
Total		0-3	4-6	7-10

II. Upper Extremity Functional Index (UEFI)

It was adapted from Stratford et al., (2001). It is a self-administered questionnaire for children that measures the degree of difficulty and disability in children with upper extremity impairment. The questionnaire lists 20 activities. The tool description and scoring system are as follows.

UEFI	Scoring system (Scoring was estimated based on the child's level of ability to complete each activity in the UEFI).				
	Extreme difficulty (0)	Quite a bit of difficulty (1)	Moderate difficulty (2)	A little bit of difficulty, (3)	No difficulty (4)
1. “Usual hobbies, recreational or sporting activities”					
2. “Usual work, housework, or school activities”.					
3. “Lifting a bag of groceries to waist level”					
4. “Lifting a bag of groceries above the head”					
5. “Grooming hair”					
6. “Pushing up with hands (eg, from bathtub or chair)”					
7. “Preparing food”					
8. “Vacuuming, sweeping, or raking”.					
9. “Riding bicycle “					
10. “Dressing”					
11. “Doing up buttons”					
12. “Using tools or appliances”					
13. “Opening doors”					
14. “Cleaning”					
15. “Tying or lacing shoes”					
16. “Sleeping”					
17. “Laundering clothes (eg, washing, ironing, folding)”					
18. “Opening a jar”					
19. “Throwing a ball”					
20. “Carrying a small suitcase with your affected limb”					

The overall score of the scale =80. The lowest possible score is 0. A lower score is the

lower function of the upper limb and indicates more child ‘s difficulty to perform the activities.

Scoring system:

- 0- 27= High difficulty of the upper limb activities.
- 28- 53=Moderate difficulty of the upper limb activities.
- 54- 80= Low difficulty of the upper limb activities.

III. Box and Block Test

Box and Block Test is a simple, inexpensive, and effective method for measuring manual dexterity of the hand for children with

upper limb paresis ages 6-18 years. It was developed by Mathiowetz et al., (1985). The box and block test consisted of a wooden box 53.5 cm by 24.4 cm which was divided into two equal compartments by a 15.2 cm partition. The child was asked to transfer as many 2.5 cm cubes as possible from one compartment to the other in one minute. The subject score was the number of cubes transferred in one minute. The normal Box and Block Test mean values for healthy children aged 6-13years as follow:

A Comparison of Right-Hand Dominant and Left-Hand Dominant for Normal Children Aged 6-13 Year, On Box Block Test

Hand	Dominance	Males Mean (SD)	Females Mean (SD)
Right	Right dominant	66.4(9.5)	66.7(9.4)
	Left dominant	64.7(10.3)	65.0(6.3)
left	Right dominant	63.4(10.0)	63.6(9.4)
	Left dominant	63.9(10.0)	63.1(7.3)

IV. Dimensions of Mastery Questionnaire (DMQ18), School-age Motivation Questionnaire (scored by adults)

It was developed by Morgan et al., (2019). It is 41 items a multifarious, psychological tool reported by parents to assess the child's behaviors and abilities to solve problems and perform tasks in affronting situations as well as

expect the child's successful achievements. Subscale parents who responded on a five-point Likert scale ranging from 1 "never like this child" to 5 "exactly like this child". The DMQ18 subscales with examples and the scoring system are illustrated in the following table:

Subscale	Items	Scoring system		
		Low	Moderate	High
1. The cognition-oriented persistence (e.g., "Completes schoolwork, even if it takes a long time", "Prefers to try challenging problems instead of easy ones").	6 items (1,14,17,23,29,40)	6-13	14-22	23-30
2. Gross Motor Persistence (e.g., "Tries to do well in physical activities even when they are challenging", "Tries hard to improve his or her ball-game skills").	5 items (3,12,26,36,38)	5-12	13-18	19-25
3. Social Persistence with Adults ("Often discusses things with adults", "Tries to get adults to see his or her point of view", "Tries hard to understand the feelings of adults:)."	6 items (8,15,19,22,33,37)	6-13	14-22	23-30
4. Social Persistence with Children (e.g., "Tries hard to understand other children", "Tries hard to make friends with other kids", "Tries to get included when other kids are doing something")."	6 items (6,7,25,28,32,35)	6-13	14-22	23-30
5. Mastery Pleasure (e.g., "pleased with self when finishes something challenging", "Gets excited when he or she is successful")."	5 items (2,11,18,21,30)	5-12	13-18	19-25
6. Negative Reactions- frustration/ anger ("Gets upset when not able to complete a challenging task, "Gets frustrated when does not do well at something")."	4 items (9,13,16,41)	15-20	8-14	4-7
7. Negative Reactions-sadness/shame (e.g., "Seems sad when he or she doesn't accomplish a goal", "Withdraws after trying but not succeeding")."	4 items (5,24,34,39)	16-20	10-15	4-9
8. General Competence (e.g., "Solves problems quickly", is very good at doing most things")."	5 items (4,10,20,27,31)	4-9	10-15	16-20
Overall total		41-68	69-136	137-205

V. Coopersmith Self-Esteem Inventory (CSEI)

It was developed by Coopersmith, in 1981 to assess children's attitudes toward themselves in relation to school, parents, peers, and general

social activities. The tool consists of 58 items answered by children (like me=0, Unlike me=1). The subscales with examples and scoring system are illustrated in the following table:

Subscale	Items	Scoring system		
		Low	Moderate	High
1. General Self (Self (e.g., "often wish I were someone else", "It takes me a long time to get used to anything new", "I really do not like being a boy (girl)").	25 items (1, 2, 3, 8, 9, 10, 15, 16, 17, 22, 23, 24, 29, 30, 31, 36, 37, 38, 43, 44, 49, 50, 51, 56, 57)	0-9	10-18	19-25
2. Social self-peers (e.g., "I am a lot of fun to be with", "I am popular with children my own age").	8 items (4, 11, 18, 25, 32, 39, 45, 52)	0-3	4-5	6-8
3. Home Parents ("My parents and I have a lot of fun together", "I get upset easily at home", "My parents usually consider my feelings").	8 items (5, 12, 19, 26, 33, 40, 46, 53)	0-3	4-5	6-8
4. Lie Scale ("I am never unhappy", "I like everyone I know", "I am never shy").	8 items (6, 13, 20, 27, 34, 41, 47, 54)	0-3	4-5	6-8
5. School Academic (e.g., "I find it very hard to talk in front of the class, "I am proud of my schoolwork", "I like to be called on in class").	8 items (7, 14, 21, 28, 35, 42, 48, 55)	0-3	4-5	6-8
Overall total		0-20	21-40	41-58

Tools validity and reliability:

- Validity:** Tools were revised by 3 professors in the Pediatric and Psychiatric/Mental Health Nursing departments to check the Arabic translation of their, appropriateness and applicability. Next, minor changes were made.
- The Reliability:** The reliability of tools was assessed, by the Cronbach alpha coefficient statistical test as follows:

Tool	Cronbach Alpha
Interview Questionnaire	0.89
UEFI	0.92
ADLs	0.88
BBT	0.92
DMQ18	0.89
CSEI	0.91

Pilot study

It was applied to 6 of the children with CP and their parents in the pediatric neurology clinic to test the tools for their appropriateness, simplicity, comprehensiveness, and optimal duration. After that, the essential changes were made. Subjects who were shared in the pilot study were excluded from the main study sample.

Ethical considerations

The research permission was obtained from the ethical committee in the Faculty of Nursing, Modern University of Technology and Information, Egypt with ethical code number: FAN/14/2021, and from the Director of Children's Hospital affiliated to Ain Shams University Hospitals. Also, written consent was obtained from the subjects after their approval to share in the present study. The researchers explained to the subjects that all information is confidential, and they have the right to withdraw at any time.

Materials:

- Appropriate height suitable table for children, and comfortable steady armchair.
- Colored balls, colored cubes, drawing boards, colored pencils, and gaming cards.
- A stand-alone triangular mirror box consists of (1) A mirror (30 cm x 30 cm) with (2) two acrylic pieces (35 cm x 40 cm) that are connected with a hinge that locks the two pieces together to be stabilized on the table. These dimensions of the mirror box were suitable to allow the child to see all activities of the hand.

4. The box and block consisted of: (1) wooden box (two equal wooden compartments (8.5×25×53 cm) with a 15.2 cm middle partition, and (2) 100 pieces of colored cubes (2.5cm).
5. Stopwatch.

Procedure:

The actual fieldwork was conducted from the beginning of June 2021 to November 2021. The researchers attended the research setting two days per week (Sunday and Wednesday) from 9 a.m. to 12 p.m. The contents of the mirror intervention program were designed in the light of related literature (Narimani et al., 2019) and reviewed by 3 professors in Pediatric and Psychiatric/Mental Health Nursing to evaluate the content validity of the study tools. Ethical approval was gained from the ethical committee in the Faculty of Nursing, Modern University of Technology, and Information, and gained the agreement to conduct the study from the director of the Children's Hospital affiliated to Ain Shams University. The researchers chose the children based on the inclusive criteria of the study. The researchers interviewed each child and accompanying parent individually to collect their demographic data and gain written consent after providing explanations about the purpose, method, and process of the study intervention.

Assessment and planning phase:

Assessment was done in the first session before conducting the mirror intervention program for each participating child and accompanying parent to assess, the Upper Extremity Functional Index, Activities of Daily Living Checklist, Dimensions of Mastery Questionnaire, Coopersmith Self-Esteem Inventory while assessment of the functional ability of the affected hand was done by Box and Block test where, the child asked to transfer the cubes by the affected hand from compartment to the other compartment while the researchers observed the child and counted how many cubes were transferred in minute. The time elapsed for completion of the child's assessment was 30-45 minutes. Before applying for the mirror intervention program, the researchers provided a quiet environment in a separate room inside the research setting (free from noise and other disruptive stimuli) to maintain the

child's relaxation and mental illusion for mirror intervention.

Implementation phase:

A mirror intervention program was conducted over a period of 12 weeks through 36 sessions, 30 minutes for each session. During the implementation of the mirror intervention program, the child sits on the armchair in front of the table. The mirror box was placed on the table in front of the child 's midline with a suitable length appropriate to the child's trunk and arm. The non-affected hand was situated in front of the mirror to facilitate complete visible reflection of the unaffected hand while the affected hand was placed in a safe comfortable position behind the mirror box. Parents were invited to sit behind their children during the mirror intervention program to comfort their children and train them to assist their children in performing mirror program sessions at home. During all sessions, the child was directed to perform hand exercises in the form of (clenching and opening the hand, playing with colored balls, gaming cards, transferring colored cubes, connecting dots of animals and letters on a board, and drawing and coloring using colored pencils, etc.). During the session, the researchers frequently directed the child to focus on the movements of the unaffected hand in front of the mirror box to improve the mirror illusion. Hand activities during the 12 weeks of the mirror intervention program ranged from simple movements such as clenching the hand and transferring colored cubes and balls to more difficult movements such as pushing, pulling objects on the table, drawing, coloring, and connecting dots.

The mirror box and some objects such as colored pencils, drawing board, and balls were sent home with the child to complete the mirror program sessions at home under the supervision of their parents. The researchers met the participating children and their accompanying mothers every four weeks on the day they visited the clinic for follow-up and receive medications. Most of the studied children enjoyed practicing mirror intervention and transferring objects as well as considering them as play. This can motivate the children to be willing to practice and complete the sessions.

Evaluation phase:

Evaluation of the program was done immediately after the implementation of 12 weeks of the mirror hand activities. Each child was evaluated individually in the pediatric neurology clinic to investigate the effect of the mirror intervention program on improvements in hand activity, mastery motivation, and self-esteem through using the previously mentioned tools. The researchers evaluate the functional ability of the affected hand using the Box and Block test to determine the level improvement by the number of transferring cubes in a minute. In addition, the follow-up phase was done after six months from the beginning of the program by using the previously mentioned study tools.

Data analysis

Data were coded, tabulated, and analyzed using Statistical Package for Social Sciences (IBM SPSS V22), The ANOVA (F-test) is used for comparisons of the study variables through the three phases of the mirror intervention program. Pearson correlation to assess the associations between study variables. the statistically significant differences were detected as follows:

- A statistically significant difference= P-value \leq 0.05
- A non-statistically significant difference= P-value $>$ 0.05

Results

Table (1) reveals that the Mean \pm SD of the studied children's age was 10.83 ± 4.64 and 44% of them were females and the same percentage of the child was ranked as first baby. Also, 54% of studied children have affected left limbs while 46% of them have affected right limbs.

Table (2) illustrates that 64% of the studied mothers aged between 25- < 35 years with Mean \pm SD 38.61 ± 4.64 . Regarding the relationship with the child, 80% of them were mothers and 44 % of the studied parents had a middle educational level.

Table (3) shows the overall increase in the mean scores of the upper extremity functional index among the studied children after the mirror intervention program and follow-up with a statistically significant difference at P-Value 0.05. There were improvements in the mean scores on the scale of the items after post-intervention and follow-up such as pushing up with hands (mean increased from 2.09 to 2.78, 3.20 respectively), grooming hair

(mean increased from 2.24 to 2.99, 3.17 respectively), opening the door (mean increased from 2.45 to 2.99, 3.22 respectively), and throwing a ball (mean increased from 2.61 to 2.97, 3.12 respectively), compared by pre-intervention with statistically significant differences (P-Value at 0.05).

Table (4) clarifies the overall improvement of the daily living Activities among the studied children, after a follow-up of the mirror intervention program such as personal hygiene and eating (mean scores increased from 1.01, 1.22 to 1.71, 1.90 respectively) compared by pre-intervention with statistically significant differences (P-Value at 0.05).

Table (5) reveals an increased Mean of Box and Block Test of the studied children with CP post, and follow-up Mirror Intervention Program compared to the pre-intervention (mean increased from 4.6 to 8.08, 9.8 respectively) with statistically significant differences (P Value at 0.05).

Table 6 shows a statistically significant increase in the mean scores of DMQ18 subscales as related to cognition-oriented persistence; the mean scores increased in the follow-up compared to the pre-intervention phase (mean increased from 11.3 to 18.7 respectively) with a P Value at 0.05. The mean scores of the Gross Motor Persistence and Mastery Pleasure subscales were statistically increased throughout the three phases of assessments (from 12.9 to 18.0 & 19.4 and from 11.0 to 17.0 & 18.3 respectively) with a P Value at 0.05. negative reactions- frustration/ anger and negative reactions/shame also statistically improved during the follow-up phase compared to the pre-assessment phase (mean increased from 6.3 to 9.6 and from 6.27 to 9.3 respectively) with a P-Value at 0.05. So, the DMQ18 overall total was statistically improved from the pre-intervention to follow-up phases (from 52.09 to 76.4).

Table 7 reveals that there were no statistically significant changes in the mean scores of CSEI subscales except for the home parents; the mean scores increased in the follow-up phase compared to the pre-intervention phase (from 3.12 to 5.9) with a P value of 0.05. So, the overall total mean scores of CSEI were not significantly changed throughout the three assessment phases (from 21.73 to 24.5 & 28.3 respectively).

Table 8 presents the correlation associated with UEFL, ADLs, BBT, DMQ18, and CSEI among children with CP. There were strong positive associations between the variables ($r = 0.771, 0.734, 0.661, 0.653$ respectively) with a P value of 0.01.

Table (1): Distribution of characteristics of children with Cerebral Palsy (CP) (n= 50)

Items	No.	%
Age (years)		
6-< 9	26	52
9-<12	24	48
Mean \pm SD	10.83\pm4.64	
Sex		
Male	28	56
Female	22	44.0
Educational Level		
Primary	44	88.0
Preparatory	6	12.0
Child's ranking		
First	22	44.0
Second	16	32.0
Third or more	12	24.0
Residence		
Urban	38	76.0
Rural	12	24.0
Types of the affected upper limb		
Right	23	46.0
Left	27	54.0

Table (2): Distribution of demographic characteristics of primary caregivers of children with CP (n=50)

Items	No.	%
Age (years)		
25-< 35 years	32	64.0
35-<45 years	11	22
\leq 45 years	7	14
Mean \pm SD	38.61\pm4.64	
Sex		
Male	9	18.0
Female	41	82.0
Educational level		
Basic	17	34.5
Middle (Diploma Secondary school)	22	44.0
High	11	22.0
Relationship to the child		
Father	6	12.0
Mother	40	80.0
Grandmother/father	4	8.0
Number of children in the family		
1-3	22	44.0
4-5	19	38.0
< 5	9	18.0
Employment status		
Work	24	48
Not work	26	52

Table (3): Comparison between Upper Extremity Functional Index (UEFI) of children with CP pre, post, and follow-up Mirror Intervention Program (n=50).

UEFI	Pre		Post		P Value	Follow		P Value	ANOVA	
	M	SD	M	SD		M	SD		F test	Sign.
1. "Usual work, housework, or school activities".	2.03	±0.65	2.48	±0.35	0.15	2.61	±0.23	0.05	2.51	0.12
2. "Usual hobbies, recreational or sporting activities".	2.12	±0.58	2.55	±0.37	0.13	3.05	±0.56	0.05	2.50	0.05
3. "Lifting a bag of groceries to waist level".	2.16	±0.41	2.41	±0.26	0.14	2.99	±0.35	0.05	2.63	0.05
4. "Lifting a bag of groceries above head".	2.01	±0.23	2.32	±0.44	0.17	2.40	±0.53	0.15	2.41	0.16
5. "Grooming hair".	2.24	±0.55	2.99	±0.30	0.05	3.17	±0.26	0.01	3.12	0.05
6. "Pushing up with hands".	2.09	±0.44	2.78	±0.52	0.05	3.20	±0.33	0.01	3.04	0.05
7. "Preparing food".	2.24	±0.42	2.69	±0.36	0.05	3.0	±0.34	0.01	2.93	0.05
8. "Vacuuming, sweeping, or raking".	2.02	±0.52	2.15	±0.56	0.45	2.75	±0.33	0.05	2.63	0.25
9. "Riding a bicycle".	1.66	±0.46	1.71	±0.37	0.36	1.77	±0.23	0.36	2.53	0.37
10. "Dressing".	2.36	±0.42	2.99	±0.44	0.05	3.01	±0.30	0.05	2.93	0.05
11. "Doing up buttons".	2.28	±0.36	2.91	±0.39	0.05	3.11	±0.23	0.05	2.63	0.05
12. "Using tools or appliances".	2.01	±0.51	2.44	±0.32	0.16	2.88	±0.34	0.05	2.73	0.05
13. "Opening the door".	2.45	±0.62	2.99	±0.48	0.05	3.22	±0.37	0.05	3.03	0.05
14. "Cleaning".	2.39	±0.49	2.96	±0.47	0.05	3.05	±0.33	0.05	2.63	0.05
15. "Tying or lacing shoes".	1.88	±0.64	2.00	±0.62	0.33	2.56	±0.22	0.05	2.63	0.12
16. "Sleeping".	2.55	±0.42	3.12	±0.26	0.05	3.33	±0.16	0.05	3.15	0.05
17. "Laundering clothes".	1.45	±0.55	1.66	±0.42	0.39	1.66	±0.11	0.35	1.63	0.05
18. "Opening a jar".	1.62	±0.57	1.71	±0.50	0.05	2.33	±0.38	0.05	2.63	0.16
19. "Throwing a ball".	2.61	±0.42	2.97	±0.41	0.05	3.12	±0.20	0.05	2.63	0.05
20. "Carrying a small suitcase with your affected limb".	1.75	±0.58	1.78	±0.50	0.45	1.89	±0.27	0.42	2.63	0.44
Overall total	37.77	±8.61	44.58	±7.62	0.05	49.44	±3.81	0.05	48.54	0.05

Table (4): Comparison between Activities of daily living checklist (ADLs) of children with CP pre, post, and follow-up Mirror Intervention Program (n=50).

ADLs	Pre		Post		P Value	Follow		P Value	ANOVA	
	M	SD	M	SD		M	SD		F test	Sign.
1. "Personal hygiene"	1.01	±0.25	1.58	±0.35	0.05	1.71	±0.23	0.01	1.51	0.05
2. "Dressing"	0.81	±0.28	1.0	±0.37	0.13	1.45	±0.26	0.05	1.40	0.05
3. "Eating"	1.22	±0.21	1.81	±0.26	0.05	1.90	±0.11	0.01	1.75	0.05
4. "Maintaining continence"	0.92	±0.13	1.02	±0.24	0.22	1.50	±0.13	0.05	1.41	0.05
5. "Transferring/Mobility"	1.01	±0.05	1.08	±0.30	0.25	1.37	±0.26	0.05	1.22	0.05
Overall total	4.97	±0.92	6.49	±1.52	0.11	7.93	0.99	0.05	7.29	0.05

Table (5): Comparison between Box and Block Test (BBT) of children with CP pre, post, and follow-up Mirror Intervention Program (n=50).

BBT	Pre		Post		P Value	Follow		P Value	ANOVA	
	M	SD	M	SD		M	SD		F test	Sign.
- The number of cubes transferred / one minute	4.6	±2.55	8.08	±2.33	0.05	9.8	±2.43	0.05	8.51	0.05

Table (6): Comparison between Dimensions of Mastery Questionnaire (DMQ18) of children with CP pre, post, and follow-up Mirror Intervention Program (n=50).

DMQ18 Subscales and overall total	Pre		Post		P Value	Follow		P Value	ANOVA	
	M	SD	M	SD		M	SD		F test	Sign.
1. The cognition-oriented persistence	11.3	±1.28	15.58	±2.82	0.31	18.7	±2.13	0.05	14.61	0.05
2. Gross Motor Persistence	12.9	±2.15	18.0	±2.37	0.05	19.4	±1.33	0.05	16.48	0.05
3. Social Persistence with Adults	9.42	±2.12	10.71	±2.26	0.43	14.9	±2.11	0.08	14.44	0.16
4. Social Persistence with Children	10.3	±2.13	11.02	±2.24	0.32	13.5	±2.13	0.17	12.85	0.28
5. Mastery Pleasure	11.0	±2.05	17.0	±2.36	0.05	18.3	±3.31	0.05	1.22	0.05
6. Negative Reactions-frustration/ anger	6.3	±2.58	8.3	±2.66	0.29	9.6	±2.16	0.05	9.12	0.06
7. Negative Reactions-sadness/shame	6.27	±2.42	8.5	±2.56	0.31	9.3	±2.11	0.05	8.44	0.07
8. General Competence	8.8	±2.88	10.2	±3.33	0.21	10.8	±2.18	0.19	9.8	0.31
Overall total	52.09	±14.18	65.73	±15.41	0.12	76.4	±14.0	0.05	54.87	0.05

Table (7): Comparison between Coopersmith Self-Esteem Inventory (CSEI) of children with CP pre, post, and follow-up Mirror Intervention Program (n=50).

DMQ18 Subscales and overall total	Pre		Post		P Value	Follow		P Value	ANOVA	
	M	SD	M	SD		M	SD		F test	Sign.
1. General self	9.44	±1.53	10.58	±1.72	0.28	11.2	±1.13	0.13	9.01	0.21
2. Social self-peers	3.0	±1.55	3.01	±0.37	0.45	3.4	±1.65	0.31	2.48	0.38
3. Home Parents	3.12	±1.72	4.26	±2.18	0.08	5.9	±1.13	0.05	5.44	0.05
4. Lie Scale	2.31	±1.14	3.03	±1.34	0.22	3.51	±2.13	0.09	2.85	0.18
5. School Academic	3.5	±1.66	3.66	±1.63	0.36	4.32	±1.31	0.08	1.22	0.12
Overall total	21.37	7.6	24.54	7.24	0.11	28.33	7.35	0.07	25.81	0.08

Table (8): Correlation between UEFI, ADLs, BBT, DMQ18, and CSEI among children with CP

The studied variable	Total UEFI,	Total ADLs	Total BBT	Total DMQ18	Total CSEI
Total UEFI,	r test				
	P value				
Total ADLs	r test	0.771			
	P value	0.01**			
Total BBT	r test	0.734	0.748		
	P value	0.01**	0.01**		
Total DMQ18	r test	0.661	0.614	0.651	
	P value	0.01**	0.01**	0.01**	
Total CSEI	r test	0.653	0.633	0.679	0.695
	P value	0.01**	0.01**	0.05*	0.01**

Correlation is significant at the 0.05 level **Correlation is significant at the 0.01 level

*** Correlation is significant at the 0.001 level

Discussion

Hemiparesis is one of the most common motor disabilities in children with cerebral palsy

(CP). The neonatal prevalence of unilateral spastic CP worldwide is estimated to be

between 1.5-3 per 1000 live births (WHO, 2018).

A mirror intervention program is a non-expensive, non-invasive, feasible application and may be considered as a rehabilitation adjunct for children with hemiplegic CP. In the beginning, mirror intervention was conducted by previous research on adults with hemiplegia after stroke, which showed significant improvement in upper extremity skills and hand activity of paretic arm function, as well as improved perceptual, sensory, cognitive function, and psychological aspects (Beebe and Lang 2009 ; Bruchez et al., 2016).

Concerning children's Characteristics, the researchers chose the age of the studied children in the present study ranging from six to twelve years with a mean age of 10.83 ± 4.64 years. As confirmed by Humphry and Case-Smith (2005) and Berk, (2015) by the age of six years, the child can assume maturation of hand activity with regular force either to grasp or to lift the object without slipping it through the fingers. Furthermore, above half of the studied children were males and with affected left-side arm paresis. This comes in agreement with Narimani et al., (2019) in the study titled "Effect of Mirror Therapy on Dexterity and Hand Grasp in Children Aged 9-14 Years with Hemiplegic Cerebral Palsy" who revealed that the mean age of studied children was 12.29 ± 3.49 years and most of them with left side hemiplegia and males. In contrast, the findings of the current study were in confront with the findings of Kara et al., (2019) who studied "Combined Effects of Mirror Therapy and Exercises on the Upper Extremities in Children with Unilateral Cerebral Palsy: A Randomized Controlled Trial" stated that the mean age of studied children were 12.3 ± 2.69 years, more than half (53.3%) of the females and the right-side hemiparesis was affected in 53.3% of the studied children.

As regards the demographic characteristics of the studied caregivers caring for children with CP were included in the present study; their main age was 38.61 ± 4.64 years and most of them were mothers. Adam et al., (2010) mentioned that mothers should be at a suitable age to be able to care for their children with special needs. Also, nearly half of the studied

caregivers were working and had from 1-3 other children in the family. These results were consistent with Afif et al., (2018) entitled "An Intervention Program for Mothers Regarding Dependency Level of their Children with Cerebral Palsy" who mentioned that the mean age of studied mothers was 37.6 ± 0.6 years, and nearly one-third of them had more than three children and nearly quarter of them have a job. Vadivelan et al., (2020) highlighted that mothers of children with CP tend to bear a great load to care for their children. This includes helping the child with amputation, hygiene, feeding, help in physical therapy, playing with the child, etc. In addition to all this, she also has the household chores as well as caring for their other children and family members.

The researchers viewed this point as improvement of the affected limb function in children with CP is more difficult to achieved compared with adults with cerebral stroke because the disability resulting from CP manifested early after birth, neither they had not any previous experience to learn normal motor patterns of the paretic limb, nor to develop the integrated perceptual-motor cortex in the brain compared to adult with stroke they have previous developed normal motor pattern.

During the mirror intervention of non-paretic limb movements, the children looked into the mirror watching the image of their non-affected hand. Mirror illusion helps to recruit the premotor cortex through an intimate connection between visual input and premotor areas creating visual feedback of the imagined action with the impaired limb (Stevens and Stoykov, 2003). Motor imagery with the mental performance of a movement has proven to be beneficial in the improvement of hand function and the learning of new skills by visual inspection of the skill (Michielsen, 2012).

As regards the effect of the mirror intervention program on upper Extremity Functional Index (UEFI) scores of children with CP. The current study findings revealed that significant improvements in overall UEFI scores post-implementation of the mirror intervention program and at the follow-up phase of the program. The improvements have been observed in scores in ten items out of 20 (5,6,7,10,11,13,14,16,17 and 18) of UEFI post

implementation of the program while the improvement was observed in thirteen items out of 20 items (2,3,5,6,7,10,11,12,13,14,16,17 and19) of UEFI at follow-up. These results were in accordance with the results of **Kara et al., (2019)** who reported there was a statistically significant enhancement in total scores of UEFI after 12 weeks of mirror therapy combined with power and strength training (P-Value < .05).

Hand activity is an essential basic function for children to perform routine activities of daily living. Children with CP have Spastic hemiplegia, so the hand function and hand movement are negatively affected. When hand function is impaired, the child becomes more dependent. So, Hand movement is essential in reducing spasticity, and improves daily living activity to help the child functionally independent (**Elanchezhian and Kumari, 2020**).

During mirror intervention, it was observed that marked improvement in some aspects of domains of Activity of Daily Living (ADLs) of the studied children which revealed an increased level of independence to perform the routine activities of daily living and indirectly affected the psychological aspects of the child with CP. The findings of the present study revealed that there were statistically significant differences in personal hygiene and eating post-implementation of the mirror intervention program, children with CP showed significant improvements in all aspects of ADLs at follow-up. These findings were consistent with **Berdien et al., (2015)** who studied “Activities of Daily Living in Children with Developmental Coordination Disorder: Performance, Learning, and Participation” mentioned that significantly improved Activity of Daily Living (ADLs) of the studied children after practicing mirror program.

The researchers viewed that the application of a mirror intervention program may help the child to reverse the problem of not using the affected hand in daily activities by exposing them to a new learning experience of hand activities focusing on improvement of the activity function of the affected hand to improve their level of independence consequently improve their psychological aspects.

The current study findings revealed significantly improved hand dexterity by observations of the number of cubes transferred per minute by moving the paretic hand post-mirror intervention program and at follow-up even if the pre- and post-values are not seen varied to a greater extent, but the change observed was significant. These results were in the same line with the findings of **Shahanawaz and Joshi (2015)** entitled “Effect of Mirror Therapy on Hand Functions in Children with Hemiplegic Cerebral Palsy: A Case Study” had reported significantly improved hand dexterity of paretic limb after implementation of mirror therapy.

The researchers’ opinion on this point was that the obtained data from the assessment phase about the affected hand function, before the beginning of mirror therapy intervention, revealed the degree of dependency among the studied children in performing Activities of Daily Living (ADL). Neglect of using the child’s affected hand may contribute to more hand weakness and reduce muscle strength, consequently, the child feels failure to perform basic hand activity. The results of the study showed mirror intervention program significantly improved the activity of the affected hand.

In the comparison of dimensions of mastery motivation among children with CP pre- post, and follow-up mirror intervention program, significant differences were observed in the overall motivation mastery mean scores during the follow-up of the program. furthermore, there were improvements in the mean scores of the Gross Motor Persistence and Mastery pleasure subscale after program and follow-up. It means that children submitted low mean scores in hand activity and daily living activities pre-intervention of the program and became more independent with increasing their functional ability after and follow-up implementation of the mirror intervention program as well and they became more interested in practicing their physical exercise. The parents reported that their children were more motivated to achieve in schoolwork and physical activities.

In addition, this result may be because of the current research program that provided supportive intervention to children with CP to

initiate their willingness to achieve and support readiness and achievement. These results are consistent with **Choi et al., (2019)** who showed that a significant improvement was found in the mirror intervention applied to a group of stroke patients regarding motivation and rehabilitation intention as compared with the control group. These results are also congruent with **Miryutova et al., (2021)** who stated that adding a mirror intervention program to the conventional care for patients after stroke resulted in the improvement in motor function of the paretic arm, and enhancing their positive emotions and motivation, mitigation of recurrent stroke risk factors, as well as significant effect on the cognitive functions and improvement of patients' abilities of self-care.

In the comparison of the Coopersmith Self-Esteem Inventory among studied children with CP pre-post, and follow-up mirror intervention program implementation, there were no statistically significant improvements in the overall total and subscales except for the home parents. It means that self-esteem among children was not enhanced after the program, this may be because self-esteem is a lifelong and multifactorial process that needs prolonged and continuous interventions for positive change and improvement. In the current study, the improvement happens in one aspect of self-esteem including the home parents. Although the other aspects were not significantly improved, their mean scores increased throughout the assessment phases. Another factor that may affect the significant effect of the program is children with CP still have physical limitations despite their improvements in hand activity and their activities of daily living, most of their mean scores ranged from low to moderate level. This analysis was supported by **Rudebeck, (2020)** who mentioned that psychological problems in children with CP cannot be easily improved due to one or a few factors. It is a multifaceted interactive process that changes over time. The analysis of the current study was supported also by **Elad, et al., (2018)** who asserted that physical function and activity have an essential role in a child's level of self-esteem, sense of autonomy and motivation in performing ADLs, and task performance.

The result of the current study showed that there were positive correlations between hand activity, mastery motivation, and self-esteem among children with CP pre-post and follow-up mirror intervention program. It means that the study variables are interrelated in which improving or altering one of them would affect the others. These results are congruent with **Salavati, et al., (2018a)** who reported that a child's motivation is an important personal factor that can affect the motor potential among children with CP and the children who make efforts and challenge tasks or risks against successive failure. They are more likely to have higher self-esteem which eventually may affect various aspects of their life.

In addition, these results agree with **Elad, et al., (2018)** who reported that motor impairment has a significant impact on the functioning level of the child. Nevertheless, a child's functioning is a complex concept that is also affected by his/her sense of autonomy. Consequently, a sense of autonomy can serve as a turning point in improving the functioning ability among children with CP.

Conclusion

The current study concluded that there were statistically significant differences among studied children with CP regarding hand activity in terms of Upper Extremity Functional Index, Activities of the daily living checklist, and Box and Block Test throughout the three phases (pre-, post, and follow-up) of assessment after implementing the mirror intervention program. The study also revealed statistically significant differences in some aspects of the Mastery Motivation questionnaire and the total scores, especially during the follow-up assessment after implementing the mirror intervention program. Although there were no statistically significant changes in the total scores of the Self-esteem Inventory and its subscales, the home parents' subscale was statistically improved after the follow-up assessment.

Recommendations

- Approving the mirror intervention program in routine care of children with hemiplegic cerebral palsy.

- Conducting further research evidence to evaluate the effect of mirror intervention program on other motor variables such as fine and gross motor, motor-eye coordination, and hand grasp strength.
- A longitudinal study should be conducted to assess the effect of the mirror intervention program on children with special disabilities self-esteem, and other psychological aspects.
- Further research evidence should be implemented to evaluate the effectiveness of mirror intervention programs on child and adolescent psychiatry, especially eating disorders and gender dysphoria.
- A longitudinal study should be conducted to assess the effect of the mirror intervention program on children with special disabilities related to daily living activities, somatosensory function, motivation, and self-concept.
- Applying mirror exposure intervention for psychiatric disorders with negative body image (body dissatisfaction) features such as body dysmorphic disorder and eating disorders utilizing the power of mirrors to draw out an emotional reaction to self-image through viewing oneself in a mirror in a structured repetitive way.
- Utilizing mirror therapy for amputee children as chronic pain management to improve the quality of residual limb activities and their functional outcomes.

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