



## CORRELATION BETWEEN UPPER LIMB IMPAIRMENTS AND MANUAL ABILITY IN CHILDREN WITH CEREBRAL PALSY

### Physiotherapy

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### ABSTRACT

**Background:** Cerebral Palsy (CP) describes as a group of permanent disorder of development of movement and posture causing activity limitation that are attributed to non-progressive disturbances occurred in developing fetal or infant brain. **Method:** Two motor and two sensory impairments were measured on both hands. Motor impairments included grip strength (hand held dynamometer), gross manual dexterity (Box and Block Test). Sensory impairments included stereognosis (Manual Form Perception Test) and proprioception (passive mobilization of the metacarpophalangeal joints). Manual ability was measured with the ABILHAND-Kids questionnaire. The correlation between hand impairments and manual ability was studied through Multivariate regression analysis. **Result:** Motor impairments, sensory impairments were statistically significant. GMD 51% was maximum and able to predict manual ability followed by proprioception (34%) stereognosis (38%). Grip strength was not able to predict the manual ability. result it can be predicted that manual ability is highly dependent on GMD. **Conclusion:** The present study concluded that, manual ability was statistically significant but moderately correlated with both motor and sensory impairments. As well as motor and sensory impairments were significantly but strongly correlated with each other. Hence it can also be concluded that grip strength, manual dexterity, sensory impairments all affects manual ability of a cerebral palsy child and hampers the upper limb performance.

### KEYWORDS

Cerebral palsy, Manual ability, Upper limb impairments.

#### INTRODUCTION

Cerebral Palsy (CP) describes as a group of permanent disorder of development of movement and posture causing activity limitation that are attributed to non-progressive disturbances occurred in developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication and behaviour as well as seizures and secondary musculoskeletal problems.<sup>[1]</sup>

Manual ability is a behaviour and it can be defined as “the capacity to manage daily activities requiring the use of the upper limbs, whatever the strategies involved.” Manual ability is based upon upper limb function, but it also involves environmental (e.g., assisting devices, school education) or personal (e.g., motivational, cognitive and emotional status, compensatory behaviours) contextual factors.<sup>[2]</sup>

The upper limb (UL) is more involved than the lower, with impairments of spasticity, sensation, and reduced strength. Effective use of the arm and hand to reach, grasp, release, and manipulate objects is often compromised.<sup>[3]</sup> Somatosensation has been defined as “all aspects of touch and proprioception that contribute to a person's awareness of his or her body parts and the direct interface of these with objects and the environment”.<sup>[4]</sup>

#### Need Of Study

Manual ability is an important aspect of ADL. It helps child to do things more independently and freely. Sensory and motor impairments have been the major issues which hampers the CP child in doing their activities. Previous studies are done to examine motor impairments and how it affects their manual ability, but apart from motor, sensory impairments are also more prevalent. So, the need of present study arises and it focus on how both motor & sensory impairments affect manual ability in CP patients. The objectives of this study were to correlate the motor impairments, sensory impairments and manual ability in CP children.

#### Aim Of The Study

Aim of the present study is to correlate the upper limb impairments and manual ability in children with CP.

#### Objectives Of The Study

- To correlate the motor impairments and manual ability in CP children.
- To correlate the sensory impairments and manual ability in CP children.
- To correlate motor and sensory impairments in CP children.
- To compare the motor and sensory impairments with manual ability in CP children.

#### METHODS

This study was approval by Institutional Ethical Committee. A total of 46 children with CP (age 4-18 year) were recruited through Various pediatric rehabilitation Centers and were assessed by the same examiner. Confirmed diagnosis of CP, both genders, all types of CP children, Children who are able to follow commands were included in this study. Uncontrolled seizures, Orthopedic surgery in the upper extremity within the previous 6 months, Severe visual problems, Botulinum toxin injections administered within 6 months were excluded in this study.

#### Assessment Of Hand Impairment

The children were tested individually in a quiet room and were instructed how to perform each test. 2 motor and 2 sensory impairments were assessed on both hands, starting with the dominant hand (DH). Handedness was determined by writing hand preference. Motor impairments included grip strength, gross manual dexterity. Grip strength was measured with a Dynamometer according to the procedure described by Mathiowetz. It is consisting of sealed hydraulic system with adjustable hand spacing the registered hand grip force in kilogram.<sup>[5]</sup> Gross manual dexterity was measured using the Box and Block test (BBT) according to the procedure described by Mathiowetz. Lower scores indicate less manual dexterity.<sup>[6]</sup> Sensory impairments included stereognosis, and proprioception. stereognosis test determines the ability to recognize the form of objects by touch. The patient is asked to name the object verbally. For patients with speech impairments, sensory testing shields can be used.<sup>[7]</sup> Ten objects of daily use (toothbrush, tennis ball, comb, candy-in-wrapper, large cup) and five shapes (circle, triangle, square, diamond, and octagon) were randomly presented to children. The total number of correctly identified items was the final score.<sup>[8]</sup> proprioception test examines joint position sense and the awareness of joints at rest. The extremity or joint(s) is moved through a Range of Motion (ROM) and held in a static position. The patient is asked to describe the position verbally or to duplicate the position of the extremity or joint(s) with the contralateral extremity (position matching) with blindfolded children.<sup>[7]</sup> Proprioception was measured by passively moving the metacarpophalangeal joints of the index finger and thumb according to the procedure of Cooper et al.<sup>[8]</sup>

#### Manual Ability Assessment

Manual ability was measured with the ABILHAND-Kids questionnaire. 21 mostly bimanual activities were rated by the children's parents on a 3-level scale (0: impossible, 1: difficult, or 2: easy) by providing their child's perceived difficulty in performing each activity. The parents were asked to complete the questionnaire by estimating their child's ease or difficulty in performing each activity, when the activities were done: 1. Without other technical or human

help (even if the child actually uses help in daily life) 2. Irrespective of the limb(s) actually used to do the activity 3. Whatever the strategy used (any compensation is allowed). Activities not attempted in the last 3 months were not scored and were encoded as missing responses. The manual ability measures were expressed in "logits", a probabilistic unit defined as the natural logarithm of the odds of success of a child to an activity (i.e., the pass/fail probability ratio).<sup>[9]</sup> Test-retest reliability was 0.92. ABILHAND-Kids scores can be reliably used as a performance- and capacity-based rating method across different raters<sup>[10]</sup>

**RESULTS**

The present study was conducted to correlate between upper limb impairments and manual ability in children with cerebral palsy. Total 46 subjects were included in the study over the age of 4-18 years according to inclusion criteria. Basic demographic details of the CP child were taken. Two motor and two sensory impairments were assessed on both hands.

**Table 1: Demographic Characteristics Of Children**

CHARACTERISTICS	MEAN	SD
AGE (N= 46) YEARS	10.24	5.34
BMI (Kg/m2)	15.37	4.07

**Table 2: Characteristics Of Children (N=46)**

		NUMBER	PERCENTAGE (%)
HAND DOMINANCE	RIGHT	28	60.86 %
	LEFT	18	39.13 %
TYPE OF CP	DIPLEGIC	30	65.21 %
	HEMIPLEGIC	6	13.04 %
	ATAXIC	2	4.34 %
	QUADRIPLLEGIC	7	15.21 %
	MIXED	1	2.17 %
GENDER	MALE	30	65.21 %
	FEMALE	16	34.78 %

**Table 3: Mean And Standard Deviation Of All Outcome Measures**

	MEAN	SD
GS <sub>DH</sub>	6.86	6.64
GS <sub>NDH</sub>	4.08	3.97
GMD <sub>DH</sub>	18.60	8.05
GMD <sub>NDH</sub>	14.84	6.78
PROPRIOCEPTION <sub>DH</sub>	7.60	3.18
PROPRIOCEPTION <sub>NDH</sub>	7.52	3.37
STEREOGNOSIS <sub>DH</sub>	8.41	2.32
STEREOGNOSIS <sub>NDH</sub>	8.26	2.48
ABILHAND-Kids questionnaire	28.69	11.09

DH – Dominance Hand, NDH –Non-Dominance Hand, GS- Grip Strength, GMD– Gross Manual Dexterity

**A) Correlation Of Motor Impairments With Manual Ability**

**Table 4: Correlation Of Grip Strength, Gross Manual Dexterity With Manual Ability**

	r value	p value
GS <sub>DH</sub>	0.34	0.02
GS <sub>NDH</sub>	0.42	0.00
GMD <sub>DH</sub>	0.71	0.00
GMD <sub>NDH</sub>	0.63	0.00

**Table 5: Correlation Of Grip Strength With Gross Manual Dexterity**

	GMD <sub>DH</sub>	GMD <sub>NDH</sub>
GS <sub>DH</sub>	0.59(p=0.00)	0.50(p=0.00)
GS <sub>NDH</sub>	0.64(p=0.00)	0.59(p=0.00)

**Table 6: Correlation Of Dominance And Non- Dominance Hand Grip Strength, Gross Manual Dexterity**

	r value	p value
GS <sub>DH</sub>	0.94	0.00
GMD <sub>DH</sub>	0.84	0.00

**B) Correlation Of Sensory Impairments With Manual Ability**

**Table 7: Correlation Of Proprioception, Stereognosis With Manual Ability**

	r value	p value
PROPRIOCEPTION <sub>DH</sub>	0.58	0.00

PROPRIOCEPTION <sub>NDH</sub>	0.56	0.00
STEREOGNOSIS <sub>DH</sub>	0.58	0.00
STEREOGNOSIS <sub>NDH</sub>	0.59	0.00

**Table 8: Correlation Of Proprioception With Stereognosis**

	STEREOGNOSIS <sub>DH</sub>	STEREOGNOSIS <sub>NDH</sub>
PROPRIOCEPTION <sub>DH</sub>	0.89(p=0.00)	0.89(p=0.00)
PROPRIOCEPTION <sub>NDH</sub>	0.821(p=0.000)	0.85(p=0.00)

**Table 9: Correlation Of Dominance And Non- Dominance Hand Proprioception, Stereognosis**

	r value	p value
PROPRIOCEPTION <sub>DH</sub>	0.91	0.00
STEREOGNOSIS <sub>DH</sub>	0.96	0.00

**C) Correlation Of Motor And Sensory Impairments**

**Table 10: Correlation Of Motor And Sensory Impairments In Dominance Hand**

	PROPRIOCEPTION <sub>DH</sub>	STEREOGNOSIS <sub>DH</sub>
GS <sub>DH</sub>	0.33(p=0.02)	0.41(p=0.00)
GMD <sub>DH</sub>	0.57(p=0.00)	0.57(p=0.00)

**Table 11: Correlation Of Motor And Sensory Impairments Non-dominance Hand**

	PROPRIOCEPTION <sub>NDH</sub>	STEREOGNOSIS <sub>NDH</sub>
GS <sub>NDH</sub>	0.39(p=0.00)	0.38(p=0.01)
GMD <sub>NDH</sub>	0.59(p=0.00)	0.59(p=0.00)

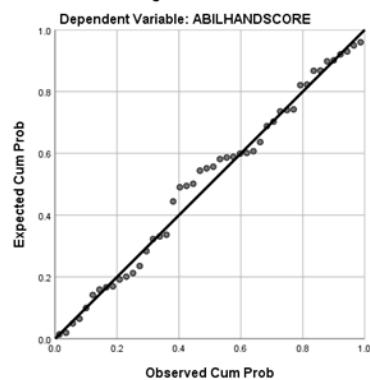
**Table 12: Multivariate Regression Analysis**

OUTCOME MEASURES	R <sup>2</sup> (PERCENTAGE)	p value
GS	0.189(18%)	> 0.05
GMD	0.517(51%)	< 0.005
PROPRIOCEPTION	0.340(34%)	< 0.005
STEREOGNOSIS	0.384(38%)	< 0.005

Multivariate regression analysis of all the outcome measure was done to find the predictability of dependent variable (manual ability). All motor and sensory outcomes were analyzed with manual ability to find predicted percentage.

Table 16 shows that GMD (DH & NDH), Proprioception (DH & NDH), Stereognosis (DH & NDH) were statically significant with p < 0.005. Grip strength was not able to predict the manual ability with p >0.05 From all the outcomes GMD value, 51% was maximum and able to predict manual ability followed by proprioception (34%) stereognosis (38%). From the above result it can be predicted that manual ability is highly dependent on GMD.

**Normal P-P Plot of Regression Standardized Residual**



**Graph 1: Multivariate Regression Analysis**

**DISCUSSION**

The Present study was conducted to find out Correlation Between Upper Limb Impairments and Manual Ability in children with cerebral palsy. Total participants falling in age group 4-18 years were investigated in 46 children with CP.

As per the results, manual ability was statistically significant but moderately correlated with both motor and sensory impairments. As well as motor and sensory impairments were significantly but strongly correlated with each other. Hence it can also be concluded that grip strength, manual dexterity, sensory impairments all affects manual ability of a cerebral palsy child and hampers the upper limb

performance.

All hand impairments were less prevalent on the DH than on the NDH, confirming that children with CP have developed their handedness on the less affected side.<sup>[11]</sup>

### Motor Impairments And Manual Ability

Present study found significant correlation of DH as well as NDH to both the motor impairments but DH correlation was stronger than the NDH.

This can be explained by a corticospinal tract integrity. Cerebral palsy causes interruption in the corticospinal tract leads to loss of voluntary motor control and finger dexterity.<sup>[11]</sup>

In the present study Gross manual Dexterity is strongly correlated with manual ability for both DH as well as NDH.

This can be explained by the fact that when manipulating bigger objects children use different manual strategies to perform the tasks contrary to fine finger dexterity, which requires more complex movements.<sup>[12-16]</sup>

### Sensory Impairments And Manual Ability

In present study sensory impairments like stereognosis and proprioception is correlated with the manual ability in CP children which is found to be moderate positively correlate with the ability of a child.

Disturbed sensory input from the affected hand of children with unilateral CP leads to reduced internal representation of the properties of objects, producing a reduction in anticipatory control and thus the ability to manipulate objects in the hand and to grasp effectively.

Sensory function is critical to functional outcome, and overall, a greater emphasis needs to be developed in clinical practice to record and potentially treat sensory function.<sup>[17-19]</sup>

In Present study Stereognosis and proprioception was statistically positively strongly correlated with each other for both DH and NDH.

This can be explained by the fact that to perform ADL activities the child needs coordinated work from object identification as well as manipulation.

If any of the sensory function is impaired it can directly affect the manual ability.

GMD of DH and NDH and stereognosis were the best predictor from manual ability of children with CP. This can be explained by the fact that routine activity requires cooperation of both the hand. For example, open a lid of jar or writing with the pencil or crayon requires dexterity as well as stereognosis both.

### CONCLUSION

The present study concluded that, manual ability was statistically significant but moderately correlated with both motor and sensory impairments. As well as motor and sensory impairments were significantly but strongly correlated with each other. Hence it can also be concluded that grip strength, manual dexterity, sensory impairments all affects manual ability of a cerebral palsy child and hampers the upper limb performance.

### Limitation Of The Study

- Smaller sample size.
- Sample size was nor similar in all the types of CP
- Limited impairments were taken for motor and sensory aspect.
- Other co variates like activity level of a child, spasticity, deformities, cognition, BMI were not considered.

### Future Recommendations Of The Study

- Larger sample can be taken with equal sample size in all CP type.
- More objective outcome measures can be taken to quantify the impairments.
- Manual ability can be correlate with cognition, along with the motor and sensory domain.
- Prospective study would therefore be useful to determine how changes in hand impairments influence child's manual ability.

- Interventional study can be done to treat upper limb impairments which will further help in improving manual ability and ADLs of CP children.

### Clinical Implications

Motor, sensory outcomes and manual ability would be identifying risk guide rehabilitation therapist in clinical decision makings in terms of treatment planning.

Identifying the exact impairments which hampers the daily activities of a child will be helpful in planning the rehabilitation for children with CP.

Motor, sensory and manual ability towards children is an important factor for child's prognosis and future life.

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