

## Research Paper

## The Relationship Between Manual Ability and Self-care in Children Aged 1-8 Years With Spastic Cerebral Palsy: A Cross-sectional Study

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**Citation** Amiri M, Dalvand H, Rassafiani M, Almasi A. The Relationship Between Manual Ability and Self-care in Children Aged 1-8 Years With Spastic Cerebral Palsy: A Cross-sectional Study. *Iranian Rehabilitation Journal*. 2023; 21(4):601-610. <http://dx.doi.org/10.32598/irj.21.4.160.4>

**doi** <http://dx.doi.org/10.32598/irj.21.4.160.4>

**Article info:****Received:** 08 Apr 2023**Accepted:** 27 Jul 2023**Available Online:** 01 Dec 2023**Keywords:**

Manual ability classification system (MACS), Mobility, Self-care, Spastic cerebral palsy

**ABSTRACT**

**Objectives:** Limitations in the ability to perform manual functions decrease the individual's participation in activities of daily living (ADLs). Thus, it is required to study the relationship between manual skills and self-care activities in children. This study aims to investigate the relationship between manual ability and self-care in children with spastic cerebral palsy at the ages of 1 to 8 years.

**Methods:** In this cross-sectional study, 125 children aged 1-8 years with spastic cerebral palsy who were chosen by the convenience sampling method from 8 occupational therapy clinics in Tehran City, Iran, in 2022 were studied. The evaluation tools were manual ability classification system (MACS), mini-manual ability classification system (Mini-MACS), pediatric evaluation of disability inventory (PEDI), and cognitive level form designed in the SPARCLE project. After collecting the data, Stata software, version 14 was used to analyze data using chi-square, Spearman correlation coefficient, Mann-Whitney, Kruskal-Wallis, and regression.

**Results:** In this research, the mean age of the children was 54.2±15 months and 43.2% had a cognitive level >70. The mean self-care and mobility in children were 49.65±30.60 and 40.78±26.97, respectively. With increasing age, self-care and mobility of children showed a significant increase (P<0.001). No significant difference was observed between boys and girls in self-care and mobility (P<0.05). By changing the education level of the main caregiver, no significant difference was found in self-care and mobility (P<0.05). With the increase in children's cognitive ability level and MACS level, self-care and mobility improved significantly (P<0.001). Moreover, the level of MACS and mobility with the highest beta values (-0.530 and 0.512, respectively) showed a greater contribution to the prediction of self-care.

**Discussion:** The results showed that with increasing age, cognitive ability level, and MACS level, self-care and mobility improve significantly in children with spastic cerebral palsy. Therefore, it is suggested to pay more attention to manual ability to improve self-care and mobility in these children.

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## Highlights

- In children with spastic cerebral palsy, self-care activity has increased with the improvement of the cognitive level.
- Self-care activity has increased with increasing levels of manual ability classification system (MACS) in children with spastic cerebral palsy.

## Plain Language Summary

This study showed that in children with spastic cerebral palsy, self-care activity has a relationship with cognitive level and manual ability classification system (MACS) level. Occupational therapists should pay more attention to manual ability to improve self-care in these children.

## Introduction

Cerebral palsy (CP) includes a group of non-progressive and non-contagious neurological disorders that cause physical and cognitive disabilities in human development and influence performance, participation, mobility, posture, muscular strength and endurance, visual system, perception, communication and behavior [1, 2]. The prevalence of this disorder in Iran is reported to be 2.06 cases per 1000 live births [3]. Sensory-motor damage in the upper limb mainly causes problems in activities of daily living (ADLs) [4]. Compared to gross motor function, less attention is often paid to manual ability and statistics show that manual ability is challenging in approximately 50% of children with CP [4, 5]. Limitations in manual ability can cause restrictions in performing and completing ADLs [6]. Limitations in manual ability, regardless of gross motor function, have a crucial impact on the participation of people with CP [7]. The manual ability classification system (MACS) is directed at children with CP aged 4 to 18 years based on the way of using two hands when manipulating objects during ADLs [8]. Recently, this classification system has been expanded and can also check the manual ability of children with CP aged 1 to 4 years, which is called the mini-manual ability classification system (Mini-MACS) [9].

On the other hand, children must learn the ability to take care of themselves, and this develops at the age of 8 years. The pediatric evaluation of disability inventory (PEDI) is one of the most common tools to evaluate performance in children with CP [10]. PEDI indicates the functional status and occupational performance of children with disabilities in the self-care, mobility, and social function domains [11]. The study conducted by Kuijper et al. indicated an inverse relationship between the level of ability to perform self-care activities and the

severity of the damage to manual ability [12]. The study results of Burges et al. showed that children who scored the highest in self-care based on the PEDI demonstrated the highest level of manual ability [13].

One of the crucial priorities of children with CP and their families is independence in performing ADLs, especially self-care. Therefore, it is required to know about the ability level of children and the expected level of these abilities in performing ADLs. Moreover, considering the difference in the level of providing rehabilitation and medical services in developing countries and developed countries and cultural differences regarding daily activities, such as going to the toilet, it is essential to determine the relationship between manual ability and self-care in children with spastic CP. So far, no study has been conducted on the use of the Mini-MACS. Therefore, this study was conducted to investigate the relationship between manual ability and self-care in children aged 1 to 8 years with spastic CP.

## Materials and Methods

This study was a cross-sectional (descriptive and analytical) research. The study population included all children with spastic CP aged 1-8 years who were referred to public and private occupational therapy clinics in Tehran City in 2022 and were included in the study using the convenience sampling strategy. The inclusion criteria included the diagnosis of the spastic CP by a pediatric neurologist, age between 1 and 8 years, and having literate parents. The exclusion criteria included botulinum toxin injection in the last 6 months and surgery in the last 9 months. Evaluation tools were MACS, Mini-MACS scales, PEDI, and cognitive ability estimation forms designed in the SPARCLE project.

### Manual ability classification system (MACS)

The MACS is designed based on the child's performance in performing ADLs and how to use both hands when using objects for children with CP aged 4 to 18 years in five levels [8]. Children at level 1 control objects easily and without restrictions, and independence is maintained in ADLs. At level 5, the child cannot control objects [14]. This tool was translated into Persian by Ryahi et al. [14] and its validity and reliability were measured (intraclass correlation coefficient [ICC]=0.97). The MACS scale has recently been expanded and can also assess the manual ability of children with CP from 1 to 4 years old, which is called the mini-manual ability classification system [13]. The validity and reliability of this scale was confirmed by Ryahi and et al. [15].

### Pediatric evaluation of disability inventory (PEDI)

PEDI is one of the most common tools to assess occupational performance in children with CP [10]. PEDI indicates the functional status of children with disabilities in the self-care, mobility, and social function domains [11]. The PEDI evaluates these domains in three separate scales, including 197 items related to functional skills, 20 items related to caregiver assistance, and 20 items related to modification [11]. The validity and reliability of this inventory in the children with CP were confirmed by Moradi Abbasabadi et al. (Cronbach's  $\alpha$  0.98-0.94) [16, 17].

### Cognitive level form

This form is derived from the impairment form in the SPARCLE project, which measures cognitive ability level based on ICD-10 in three categories, including cognitive ability level >70, between 50-70, and <50 [18]. This form is completed by the family of participants. If the cognitive ability level is 50-70, it is mild, and if the cognitive ability level is <50, it is severe [19]. Nobakht et al. investigated the validity of this test in children with CP [18].

After obtaining permission to conduct the research from the Research and Technology Vice-Chancellor of Tehran University of Medical Sciences, the authors referred to the public and private occupational therapy centers in Tehran City to collect data. Then, using the MACS and Mini-MACS scales, children were classified in the age groups of 1 to 2 years, 2 to 4 years, 4 to 6 years, and 6 to 8 years in five levels of MACS. Then, the PEDI was applied and caregivers part was completed by the children's family, and the functional skills were

completed by the occupational therapist, then, the score related to self-care was collected in two parts, functional skills and caregiver assistance. Each item of the PEDI in the self-care part was assigned two scores of 1 (ability) or 0 (disability). Also, a score of 0 (full assistance) to 5 (full independence) was considered for caregiver assistance items. The collected data was analyzed using Stata software, version 14 by descriptive statistics (frequency and Mean $\pm$ SD) and analytical statistics (correlation coefficient, chi-square, independent t-test, Fisher's test, and one-way analysis of variance and regression if the data was normal). Non-parametric tests were used in the case of non-normal distribution of the variables.

### Results

In this study, 125 children aged 1 to 8 years with spastic CP were examined, and 71 of them (56.8%) were boys. The average age of the children was 54.2 $\pm$ 15 months. Table 1 presents the demographic characteristics of children with spastic CP.

According to the results, the average level of MACS of children with spastic CP in this study was 3.01 in the range of 1 to 5. The average self-care in these children was 49.65 with a minimum and maximum of 2 and 113, respectively.

Table 2 presents the relationship between the gender and education level of the main caregiver with the levels of MACS in children with spastic CP. The results of Table 2 indicated that a significant difference was observed between boys and girls in the levels of MACS ( $P=0.031$ ). Also, no significant difference was observed in the levels of children's MACS according to the education levels of the main caregiver ( $P=0.772$ ). A significant difference was observed in the levels of MACS in these children according to cognitive ability level ( $P<0.001$ ). A significant relationship was observed between the age of children with spastic CP and their levels of MACS.

In this study, the relationship between the age of children with spastic CP and the children's self-care was analyzed using the Spearman correlation test, and a statistically significant relationship was observed between the age and the variables of the children's self-care ( $P<0.001$ ); that is, as the age of the children increases, the ability to take care of themselves increases significantly. The relationship between gender and self-care in children with spastic CP was analyzed using the Mann-Whitney test, and no significant difference was observed between boys and girls in self-care ( $P=0.455$ ). Based on the result of Table 3, with the change in the education

**Table 1.** Demographic characteristics of children with spastic CP

Variables	Minor Classes	No. (%)
Gender	Girls	54(43.2)
	Boys	71(56.8)
Types of CP	Monoplegic	9(7.2)
	Hemiplegic	39(31.2)
	Diplegic	32(25.6)
	Quadriplegic	45(36)
Cognitive ability levels	<50	25(20)
	50-70	46(36.8)
	>70	54(43.2)
MACS levels	I	17(13.6)
	II	35(28)
	III	27(21.6)
	IV	22(17.6)
	V	24(19.2)
Caregiver's education levels	Below high school	20(16)
	High school and associate degree	32(25.6)
	Bachelor	50(40)
	Master and higher	23(18.4)

MACS: Manual ability classification system; CP: Cerebral palsy.

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level of the main caregiver, no significant difference was observed in the self-care of children with spastic CP ( $P=0.673$ ); however, with the increase in children's cognitive ability level, the levels of MACS, and in children with spastic CP, the ability to take care of themselves increased significantly ( $P<0.001$ ).

The results test revealed a significant difference between different levels of cognitive ability level in terms of self-care ( $P<0.001$ ). In comparing cognitive ability levels, a significant difference was observed among levels <50, between 50-70, below 50 and >70, between 50-70, and >70. Regarding the children's MACS levels, no statistically significant difference was found in self-care between levels I and II, levels II and III, levels III and IV, and levels IV and V (Table 4).

A regression test was used to investigate the significant relationship between children's mobility and their self-

care, and the  $R^2$  value was equal to 0.773, which showed that 77% of changes in the self-care variable were described by children's mobility variables. It showed the linearity of these relationships. Also, according to the regression coefficients and the beta coefficient, the mobility variable with an impact factor of 0.88 had a significant effect in predicting the self-care of children. To investigate the significant relationship between the variables of age, level of cognitive ability, level of MACS, and mobility of the studied children with their self-care, a regression test was performed and the  $R^2$  value was obtained equal to 0.881, which showed that 88% of changes in the self-care variable is described by these variables.

A significant relationship was observed between the variables of age, MACS level, and mobility of children with self-care ability ( $P<0.0001$ ); however, the effect of children's level of cognitive ability on their self-care ability was not significant ( $P=0.815$ ) and did not affect

**Table 2.** The relationship between the gender and education level of the main caregiver with the level of manual ability in children with spastic CP using chi-square test

MACS	Gender/Education	No. (%)					P
		Level I	Level II	Level III	Level IV	Level V	
Gender	Boys	6(8.5)	21(29.6)	12(16.9)	18(25.4)	14(19.7)	0.031
	Girls	11(20.4)	14(25.9)	15(27.8)	4(7.4)	10(18.5)	
Caregiver's education levels	Below high school	1(5)	6(30)	4(20)	3(15)	6(30)	0.772
	High school and associate degree	3(9.4)	8(25)	7(21.9)	8(25)	6(18.8)	
	Bachelor	8(16)	14(28)	13(26)	6(12)	9(18)	
	Master and higher	5(21.7)	7(30.4)	3(13)	5(21.7)	3(13)	
Cognitive ability levels	>70	16(29.6)	26(48.1)	11(20.4)	1(1.9)	0	<0.001
	50-70	1(2.2)	8(17.4)	16(34.8)	15(32.6)	6(13)	
	<50	0	1(4)	0	6(24)	18(72)	

MACS: Manual ability classification system.

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on predicting the dependent variable. According to the beta coefficients and comparing its values, the factor of MACS level and mobility with the highest beta values (-0.530 and 0.512, respectively) had a greater contribution in predicting self-care ability compared to other variables (Table 5).

## Discussion

Based on the result of this study, with the increase in the MACS level of children with spastic CP, their performance in self-care increased significantly. Based on the study results of Kuijper et al. [12] and Burges et al. [13], an inverse relationship was observed between the level of self-care and the severity of injury in the MACS, which was consistent with the results of the present study. In the study conducted by Gunel et al. [20], the self-care of children with disabilities increased significantly with the increase in the level of MACS, which is consistent with our results.

According to the results of this study, with the increase in the level of cognitive ability of children aged 1 to 8 years with spastic CP, the self-care of these children was increased. The significant relationship between cognitive ability level and self-care has not been specifically investigated in children with CP; however, Himmelmann et al. [21] and Türkoğlu et al. [22] mentioned the relationship between the higher severity of CP and lower cognitive ability level in their studies. The critical difference of these studies is the dearth of reliable information

in which the specific norms of society are considered for the intellectual evaluation of children with CP. For example, different assessment materials and tests are needed for children who have visual and communication problems with a high level of motor difficulty [23], and different systems for evaluating the cognitive ability level of children with CP and lead to different results.

The results of this study indicated that in children with spastic CP aged 1 to 8 years, no significant relationship was observed between the education level of the main caregiver and the child's performance level in self-care. Studies that have assessed demographic variables about children with CP have examined the child's education level or socioeconomic variables, and no similar study was found that examined the education level of the main caregiver about self-care in children with CP. Considering that it is expected that with the increase in the education level of the caregivers, their awareness and knowledge regarding the type of disease, the condition of the children, and the type of behavioral intervention will increase and consequently the ability of the children under their care in functional skills will be strengthened and increased. However, a different result was obtained and this relationship was not significant.

According to the results of the research, no significant difference was observed between boys and girls in self-care. Jarvis et al. reported a higher probability of birth of male infants with severe CP compared to female infants [24]. In the study conducted by Pfeifer et al., no signifi-

**Table 3.** Correlation of variables of caregivers' education level, cognitive ability level MACS and self-care using Kruskal-Wallis test

Variables Statistics	Classification	Rank Mean	X <sup>2</sup>	P
Education level of the main caregiver	Below high school	56.85	61.105	0.0001
	High school and associate degree	59.47		
	Bachelor	65.43		
	Master and higher	67.98		
Cognitive ability levels	<50	19.94	61.105	0.0001
	50-70	57.61		
	>70	87.53		
MACS levels	Level I	106.35	91.157	0.0001
	Level II	85.76		
	Level III	68.30		
	Level IV	40.05		
	Level V	14.19		

Abbreviations: MACS: Manual ability classification system.

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**Table 4.** Pairwise comparison of children's level of cognitive ability MACS and self-care based on Dunn's post hoc test

Variables	Classification	Z	P
Cognitive ability levels	(<50)-(50-70)	-37.669	>0.001
	(<50)-(>70)	-67.588	>0.001
	(50-70)-(>70)	-20.919	>0.001
MACS levels	Level I-Level II	20.596	0.544
	Level I-Level III	38.057	0.007
	Level I-Level IV	66.307	>0.001
	Level I-Level V	92.165	>0.001
	Level II-Level III	17.461	0.599
	Level II-Level IV	45.712	>0.001
	Level II-Level V	71.570	>0.001
	Level III-Level IV	28.251	0.660
	Level III-Level V	54.109	>0.001
Level IV-Level V	25.858	0.156	

MACS: Manual ability classification system.

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**Table 5.** The results related to the regression coefficients of demographic and functional variables with the beta factors

Predictive Variables	Regression Coefficient B	SE	$\beta$	P
Constant	35.478	9.767	-	>0.0001
Age	0.259	0.045	0.204	>0.0001
Cognitive ability levels	0.479	2.043	0.012	0.815
MACS	-12.139	1.589	-0.530	>0.0001
Mobility	0.581	0.074	0.512	>0.0001

MACS: Manual ability classification system; SE: Standard error.

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cant difference was observed between gender and gross motor performance [25-27]. However, no independent studies were found that investigated the relationship between the gender of children with CP and self-care. The differences mentioned in this study can probably be due to cultural differences, different age ranges, scales, and different populations studied.

According to the results, as the age of the children increased, their self-care increased significantly ( $P < 0.05$ ). Öhrvall et al. realized a significant relationship between age and self-care, which was consistent with the results of the present study [28]. In another study conducted by Phipps and Roberts, a significant relationship was found between age and self-care [26], which was consistent with our results, although a smaller age range was examined in the present study. Østensjø et al. recognized that preschool children with CP were unable to perform functions individually [27]. However, when older children and adolescents were examined in the analyses, children's MACS and gross motor function classification system (GMFCS E & R), and subsequently self-care and mobility skills increased significantly with increasing age [28].

The regression analysis results showed that 88% of the changes in the self-care variable were described by the variables of age, MACS level, level of cognitive ability, and mobility of the children. According to the regression analysis results, the variables of age, MACS level, and mobility of children were significant with self-care ( $P < 0.05$ ), while the effect of children's level of cognitive ability on their self-care was not significant ( $P > 0.05$ ), and it did not affect predicting the dependent variable. Finally, MACS level and mobility had a greater contribution to the prediction of self-care compared to other variables, respectively. In the study conducted by Öhrvall et al., the level of MACS (66%) was the strongest predictor for self-care [28], which is consistent with the results of this study. Based on the results, the level of

MACS describes 53% of changes in the self-care. This may be partly explained by the item content of the PEDI. It can be assumed that these results originate from the fact that self-care includes items that do not measure manual ability. In addition, several factors that were not examined in this study affect the achievement of functional skills, such as cognition, motivation, and attention [9, 27, 29-31].

The limitations of this study included the problems of access to children with spastic CP and the cooperation of clinic managers, which their satisfaction and cooperation were obtained to a large extent by justifying and explaining the importance of research and the application of the results to promote and improve the condition of children. The data collection period coincided with the outbreak of COVID-19, which caused problems in children's access and completing the data, and the data was collected by following the protocols. The long time for the tests and the problems of the clients' traveling were among the other limitations of the study.

## Conclusion

According to the results, self-care was promoted significantly as children aged 1-8 years with CP increased; however, gender did not show a significant effect. By increasing children's level of cognitive ability and increasing the level of children's MACS, self-care increased significantly. Furthermore, the self-care was greatly influenced by the level of MACS and mobility. The results of this study showed that by strengthening manual skills, we hope to improve the conditions of children with CP by improving self-care. It is suggested that future studies investigate manual function ability, self-care, and mobility compared to the healthy or control group. Also, it is recommended to examine the effectiveness of intervention occupational therapy in enhancing the self-care, mobility, and social function of children, adolescents, and young adults with CP.

## Ethical Considerations

### Compliance with ethical guidelines

This research approved by the Ethical Committee of [Tehran University of Medical Sciences](#) (Code: TUMS.FNM.REC.1399.174). The information of the participants remained confidential, and if they did not want to participate in the study, their information was removed from the research data set.

### Funding

This article extracted from master's thesis of Mohammad Amiri, approved by School of Rehabilitation, [Tehran University of Medical Sciences](#). This study was financially supported by the [Tehran University of Medical Sciences](#).

### Authors' contributions

All authors equally contributed to preparing this article.

### Conflict of interest

The authors declared no conflict of interest

### Acknowledgments

The authors of the article highly appreciate the children's parents and healthcare providers who participated in the study.

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