

## Article

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## Evaluation of the Relationship Among Upper Extremity Anthropometric Factors and Grip Strength in Children Diagnosed with Hemiplegic Cerebral Palsy

Gülüzar Gül , Tuncay Çolak , Ayla Tekin 

**Abstract**

**Background/purpose.** The aim of this research is to investigate the relationship among anthropometric measurements of the upper extremity, joint range of motion (ROM), and grip strength in children diagnosed with hemiplegic cerebral palsy (HCP).

**Materials/methods.** The research included 30 children diagnosed with HCP, comprising 18 boys and 12 girls. Anthropometric measurements, ROM, and grip strength of both affected and unaffected sides were measured and analyzed.

**Results.** In children, degrees of ROM and grip strength on the affected side were significantly lower compared to those on the unaffected side ( $p < 0.05$ ). Positive and strong correlation was observed in the affected sides among radial deviation, thumb/carpometacarpal (CMC) abduction, all anthropometric measurements and grip strength through correlation analysis

**Conclusion.** The grip strength of children diagnosed with HCP on the affected side is crucial for their ability to perform daily life activities independently. It is anticipated that exercises focusing on increasing radial deviation and CMC abduction degrees will lead to an improvement in the grip strength of the affected sides.

## 1. INTRODUCTION

Cerebral palsy (CP) is a group of motor and sensory disorders, along with associated postural dysfunction, arising from a static lesion in the developing brain (Sharma & Kaur, 2017). Among the types of CP, spastic CP is the most common type (Wimalasundera & Stevenson, 2016). Hemiplegic cerebral palsy (HCP) accounts for 39% of all spastic CP cases and has various etiologies such as prematurity, birth asphyxia, and prolonged labor (Novak, 2014). The prevalence of HCP has been reported to be among 0.6 and 0.9 per 1000 live births (Odding et al., 2006). In HCP, the upper extremities are more affected than the lower extremities, and with rehabilitation, these children can gain walking abilities (Arnould et al., 2014).

Approximately 60% of children with CP exhibit upper extremity impairments (Arner et al., 2008), and this is essential for the functional use of the upper extremity (Temur, 2017). Grasping is considered the most important function of the hand, and grip strength serves as an objective measure in evaluating upper extremity performance (Hegazy et al., 2019). Furthermore, a study clearly indicated that grip strength represents the overall body strength (Williams et al., 1973) and serves as an indicator of general body health (Yücel & Kayhan, 2008). In terms of classification, 79% of HCP children are classified as level I or II in accordance with the Manual Ability Classification System (MACS), with level I indicating the ability to grasp objects easily, and level II indicating the ability to grasp objects at a slightly lower quality and speed (Fehlings et al., 2021; Eliasson et al., 2006). When the literature is examined, there is a restricted number of research examining the relationship among grip strength, anthropometric measurements, and ROM in children with HCP. Our study aims to fill this gap in the literature that we believe exists in this area.

## 2. METHODOLOGY

The research was carried out on a total of 30 children with HCP who were receiving physiotherapy and rehabilitation at Special Education and Rehabilitation Centers. The criteria for inclusion in the research were as follows: the ability to understand basic commands at a cognitive level, a maximum spasticity score of 1-2 according to the Modified Ashworth Scale (MAS) in the forearm, hand, and wrist (considering 1+ as 2 on a scale of 0-5), no limitations in passive range of motion at the hand-wrist, elbow, and shoulder joints as measured by goniometry, having a grasp level of I or II according to MACS, no history of surgical intervention or botulinum toxin injections in the past 6 months, and not using any devices for the upper extremity. Considering that the differences in growth patterns between boys and girls with HCP aged 5-12 years are negligible, gender differentiation was not taken into account in our study (Özer & Özer, 2012).

The following information was taken from the files of the children incorporated in the research: full name, age, gender, date of birth, and information regarding the affected side. Anthropometric measurements included length, circumference, and diameter measurements. In addition, ROM and grip strength measurements were conducted. For circumference and length measurements, a non-elastic measuring tape with a width of 7 millimeters (mm) was used. For diameter measurements, a Harpenden-type Holtain anthropometric set was used. Goniometer was used for ROM measurement. For weight measurement, a digital scale accurate to 0.1 kg was used. Grip strength measurement was performed using a Jamar hand dynamometer. A study investigating the reliable measurement of grip strength in children with unilateral CP concluded that the Jamar hand dynamometer is a reliable measure (Klingels et al., 2010). Grip strength measurements were conducted using the Jamar dynamometer and recorded in kilograms (kg). Grip strength was measured in the standard test position defined by the American Society of Hand Therapists. The children were instructed to perform a maximal voluntary grip, and measurements were taken three times, with the average values calculated (Roberts et al., 2011; Mohamed et al., 2021). All measurements were performed by a single person. The obtained data from our study were recorded in an evaluation form.

## 2.1. Statistical analysis

Statistical analysis of the obtained data was performed using the SPSS (Statistical Package for Social Sciences) 22.00 software package. Affected and unaffected sides of children with HCP were compared using the Mann-Whitney U test. A p-value below 0.05 was deemed statistically significant. Spearman correlation analysis was performed to determine the relationship among the anthropometric measurements, ROM, and grip strength in children with HCP. The correlation coefficient (r) was used to represent the correlation, and the significance level was set at 0.01 to 0.05.

## 3. RESULTS

### 2.1. Statistical analysis

A total of 30 children participated in the study, including 18 boys and 12 girls. It was observed that 14 children had their left hand affected, while 16 children had their right hand affected. The average age of the children was  $8.0 \pm 2.7$  years, with a mean height of  $123.3 \pm 19.3$  cm, average weight of  $28.4 \pm 12.4$  kg, and average body mass index of  $18.0 \pm 2.8$  kg/m<sup>2</sup>. The data obtained from the affected and unaffected upper extremities of the children with HCP are presented in Table 1 and Table 2.

**Table 1.** Values of anthropometric measurements, ROM, and grip strength for the affected and unaffected upper extremities of children with HCP.

|                                         | HCP- Affected Side<br>(n=30) |      | HCP- Unaffected Side<br>(n=30) |     | p value |
|-----------------------------------------|------------------------------|------|--------------------------------|-----|---------|
|                                         | mean                         | SD   | mean                           | SD  |         |
| Shoulder Joint Circumference (cm)       | 24.2                         | 5.1  | 25.5                           | 5.4 | 0,250   |
| Arm Circumference (cm)                  | 19.0                         | 4.0  | 19.6                           | 4.1 | 0,377   |
| Elbow Joint Circumference (cm)          | 18.5                         | 3.2  | 18.9                           | 3.3 | 0,630   |
| Forearm Circumference (cm)              | 17.0                         | 2.8  | 17.5                           | 3.0 | 0,454   |
| Wrist Joint Circumference (cm)          | 12.9                         | 1.7  | 13.1                           | 1.5 | 0,434   |
| Upper Extremity Length (cm)             | 51.8                         | 9.0  | 53.8                           | 9.9 | 0,355   |
| Arm Length (cm)                         | 24.4                         | 4.4  | 25.0                           | 4.5 | 0,694   |
| Forearm Length (cm)                     | 20.5                         | 3.6  | 21.2                           | 3.9 | 0,385   |
| Hand Length (cm)                        | 14.0                         | 2.2  | 14.7                           | 2.4 | 0,333   |
| Elbow Joint Diameter (cm)               | 43.3                         | 6.3  | 44.4                           | 6.2 | 0,373   |
| Wrist Joint Diameter (cm)               | 37.5                         | 5.1  | 39.6                           | 5.4 | 0,091   |
| Hand Diameter (across metacarpals) (cm) | 54.0                         | 8.6  | 56.8                           | 9.4 | 0,171   |
| Forearm Supination (°)                  | 63.9                         | 33.4 | 90                             | 0   | 0,000   |
| Wrist Extension (°)                     | 49.9                         | 24.8 | 70                             | 0   | 0,000   |
| Radial Deviation (°)                    | 10.2                         | 9.0  | 20                             | 0   | 0,000   |
| Thumb/CMC Abduction (°)                 | 50.7                         | 33.0 | 80                             | 0   | 0,000   |

|                              |     |     |     |     |       |
|------------------------------|-----|-----|-----|-----|-------|
| Grip Strength                | 4.8 | 4.3 | 8.5 | 6.0 | 0,002 |
| SD: Standart deviation score |     |     |     |     |       |

**Table 2.** Relationship among anthropometric measurements, ROM, and grip strength of affected and unaffected upper extremities of children with HCP.

|                                    |   | Grip Strength (kg) |                     |
|------------------------------------|---|--------------------|---------------------|
|                                    |   | HPS-Affected Side  | HPS-Unaffected Side |
| Shoulder Joint Circumference       | r | 0,559              | 0,792               |
|                                    | p | 0,001              | 0,000               |
| Arm Circumference                  | r | 0,575              | 0,691               |
|                                    | p | 0,001              | 0,000               |
| Elbow Joint Circumference          | r | 0,574              | 0,769               |
|                                    | p | 0,001              | 0,000               |
| Forearm Circumference              | r | 0,385              | 0,617               |
|                                    | p | 0,036              | 0,000               |
| Wrist Joint Circumference          | r | 0,558              | 0,756               |
|                                    | p | 0,001              | 0,000               |
| Upper Extremity Length             | r | 0,667              | 0,902               |
|                                    | p | 0,000              | 0,000               |
| Arm Length                         | r | 0,635              | 0,840               |
|                                    | p | 0,000              | 0,000               |
| Forearm Length                     | r | 0,668              | 0,892               |
|                                    | p | 0,000              | 0,000               |
| Hand Length                        | r | 0,721              | 0,877               |
|                                    | p | 0,000              | 0,000               |
| Elbow Joint Diameter               | r | 0,420              | 0,659               |
|                                    | p | 0,021              | 0,000               |
| Wrist Joint Diameter               | r | 0,662              | 0,753               |
|                                    | p | 0,000              | 0,000               |
| Hand Diameter (across metacarpals) | r | 0,733              | 0,832               |
|                                    | p | 0,000              | 0,000               |
| Forearm Supination                 | r | 0,294              |                     |
|                                    | p | 0,115              |                     |
| Wrist Extension                    | r | 0,298              |                     |
|                                    | p | 0,110              |                     |
| Radial Deviation                   | r | 0,481              |                     |
|                                    | p | 0,007              |                     |
| Thumb/CMC Abduction                | r | 0,477              |                     |
|                                    | p | 0,008              |                     |

The measurements for the circumference, length, and diameter of the affected upper extremities in HCP children did not show a statistically significant difference compared to the unaffected side ( $p>0.05$ ). However, the values of forearm supination, wrist extension, radial deviation, and CMC abduction in the affected side of HCP children were significantly less than the measurements on the unaffected side ( $p<0.01$ ). The grip strength measurements on the affected side in children with HCP were markedly inferior to those on the unaffected side ( $p<0.05$ ).

HCP children's affected sides showed a strong positive correlation among radial deviation, CMC abduction, and all anthropometric measurements, as well as grip strength on the affected side ( $p<0.05$ ). HCP children's unaffected sides demonstrated a very strong positive correlation among circumference, length, and diameter values, as well as grip strength on the unaffected side ( $p<0.01$ ). Due to the complete values of ROM on the unaffected sides, correlation analysis was not deemed necessary.

#### 4. DISCUSSION

Assessment of the upper extremity's development, which is most affected in children \* -with HCP and actively used in daily life activities, is highly significant. However, there is a deficiency of sufficient resources for measuring anthropometric measurements and ROM upper extremity and grip strength in children with HCP. In a study conducted on 32 children with HCP among the ages of 5 and 12, significant variances were observed among the affected and unaffected sides of the upper extremity in terms of length, circumference and diameter measurements (Uygur et al., 2013). In our study, the length, circumference, and diameter measurements of the affected sides of HCP children aged between 5 and 12 were found to be lower compared to their unaffected sides, demonstrating compatibility with the literature (Table 1). Nevertheless, there was no statistically significant variance detected between the affected and unaffected sides. The cases included in the other study were selected randomly without considering specific criteria such as MASH or MACS classifications. However, in our study, we specifically included cases with a maximum spasticity level of 1-2 according to MAS and a grasping level of I or II according to MACS, indicating mild impairment. We believe that this difference in case selection might have contributed to the variation in results.

In our study, we included children with mildly affected HCP, which resulted in no limitations in active shoulder and elbow ROM in these children. Therefore, measurements of forearm supination, wrist extension, radial deviation, and CMC abduction angles, which are necessary for performing daily life activities, were taken in HCP children, in whom spasticity does not heavily affect the functioning of certain muscles. There was no limitation in the ROM of the unaffected upper extremities in HPS children. In the measurements conducted on 27 children with HCP, with an average age of 13, the affected side showed an average of 28° of forearm supination (min. = -70°, max. = 80°), 70° of wrist extension (min. = 20°, max. = 80°), and 12° of radial deviation (min. = 0°, max. = 20°) (Fitoussi et al., 2011). In the measurements conducted on 9 children with spastic type cerebral palsy, aged among 6 and 18, the average CMC abduction was found to be 15° (Novikov & Umnov, 2015). Due to the inclusion of HPS children with contractures in the studies in the literature, the ROM values of the affected sides of our HCP children in our study were found to be higher compared to the literature (Table 1). Our study is compatible with the literature in that the affected side of children with HCP have lower ROM values than the healthy side and there is a significant difference among the affected side and the healthy side.

In a study conducted with 33 HCP children aged among 6 and 16 years, the grip strength of the affected side was reported as 2.7±3.4 kg (Tomhave et al., 2015). The reason for the higher grip strength values of the affected sides in HCP children compared to the literature may be attributed to the fact that the children in the other study were candidates for surgery based on standard indications determined by a hand surgeon (Table 1). We believe that the reason for obtaining

different results from the study, which found the grip strength of the affected side of the hand in 20 children with HCP among the ages of 6 and 8 as  $5.95 \pm 1.19$  kg, is likely due to both the variation in age and the difference in sample size (Mohamed et al., 2021). All these results clearly demonstrate that mildly affected children with HCP have their upper extremity plegic sides anthropometrically (circumference, length, and diameter) close to their unaffected sides. However, functionally (ROM and grip strength), they lag behind their unaffected sides.

According to the evaluation of 367 children with CP among the ages of 4 and 14, it has been reported that 60% of the children experienced problems related to hand function (Richards & Malouin, 2013). The best, simple, and cost-effective method to evaluate hand function and overall upper extremity strength is by measuring grip strength (Martins et al., 2015; Hegazy et al., 2019). We could not come across a study examining the relationship among anthropometric measurements and grip strength, ROM in children with HSP. However, in studies conducted on healthy individuals, a significant positive correlation was observed among grip strength and hand anthropometric measurements (Ulçay et al., 2021). In children with HCP, a significant positive correlation can be observed among grip strength and various parameters such as radial deviation, CMC abduction, and all anthropometric measurements on the affected side. This indicates that as these parameters increase, grip strength also increases. In our study, as we focused on mildly affected children with HCP, the values of forearm supination and wrist extension were found to be close to normal. Due to this, we believe that there is no correlation among these values and grip strength (Table 2).

## 5. CONCLUSION

The children with HCP included in our study were among the ages of 5 and 12, and they were attending primary schools. Despite being mildly affected, these children are likely to encounter various challenges in both school and non-school settings in activities that require ROM and strength, consistent with the results obtained in our study. Children with hemiplegic cerebral palsy experience difficulty using their affected hands in activities that involve the use of both hands, such as play, leisure, and self-care activities, due to their unilateral impairment. To improve essential hand functions required for these and similar activities, it is crucial to enhance the grip strength of the affected side in these children. When planning treatment programs for children with HCP, in addition to anthropometric measurements, it is essential to include exercises focusing on increasing radial deviation and CMC abduction angles through goniometric measurements. We believe that our study can provide significant benefits to surgeons in planning orthopedic interventions, to occupational therapists in designing equipment used in the daily lives of these children, and in selecting appropriate orthoses and assistive devices.

## 6. SUGGESTIONS

By increasing the sample size and including a control group, more meaningful statistical results can be achieved in the future, leading to further insights in the literature.

## DECLARATIONS

**Author Contributions.** G.G., T.Ç., A.T.: Literature review, conceptualization, G.G., T.Ç., A.T.: methodology, data analysis, G.G., T.Ç., A.T.: review-editing and writing, original manuscript preparation. All authors have read and approved the published on the final version of the article.

**Conflicts of Interest.** All authors declared no potential conflicts of interest.

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**Data Availability Statement** The sharing of data and materials is not relevant, as the study did not involve the creation or analysis of new data.

## REFERENCES

- Akın F. & Aslan N. (2021). COVID-19 Pandemisinde Okul Öncesi Dönemindeki Öğrencilerin Uzaktan Eğitimi: Bir Eylem Araştırması. *Alanyazın-CRES Journal* 2(1), 7-14. <http://dx.doi.org/10.22596/cresjournal.0201.7.14>
- Arner, M., Eliasson, A. C., Nicklasson, S., Sommerstein, K., & Hägglund, G. (2008). Hand function in cerebral palsy. Report of 367 children in a population-based longitudinal health care program. *The Journal of hand surgery*, 33(8), 1337–1347. <https://doi.org/10.1016/j.jhsa.2008.02.032>.
- Arnould, C., Bleyenheuft, Y., & Thonnard, J. L. (2014). Hand functioning in children with cerebral palsy. *Frontiers in neurology*, 5, 48. <https://doi.org/10.3389/fneur.2014.00048>.
- Eliasson, A. C., Krumlinde-Sundholm, L., Rösblad, B., Beckung, E., Arner, M., Ohrvall, A. M., & Rosenbaum, P. (2006). The Manual Ability Classification System (MACS) for children with cerebral palsy: scale development and evidence of validity and reliability. *Developmental medicine and child neurology*, 48(7), 549–554. <https://doi.org/10.1017/S0012162206001162>.
- Fehlings, D., Krishnan, P., Ragguett, R. M., deVeber, G., Gorter, J. W., Hunt, C., Kim, M., Mesterman, R., McCormick, A., & CP-NET Group (2021). Neurodevelopmental profiles of children with unilateral cerebral palsy associated with middle cerebral artery and periventricular venous infarctions. *Developmental medicine and child neurology*, 63(6), 729–735. <https://doi.org/10.1111/dmcn.14818>.
- Fitoussi, F., Diop, A., Maurel, N., Laasel, eIM., Ilharreborde, B., & Penneçot, G. F. (2011). Upper limb motion analysis in children with hemiplegic cerebral palsy: proximal kinematic changes after distal botulinum toxin or surgical treatments. *Journal of children's orthopaedics*, 5(5), 363–370. <https://doi.org/10.1007/s11832-011-0365-z>.
- Hegazy, R. H., El-Negamy, E. H., M Kamal, H., & Hendawy, A. S. (2019). Effect of push-up exercises on hand grip strength in diplegic children. *Biomedical Research*, 30(2). <https://doi.org/10.35841/biomedicalresearch.30-19-115>.
- Hegazy, R. H., El-Negamy, E. H., M Kamal, H., & Hendawy, A. S. (2019). Effect of push-up exercises on hand grip strength in diplegic children. *Biomedical Research*, 30(2). <https://doi.org/10.35841/biomedicalresearch>.
- Klingels, K., De Cock, P., Molenaers, G., Desloovere, K., Huenaerts, C., Jaspers, E., & Feys, H. (2010). Upper limb motor and sensory impairments in children with hemiplegic cerebral palsy. Can they be measured reliably? *Disability and rehabilitation*, 32(5), 409–416. <https://doi.org/10.3109/09638280903171469>.
- Martins, J. C., Teixeira-Salmela, L. F., Castro e Souza, L. A., Aguiar, L. T., Lara, E. M., Moura, J. B., & Coelho de Morias Faria, C. D. (2015). Reliability and validity of the modified sphygmomanometer test for the assessment of strength of upper limb muscles after stroke. *Journal of rehabilitation medicine*, 47(8), 697–705. <https://doi.org/10.2340/16501977-1978>.
- Mohamed, R. A., Yousef, A. M., Radwan, N. L., & Ibrahim, M. M. (2021). Efficacy of different approaches on quality of upper extremity function, dexterity and grip strength in hemiplegic children: a randomized controlled study. *European review for medical and pharmacological sciences*, 25(17), 5412–5423. [https://doi.org/10.26355/eurrev\\_202109\\_26648](https://doi.org/10.26355/eurrev_202109_26648).

- Mohamed, R. A., Yousef, A. M., Radwan, N. L., & Ibrahim, M. M. (2021). Efficacy of different approaches on quality of upper extremity function, dexterity and grip strength in hemiplegic children: a randomized controlled study. *European review for medical and pharmacological sciences*, 25(17), 5412–5423. [https://doi.org/10.26355/eurrev\\_202109\\_26648](https://doi.org/10.26355/eurrev_202109_26648).
- Novak, I. (2014). Evidence-based diagnosis, health care, and rehabilitation for children with cerebral palsy. *Journal of child neurology*, 29(8), 1141–1156. <https://doi.org/10.1177/0883073814535503>.
- Novikov, V. A., & Umnov, V. V. (2015). Surgical treatment of thumb adduction contracture in children with infantile cerebral palsy. *Pediatric Traumatology, Orthopaedics and Reconstructive Surgery*, 3(2), 25–31. <https://doi.org/10.17816/ptors3225-31>.
- Odding, E., Roebroeck, M. E., & Stam, H. J. (2006). The epidemiology of cerebral palsy: incidence, impairments and risk factors. *Disability and rehabilitation*, 28(4), 183–191. <https://doi.org/10.1080/09638280500158422>.
- Özer, M.K., & Özer, D.S. (2012). Çocuklarda motor gelişim.
- Richards, C. L., & Malouin, F. (2013). Cerebral palsy: definition, assessment and rehabilitation. *Handbook of clinical neurology*, 111, 183–195. <https://doi.org/10.1016/B978-0-444-52891-9.00018-X>.
- Roberts, H. C., Denison, H. J., Martin, H. J., Patel, H. P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age and ageing*, 40(4), 423–429. <https://doi.org/10.1093/ageing/afr051>.
- Sharma, V., & Kaur, J. (2017). Effect of core strengthening with pelvic proprioceptive neuromuscular facilitation on trunk, balance, gait, and function in chronic stroke. *Journal of exercise rehabilitation*, 13(2), 200–205. <https://doi.org/10.12965/jer.1734892.446>.
- Temur, H.B. (2017). Alt ve üst ekstremitte çevre ölçüm değerleri ile el kavrama kuvveti ve sıçrama mesafesi arasındaki ilişkinin incelenmesi, *Spor ve Performans Araştırmaları Dergisi*, 8(1), 1-9.
- Tomhave, W. A., Van Heest, A. E., Bagley, A., & James, M. A. (2015). Affected and contralateral hand strength and dexterity measures in children with hemiplegic cerebral palsy. *The Journal of hand surgery*, 40(5), 900–907. <https://doi.org/10.1016/j.jhsa.2014.12.039>.
- Ulcay, T., Kamaşak, B., Kaya, K., Kara, E., Uzun, A., & Konar, N.M. (2021). The Effect of Hand Anthropometric Variables on Grip Strength in Grip Elite Athletes and Non-Athletes. *Turkish Journal of Sport and Exercise*, 23(1), 102-110.
- Uygur, R., Özen, O.A., Baş, O., Gönül, Y., & Songur, A. (2013). Hemiplejik serebral palsili çocukların üst ekstremitelerinin sağlam tarafı da gelişim geriliği gösterir. *Genel Tıp Dergisi*, 23(2), 33- 38.
- Williams, C., Reid, R. M., & Coutts, R. (1973). Observations on the aerobic power of University rugby players and professional soccer players. *British Journal of Sports Medicine*, 7(3-4), 390–391.
- Wimalasundera, N., & Stevenson, V. L. (2016). Cerebral palsy. *Practical neurology*, 16(3), 184–194. <https://doi.org/10.1136/practneurol-2015-001184>.
- Yücel, H., & Kayhan, H. (2008). Elin fiziksel özelliklerinin el fonksiyonu üzerine etkileri, *Fizyoterapi Rehabilitasyon*, 19(1), 24 - 29.

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