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# Correlation between mid-upper arm circumference and quality of life: A study in children with cerebral palsy

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## ABSTRACT

**Objective:** This study aimed to evaluate the relationship between mid-upper arm circumference (MUAC) and quality of life in children with cerebral palsy (CP).

**Material and Methods:** A total of 99 children aged 2–18 years with a diagnosis of CP were included in the study. Nutritional status and quality of life were assessed using anthropometric measurements and the Pediatric Quality of Life Inventory (PedsQL 3.0 CP Module).

**Results:** This study revealed that mid-upper arm circumference (MUAC) is a reliable indicator not only of nutritional status but also of quality of life in children with cerebral palsy. Anthropometric parameters such as height, weight, MUAC, thigh circumference, and arm length were significantly lower in children with feeding difficulties ($p<0.001$). MUAC was strongly and positively correlated with total PedsQL scores ($r=0.988$, $p<0.001$), indicating a robust association between nutritional status and perceived quality of life. Additionally, as GMFCS level increased, indicating more severe motor impairment, both growth metrics and quality of life scores declined.

**Conclusion:** MUAC measurement reflects both malnutrition and quality of life in children with CP. Routine clinical use of this parameter in follow-up is recommended.

**Keywords:** Anthropometry, cerebral palsy, quality of life

## INTRODUCTION

Cerebral palsy (CP) is one of the most common causes of physical disability in childhood and is characterized by motor dysfunctions, impaired postural control, abnormal muscle tone, and restricted movement capacity (1). Children with CP frequently experience limitations in physical activity, disrupted body composition, and various nutritional problems. Globally, the prevalence of CP is approximately 2.5 per 1000 live births, and this rate has been reported to increase with advances in neonatal intensive care services and improved survival of very low birth weight (VLBW) infants (2).

Feeding problems in CP arise from multiple factors such as limitations in motor development, tone abnormalities, coordination disorders, loss of proprioceptive sensation, absence of swallowing reflex, and dysfunction of the oral, lingual, and mandibular muscles (3-5). Inadequate trunk control and improper positioning during feeding further exacerbate these issues, potentially leading to prolonged feeding durations, aspiration, poor saliva control, coughing, choking episodes, and disruptions in parent-child interaction (3,5,6).

As a result of these challenges, nutritional difficulties negatively affect growth and development and significantly reduce the quality of life for both the child and the family (4,7). The literature indicates that conditions such as malnutrition, growth retardation, and obesity are more frequently observed in children with neurological problems (NP) compared to healthy children (6-8). Therefore, it is of critical importance to monitor

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the nutritional status of this patient group in a regular and practical manner.

One of the widely used clinical methods is mid-upper arm circumference (MUAC) measurement, which is a reliable and practical anthropometric parameter for detecting malnutrition (9). Particularly in children aged 6 months to 5 years, MUAC values of <11 cm indicate severe malnutrition, 11–12.5 cm indicate moderate malnutrition, and >12.5 cm are considered normal. Its use of a single fixed cutoff value makes MUAC advantageous for rapid screening and follow-up (9).

Moreover, current health approaches emphasize the necessity of evaluating not only physical symptoms but also the overall quality of life in children. The Pediatric Quality of Life Inventory (PedsQL) is a multidimensional and culturally adapted instrument developed to assess quality of life in children aged 2–18 years (10). PedsQL covers physical, emotional, social, and school functioning domains and can be completed by both the child and the parent. In neurodevelopmental disorders such as CP, children's quality of life is affected multidimensionally, including motor skills, social interaction, and academic performance (11).

The Türkiye version of PedsQL, which has undergone validity and reliability testing, has been successfully used in various clinical pediatric populations in Türkiye (12). This tool allows for comprehensive evaluation not only of disease burden but also of daily life difficulties, psychosocial impacts, and general well-being in individuals with disabilities (10,12).

The aim of this study was to highlight the practicality of using mid-upper arm circumference measurements in monitoring nutritional problems in children with cerebral palsy and to examine the relationship between this measurement and quality of life using the PedsQL scale.

## MATERIALS and METHODS

This study included a total of 99 children aged between 2 and 18 years who were diagnosed with cerebral palsy (CP) by a specialist physician at Karadeniz Technichal University between 2020 and 2024 years. Inclusion criteria were a confirmed diagnosis of CP and being within the specified age range. Children with additional genetic and/or neurological disorders other than CP were excluded from the study. Written informed consent was obtained from the parents of all participating children after they were informed about the purpose and methods of the study.

Medical histories were obtained, and clinical evaluations were conducted to determine the type and severity of CP. Feeding problems were assessed through symptoms such as difficulty swallowing, vomiting, aspiration, difficulty chewing, drooling, and inability to retain food in the mouth. Feeding duration, frequency, methods, and associated difficulties were also recorded. The severity of physical limitations and motor dysfunction was assessed using the Gross Motor Function Classification System (GMFCS), which classifies functional levels from I (mildest) to V (most severe). In this study, levels 1 and 2 were classified as mild, level 3 as moderate, and levels 4 and 5 as severe impairment.

Sociodemographic and clinical characteristics of the children were recorded. Anthropometric measurements included body weight, height, mid-upper arm circumference (MUAC), and thigh circumference. The most frequently reported nutritional problems were swallowing difficulties, vomiting, aspiration, chewing disorders, drooling, and inability to retain food in the mouth.

The Pediatric Quality of Life Inventory – Cerebral Palsy Module (PedsQL 3.0 CP) was administered to 45 children with mild-to-moderate CP (GMFCS levels 1–3) who did not have feeding problems, and to their mothers. This scale is a validated instrument developed to assess the quality of life in children and adolescents with disabilities and includes four age-specific forms: 2–4 years (toddler), 5–7 years (young child), 8–12 years (child), and 13–18 years (adolescent). For children aged 8–18, both child self-reports and parent proxy-reports were used. Each form evaluates four subdomains: physical functioning (PF), emotional functioning (EF), social functioning (SF), and school functioning (SchF). In addition to subscale scores, Total Scale Score (TSS) and Psychosocial Health Summary Score (PHSS) are calculated. Scores range from 0 to 100, where higher scores indicate better health status. Since children aged 2–4 years do not attend school, school functioning scores were not calculated for this age group.

**Statistical analysis:**

Statistical analysis were performed using PASW Statistics (SPSS) version 18.0. Descriptive statistics were presented as mean and standard deviation for continuous variables and as percentages and frequencies for categorical variables. Independent samples t-test was used to compare anthropometric measurements between children with and without feeding problems. Pearson chi-square test used for comparation of categorical variablies. Pearson correlation analysis was conducted to evaluate the relationships between mid-upper arm circumference (MUAC), quality of life scores, and GMFCS levels. The reliability of the PedsQL 3.0 CP module was assessed using Cronbach's alpha coefficients and intraclass correlation coefficients (ICC). A p-value of less than 0.050 was considered statistically significant.

A priori power analysis was conducted using G*Power software to determine the appropriate sample size for detecting medium effect sizes (Cohen's d = 0.5) in independent group comparisons. With an alpha level of 0.050 and desired statistical power of 0.80, the analysis indicated a minimum required sample size of 64 participants. The sample of 99 children in this study was deemed sufficient to detect statistically significant differences between groups.

**Table I: Sociodemographic and Clinical Characteristics of the Children**

| Variable | Values |
|---|---|
| Age (years)* | 8.50±4.49 |
| Gender† | |
| Male | 44 (44.44) |
| Female | 55 (55.56) |
| Type of involvement† | |
| Diparetic | 19 (19.19) |
| Hemiparetic | 20 (20.20) |
| Quadriparetic | 60 (60.70) |
| Severity of CP† | |
| Spastic | 59 (59.60) |
| Dyskinetic | 16 (16.16) |
| Ataxic | 9 (9.10) |
| Hypotonic | 7 (7.10) |
| Mixed | 8 (8.10) |
| GMFCS† | |
| Level 1 | 12 (12.12) |
| Level 2 | 14 (14.14) |
| Level 3 | 21 (21.21) |
| Level 4 | 14 (14.14) |
| Level 5 | 38 (38.38) |
| Epilepsy† | |
| Present | 36 (36) |
| Absent | 63 (64) |

***:** *mean±SD,* **†:** *n(%)*

## RESULTS

A total of 99 children aged between 2 and 18 years who had been diagnosed with cerebral palsy (CP) by a specialist physician were included in this study. The mean age of the participants was 8.50±4.49 years, with 55 (55.56%) being girls and 44 (44.44%) boys. According to the Gross Motor Function Classification System (GMFCS), 12.12% of the children were classified as level I, 14.14% as level II, 21.21% as level III, 14.14% as level IV, and 38.38% as level V. Accordingly, 48.6% were categorized as having mild to moderate impairment (levels I–III), and 51.4% as having severe impairment (levels IV–V).

Regarding clinical subtypes, 19.19% were diparetic, 20.20% hemiparetic, and 60.70% quadriparetic. Sociodemographic characteristics are presented in Table I. Among the participants, 46 (46.46%) had feeding problems, whereas 53 (53.53%) had no such issues.

Feeding problems were significantly more frequent in children with moderate to severe impairment compared to those with mild impairment (p=0.003). In the comparison of anthropometric measurements between children with and without feeding problems, statistically significant differences were found in height (t=-3.161, p<0.001), weight (t=-3.592, p<0.001), mid-upper arm circumference (MUAC) (t=-4.114, p<0.001), thigh circumference (t=-5.337, p < 0.001), and arm length (t= -3.872, p<0.001). No significant difference was observed for age (t =-1.561, p=0.120). These results are presented in Table II.

Among the 52 children with mild to moderate impairment, 41 had weight and height percentiles between the 3rd and 25th percentiles and were provided with enteral nutritional support during a six-month growth follow-up period. Quality of life before and after nutritional support was assessed using the Pediatric Quality of Life Inventory (PedsQL). PedsQL scores obtained from parents of children who received nutritional support were significantly higher compared to those of children who did not receive support (p<0.001). The internal consistency of the scale was analyzed using Cronbach's Alpha coefficient. The overall Cronbach's Alpha value was 0.820 for the child form and 0.880 for the parent form. At the subscale level, Cronbach's Alpha coefficients ranged from 0.560 to 0.830 in the child form, and from 0.570 to 0.850 in the parent form. The item-total correlation coefficients (r) between subscales of child and parent responses ranged from 0.282 to 0.719. The highest correlation was observed in the School Functioning Score subscale (r = 0.719, p < 0.001) (Table III).

In correlation analyses conducted among children with feeding problems, significant positive correlations were found between age and height (r=0.765, p<0.001), age and arm circumference (r=0.682, p=0.002), and age and thigh circumference (r= 0.701, p<0.001). When correlating quality of life scores with anthropometric measurements, mid-upper arm circumference (MUAC) showed the strongest positive correlation (r=0.988, p<0.001), indicating a highly significant relationship. When correlating quality of life scores with anthropometric measurements, mid-upper arm circumference (MUAC) showed the strongest positive correlation (r=0.988, p<0.001), indicating a highly significant relationship.

In children with mild CP (GMFCS levels I–II), after a six-month follow-up, parental satisfaction and PedsQL scores significantly increased in the group receiving enteral nutritional support; furthermore, their response to physical therapy and improvements in motor function were more pronounced compared to those who did not receive support.

## DISCUSSION

The findings of this study demonstrate that nutritional problems in children with cerebral palsy (CP) affect not only physical growth parameters but also quality of life. In particular, the strong correlation between mid-upper arm circumference (MUAC) and quality of life indicates that this anthropometric measure is not merely a marker of malnutrition, but also a reliable indicator of general health and well-being (9). When examining the relationship between nutritional status and the level of motor impairment, it was found that feeding problems were significantly more frequent in children with more severe functional limitations. These results imply that motor dysfunction in CP impacts not only mobility but also feeding abilities due to compromised oral-motor coordination and feeding

**Table II: Anthropometric measurements of all children**

| | All children | With feeding problems | Without feeding problems | t | p* |
|---|---|---|---|---|---|
| Number of patients† | 99 | 46 (46.46) | 53 (53.54) | - | - |
| Age (years)‡ | 8.50±3.59 (2–18) | 8.05±4.80 (2–18) | 8.89±4.17 (2–18) | -1.561 | 0.120 |
| Height (cm)‡ | 112.20±22.52 (75–182) | 110.62±21.67 (75–162) | 119.89±21.08 (80–182) | -3.161 | <0.001 |
| Weight (kg)‡ | 23.54±11.77 (7.7–65) | 20.94±10.58 (7.7–65) | 25.83±11.93 (9.4–65) | -3.592 | <0.001 |
| Mid-upper arm circumference (cm)‡ | 16.82±4.08 (6–38) | 15.77±3.33 (6–26) | 17.73±4.73 (8.5–38) | -4.114 | <0.001 |
| Thigh circumference (cm)‡ | 24.88±6.72 (7.5–55) | 22.61±5.03 (7.5–37) | 26.87±4.28 (13–55) | -5.337 | <0.001 |
| Arm length (cm)‡ | 23.5±5.08 (10–38) | 21.77±5.03 (10–33) | 24.04±4.89 (10–38) | -3.872 | <0.001 |

***:** *Independent samples t-test,* **†:** *n (%),* **‡:** *mean±SD (min-max)*

**Table III: Evaluation of PedsQL 3.0 CP module – child and parent reports**

| Scale | Child (n = 45) | | | Mother (n=45) | | | Child–Mother |
|---|---|---|---|---|---|---|---|
| | α | r | ICC | α | r | ICC | r |
| PedsQL | 0.820 | 0.933† | 0.929 | 0.880 | 0.933† | 0.929 | 0.494* |
| Total Physical Health Score (TPHS) | 0.830 | 0.934† | 0.953 | 0.850 | 0.934† | 0.953 | 0.488* |
| Emotional Functioning Score (EFS) | 0.560 | 0.956† | 0.922 | 0.570 | 0.956† | 0.922 | 0.496 |
| Social Functioning Score (SFS) | 0.710 | 0.980† | 0.923 | 0.760 | 0.980† | 0.923 | 0.282 |
| School Functioning Score (SFSch) | 0.740 | 0.991† | 0.988 | 0.680 | 0.991† | 0.988 | 0.719† |
| Total Psychosocial Health Score (TPHSoc) | 0.810 | 0.962† | 0.989 | 0.800 | 0.962† | 0.989 | 0.616† |

***:** *p < 0.01,* **†:** *p<0.001,* ***α:** Cronbach's alpha (internal consistency);* ***r:** item-total correlation,* ***ICC:** intraclass correlation coefficient*

capacity (3,4). As Chanie et al. (3) emphasized, impairments in gastrointestinal function in children with CP have a direct impact on growth and general health. Similarly, in this study, children with feeding problems had significantly lower values in height, weight, arm circumference, and subcutaneous fat thickness. This finding provides strong evidence for the systemic effects of undernutrition (6,7).

The PedsQL scale used to assess quality of life in this study provided a comprehensive analysis not only of children's physical health, but also of their emotional, social, and academic functioning (10). Especially in neurodevelopmental disorders such as CP, quality of life is determined not only by motor competence but also by multiple factors such as environmental support, psychological resilience, and social participation (11). Therefore, the data obtained from the PedsQL scale are of critical importance in designing multidisciplinary care plans. In our study, the significant increase in PedsQL scores among children receiving enteral nutritional support indicates that such interventions have a beneficial effect not only on weight gain but also on overall quality of life. This finding is also consistent with previous studies (4,10,11).

Moreover, the improvement in quality of life scores as reported by parents of children with CP suggests that the nutritional status of the child is closely linked to the daily quality of life of the family. In this context, it can be said that interventions targeting the child indirectly affect parental well-being. This highlights once again the importance of family-centered approaches in the care of chronically disabled children (10,12–14). However, unlike the study by Aran et al. (15), our study also evaluated the effect of nutritional intervention on quality of life. The significant increase in PedsQL scores among children receiving enteral support demonstrates that the intervention has positive effects not only in physical health but also in psychosocial domains. In this respect, our study offers not only a descriptive but also an interventional perspective.

The negative correlation between the Gross Motor Function Classification System (GMFCS) level and MUAC is also noteworthy. As functional level decreased, MUAC values declined. This suggests a direct relationship between motor abilities and nutritional status and implies that MUAC may reflect functional disability indirectly (9).

Similarly, in a study by Herrera-Anaya E et al. (16), it was reported that malnutrition is prevalent in children with CP, and is caused by factors such as limited dietary diversity, prolonged meal times, and swallowing difficulties, all of which have a direct impact on quality of life. These findings are consistent with the strong correlation identified in our study.

Furthermore, in another study conducted by Namaganda H. et al. (17), it was emphasized that simple anthropometric measures like MUAC play a critical role in the early detection of malnutrition in children with CP in developing countries, and that its impact on quality of life should not be underestimated. However, this study did not clearly establish the direct effect of nutritional status on caregiver-reported quality of life.

The results of this study bring forward several clinical recommendations. First, in the follow-up of children with CP, not

only traditional growth indicators such as weight and height, but also practical anthropometric measures like MUAC should be recorded regularly. Second, quality of life instruments such as PedsQL should not only be used for research purposes but also routinely applied to assess treatment responses. Third, early interventions like enteral support have been shown to improve both physical and psychosocial outcomes, underscoring the importance of early screening and intervention strategies (4,10,11).

Our study differs from these previous reports in that it evaluates quality of life not only from the caregiver's perspective, but within a holistic framework encompassing the child's motor impairment and nutritional status. In particular, the use of the PedsQL 3.0 CP module enabled objective comparisons in domains such as daily living activities, school functioning, and social participation.

One of the major contributions of our study is the evaluation of the correlation between child-reported and parent-reported quality of life. The results showed high concordance in physical and school functioning domains, whereas lower correlations were observed in emotional and social areas. This finding confirms frequently reported perception differences in the literature and emphasizes the importance of incorporating both perspectives in quality of life assessments (18-20).

In conclusion, although both studies confirmed a strong relationship between MUAC and quality of life in children with CP, our study contributes more comprehensively to the literature through its evaluation of interventional outcomes, subdomain-level analysis of quality of life, correlation with GMFCS levels, and parent–child agreement. These findings highlight the importance of using MUAC and tools such as PedsQL together in the follow-up of children with CP, both for clinical assessment and for monitoring the impact of interventions. The results reinforce the role of MUAC as a core component of multidisciplinary care. When combined with comprehensive quality of life scales such as PedsQL, this approach can contribute to more effective health service delivery at both the individual and systemic levels.

## Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. Ethics committee approval was obtained from the ethics committee of Karadeniz Technical University with the number 2025/42.

## Contribution of the authors

***Dilber B:*** Constructing the hypothesis or idea of research and/or article, Planning methodology to reach the conclusions, Organizing, supervising the course of progress and taking the responsibility of the research/study, Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments, Taking responsibility in logical interpretation and conclusion of the results, Taking responsibility in necessary literature review for the study, Taking responsibility in the writing of the whole or important parts of the study, Reviewing the article before submission scientifically besides spelling and grammar. ***Kamaşak T:*** Constructing the hypothesis or idea of research and/or article, Planning methodology to reach the conclusions, Organizing, supervising the course of progress and taking the responsibility of the research/study, Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments, Taking responsibility in logical interpretation and conclusion of the results, Taking responsibility in necessary literature review for the study, Taking responsibility in the writing of the whole or important parts of the study, Reviewing the article before submission scientifically besides spelling and grammar.

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## Conflict of interest

The authors declare that there is no conflict of interest.

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