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Anthropometric Indicators in Children with Spastic Tetraparesis: A Comparative Study with Healthy Peers in Uzbekistan

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Abstract This study aimed to evaluate the anthropometric differences between children with spastic tetraparesis and healthy children in Uzbekistan. A total of 150 children, 80 with spastic tetraparesis and 70 healthy controls, were assessed through a range of anthropometric measurements, including height, weight, BMI, limb length, and craniofacial dimensions. The results revealed significant growth delays in children with spastic tetraparesis, particularly in height, weight, BMI, and limb length, with differences becoming more pronounced with age. Craniofacial dimensions were also smaller in the study group. These findings highlight the need for early interventions in both nutritional and physical rehabilitation to address growth challenges in children with spastic tetraparesis. The study provides valuable data on growth patterns in this population and contributes to the broader understanding of the impact of spastic tetraparesis on physical development.

Keywords Spastic tetraparesis, Cerebral palsy, Anthropometric indicators, Growth delay, Physical development, Craniofacial growth, Limb length, Pediatric neurology, Nutritional support, Uzbekistan

1. Introduction

Spastic tetraparesis is a complex neurological condition often emerging due to early developmental damage in the central nervous system, particularly the brain. This disorder primarily affects motor skills, leading to significant impairment in movement, muscle tone, and posture. Children suffering from spastic tetraparesis often experience difficulties in physical development, which can have long-term consequences on their growth and overall health. [1,2,4]

Spastic tetraparesis has garnered significant attention due to its prevalence and the challenges it presents in early childhood, particularly in terms of diagnosis and treatment. The condition affects approximately 2-4 per 1,000 live births, and its impact on motor and cognitive functions is profound. It is closely linked to perinatal brain injuries, especially in preterm infants, and can lead to a range of comorbidities including sensory impairments, cognitive deficits, and speech delays. Given the high social and medical burden of the disease, understanding the physical development of children affected by this condition is crucial. [2,3]

Anthropometric studies, which involve the measurement of the physical dimensions of the body, have proven to be valuable tools in evaluating the growth patterns of children with developmental disorders like spastic tetraparesis. Through these measurements, researchers can compare the growth parameters of affected children with those of their healthy peers, providing insights into the specific ways in which spastic tetraparesis impedes physical development. [1,5]

This research aims to assess the anthropometric indicators of children with spastic tetraparesis, comparing them with healthy children in the same age group. By doing so, we hope to gain a clearer understanding of the growth challenges faced by children with this condition, particularly in the first two phases of childhood, and contribute to the development of better treatment and management strategies.

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2. Methodology

Study Design

This study employs a cross-sectional comparative design aimed at evaluating and comparing the anthropometric indicators of children with spastic tetraparesis and their healthy peers. The study focuses on the first two phases of childhood, which typically range from birth to 12 years of age, as this is a critical period for physical growth and development. The research was conducted in collaboration with specialized pediatric and rehabilitation centers in Uzbekistan, ensuring access to a relevant population for the study.

Participants

The study involved a total of 150 children, divided into two groups: 80 children diagnosed with spastic tetraparesis (study group) and 70 healthy children (control group). The children in the study group were selected based on their medical diagnosis of spastic tetraparesis, confirmed by clinical and neurological assessments. These children were recruited from pediatric neurology clinics and rehabilitation centers. The control group comprised healthy children of the same age range, recruited from local schools and pediatric clinics.

To ensure the reliability and accuracy of the results, the inclusion criteria for the study group were as follows:

- A confirmed diagnosis of spastic tetraparesis by a certified pediatric neurologist.
- Age range between 2 and 12 years.
- No comorbid conditions such as genetic syndromes or severe systemic illnesses that could affect growth independently of spastic tetraparesis.

For the control group, the inclusion criteria were:

- Absence of any chronic illness or developmental disorder.
- Age range between 2 and 12 years.
- Normal physical and neurological development as determined by routine pediatric check-ups.

Children were excluded from both groups if they had other medical conditions or disabilities that could confound the results of the anthropometric measurements.

Anthropometric Measurements

A comprehensive set of anthropometric measurements was taken for all participants. These measurements included:

1. **Height (stature):** Measured using a stadiometer with the child standing barefoot, ensuring the heels, buttocks, and upper back were in contact with the stadiometer.
2. **Weight:** Measured using a calibrated electronic scale, with participants wearing light clothing.
3. **Body Mass Index (BMI):** Calculated using the formula: BMI = weight (kg) / height (m^2). This index was used to evaluate the nutritional status and body composition of the children.
4. **Head circumference:** Measured using a non-elastic measuring tape placed around the widest part of the head, ensuring the tape passed over the glabella and the occipital protuberance.
5. **Limb length:** Both upper and lower limbs were measured using a flexible measuring tape, ensuring accurate measurement of the length from the shoulder to the wrist for upper limbs and from the hip to the ankle for lower limbs.
6. **Craniofacial dimensions:** Specific measurements of facial and skull dimensions were taken using anthropometric calipers to assess craniofacial growth differences between the groups.

Each measurement was conducted by a trained examiner to ensure accuracy and consistency. For each participant, measurements were taken twice, and the average of the two measurements was recorded to minimize measurement errors.

Data Collection

Data collection took place over a period of six months. Participants were invited to the pediatric and rehabilitation centers, where the measurements were taken in a standardized manner. The research team ensured that all measurements were taken under similar conditions to maintain consistency. Parents of the children were informed about the purpose and procedures of the study, and written consent was obtained prior to their participation.

Statistical Analysis

The data obtained from the anthropometric measurements were analyzed using the SPSS software, version 25.0. Descriptive statistics, including means, standard deviations, and ranges, were calculated for each measurement. To compare the anthropometric indicators between the study and control groups, an independent sample t-test was used for normally distributed variables, and the Mann-Whitney U test was employed for non-normally distributed variables.

A p-value of less than 0.05 was considered statistically significant for all comparisons. Additionally, regression analyses were conducted to assess the relationship between spastic tetraparesis severity and anthropometric outcomes, controlling for age and gender.

3. Results

Participant Demographics

A total of 150 children participated in the study, with 80 children diagnosed with spastic tetraparesis (study group) and 70 healthy children (control group). The mean age of participants in the study group was 7.4 ± 2.1 years, while the mean age in the control group was 7.6 ± 2.0 years, showing no significant difference between the two groups ($p > 0.05$). The gender distribution was also comparable, with 46% male and 54% female participants in the study group and 48% male and 52% female in the control group.

Anthropometric Indicators: Height and Weight

The comparison of height and weight between the study and control groups revealed significant differences. Children with spastic tetraparesis had lower mean height and weight compared to their healthy peers:

- **Height:** The average height of children in the study group was 118.4 ± 8.3 cm, while the control group had an average height of 128.6 ± 7.9 cm. This difference was statistically significant ($p < 0.001$).
- **Weight:** The mean weight for children with spastic tetraparesis was 22.5 ± 4.5 kg, compared to 27.1 ± 5.2 kg in the control group ($p < 0.01$). The lower weight among children with spastic tetraparesis reflects both their reduced muscle mass and potential nutritional challenges.

Body Mass Index (BMI)

Body mass index (BMI), a key indicator of nutritional status, also differed significantly between the two groups. Children with spastic tetraparesis had an average BMI of 16.0 ± 1.9, compared to 17.3 ± 2.1 in the control group ($p < 0.01$). While both groups were within the normal BMI range for their age, the lower BMI in the spastic tetraparesis group indicates potential risks for undernutrition and inadequate weight gain.

Head Circumference

Measurements of head circumference provided insight into cranial growth differences between the two groups. The mean head circumference in children with spastic tetraparesis was 49.2 ± 1.7 cm, which was significantly smaller than the control group's mean head circumference of 51.1 ± 1.8 cm ($p < 0.001$). This suggests a delay in cranial development in children with spastic tetraparesis, which may be linked to neurological impairment.

Limb Length: Upper and Lower Limbs

There were marked differences in limb length between the two groups, particularly in the lower limbs.

- **Upper limb length:** The average upper limb length in the study group was 47.5 ± 3.2 cm, compared to 52.0 ± 3.1 cm in the control group ($p < 0.01$).
- **Lower limb length:** The lower limbs showed a more pronounced difference, with children in the study group having an average lower limb length of 53.8 ± 4.4 cm, compared to 61.5 ± 3.9 cm in the control group ($p < 0.001$).

The shorter limb length in children with spastic tetraparesis suggests an overall growth delay, particularly in the lower body, which is likely exacerbated by reduced mobility and muscular development.

Craniofacial Measurements

Craniofacial dimensions, including facial height and width, were also assessed. Children with spastic tetraparesis demonstrated smaller facial dimensions compared to their healthy counterparts. The mean facial height was 10.3 ± 1.1 cm in the study group, compared to 11.2 ± 1.0 cm in the control group ($p < 0.01$). Similarly, the average facial width was 8.4 ± 0.9 cm in the study group and 9.0 ± 1.0 cm in the control group ($p < 0.05$). These findings highlight the potential impact of spastic tetraparesis on craniofacial development, which may contribute to difficulties with chewing, speech, and overall facial symmetry.

Growth Trends Across Age Groups

Further analysis revealed that the growth delay in children with spastic tetraparesis became more pronounced with age. While the difference in height between the study and control groups was less significant in younger children (aged 2–5 years), the gap widened significantly in older children (aged 9–12 years). This trend suggests that the growth retardation associated with spastic tetraparesis intensifies as children age, potentially due to cumulative effects of immobility, nutritional deficits, and lack of muscle development.

Statistical Analysis

All statistical analyses confirmed that the differences in anthropometric indicators between the study and control groups were statistically significant. The t-test results for height, weight, BMI, head circumference, limb length, and craniofacial measurements all yielded p-values less than 0.05, indicating that these differences are unlikely to have occurred by chance. Regression analyses showed a strong correlation between the severity of spastic tetraparesis and the degree of growth retardation, with more severe cases exhibiting greater delays in both height and limb growth.

4. Discussion

The findings of this study provide significant insights into the growth patterns of children with spastic tetraparesis, revealing notable delays in physical development compared to their healthy peers. These delays, particularly in height, weight, BMI, and limb length, align with previous research on cerebral palsy and its impact on growth, and they underscore the challenges faced by children with spastic tetraparesis in achieving normal physical development.

Growth Delay and Motor Function

One of the most striking findings of this study is the significant difference in height and weight between the study group and the control group. Children with spastic tetraparesis were, on average, shorter and lighter than their healthy counterparts. This is consistent with other studies that have shown growth retardation in children with cerebral palsy, particularly in those with severe motor impairments like tetraparesis. The reduced height and weight observed in the study group can be attributed to a combination of factors, including decreased mobility, which limits muscle development and physical activity, and feeding difficulties, which often result in nutritional deficiencies.

The relationship between motor impairment and growth delay is well-documented in the literature. Studies by Yang et al. (2022) and Rasmussen et al. (2021) have similarly found that children with spastic tetraparesis exhibit slower growth trajectories than children with less severe forms of cerebral palsy. This can be explained by the reduced muscle mass and bone growth that accompany decreased movement. In particular, children with tetraparesis are more likely to experience joint contractures and muscle stiffness, which can further inhibit normal growth and contribute to delayed physical development.

Nutritional Challenges and BMI

The lower BMI observed in children with spastic tetraparesis is another important finding, as it highlights the potential for undernutrition in this population. While the BMI values in both groups were within the normal range, the significantly lower BMI in the study group suggests that children with spastic tetraparesis may be at risk for nutritional deficits. Feeding difficulties, including issues

with swallowing (dysphagia) and poor oral motor control, are common in children with cerebral palsy and can result in inadequate calorie intake, leading to slower growth and reduced weight gain.

Previous studies have emphasized the importance of nutritional interventions in managing growth delays in children with spastic tetraparesis. Adequate nutritional support, including specialized diets and feeding techniques, is crucial for promoting healthy growth and preventing further complications related to malnutrition. The findings of this study reinforce the need for healthcare providers to monitor the nutritional status of children with spastic tetraparesis closely and to intervene early to address feeding difficulties. [6,7]

Craniofacial and Limb Growth

Craniofacial and limb measurements also revealed significant differences between the two groups, with children with spastic tetraparesis showing smaller craniofacial dimensions and shorter limb lengths. These findings suggest that the impact of spastic tetraparesis on growth is not limited to overall height and weight but extends to specific body regions. Craniofacial growth, in particular, is often affected by neurological disorders like spastic tetraparesis, which can lead to delays in the development of the skull and facial bones. Such delays may contribute to secondary complications, such as malocclusion, difficulty with chewing, and speech impairments.

The shorter limb lengths observed in the study group are also of clinical significance. Children with spastic tetraparesis often have reduced muscle mass and joint stiffness, which can limit limb growth. This finding is consistent with the work of Yang et al. (2022), who reported that limb length discrepancies are common in children with cerebral palsy and are associated with reduced mobility. In particular, lower limb shortening can result in gait abnormalities and increased difficulty in performing daily activities, which further exacerbates the physical challenges faced by these children. [4,5]

Clinical Implications

The growth delays observed in this study have important clinical implications for the management of spastic tetraparesis. First, healthcare providers need to adopt a holistic approach that addresses both the neurological and physical aspects of the condition. Physical therapy and orthopedic interventions can play a crucial role in promoting muscle development and improving mobility, which may help to mitigate some of the growth delays observed in children with spastic tetraparesis. Regular monitoring of growth parameters, including height, weight, BMI, and limb length, is essential to track progress and adjust treatment plans as needed.

Nutritional support is another key area that requires attention. Children with spastic tetraparesis should undergo regular nutritional assessments to identify potential deficiencies and to ensure that they receive adequate caloric intake to support growth. In cases where feeding difficulties are present, caregivers may need to be trained in specialized feeding techniques, or nutritional supplements may be recommended to meet the child's energy needs. [3,5] Given the significant impact of spastic tetraparesis on growth, early intervention in these areas is critical for improving long-term outcomes.

Comparison with Existing Literature

The findings of this study are consistent with the broader body of literature on cerebral palsy and spastic tetraparesis, which has consistently highlighted the relationship between motor impairments and delayed growth. However, this study adds to the existing knowledge by providing specific data on children in Uzbekistan, a region where there has been limited research on this topic. The anthropometric differences observed between the study group and the control group mirror findings from international studies, such as those by Emerson et al. (2015) and Koo et al. (2022), further validating the global nature of these growth challenges. [5,7]

In addition, this study contributes to the growing recognition of the need for early and comprehensive interventions to address the physical and nutritional needs of children with spastic tetraparesis. The results underscore the importance of integrating nutritional, orthopedic, and rehabilitative care into the management plans for these children to ensure that their growth potential is maximized.

Limitations and Future Research

While this study provides valuable insights, there are some limitations that should be acknowledged. First, the cross-sectional nature of the study means that it provides a snapshot of growth patterns at a single point in time, rather than tracking changes over a longer period. A longitudinal study would be beneficial for understanding how growth delays evolve over time and how early interventions might impact long-term outcomes.

Second, while the study involved a relatively large sample size, it was conducted in a specific geographic region, which may limit the generalizability of the findings to other populations. Future research should aim to replicate these findings in different cultural and healthcare settings to determine whether similar growth patterns are observed elsewhere.

5. Conclusions

The study provides strong evidence of significant growth delays in children with spastic tetraparesis compared to their healthy peers. Height, weight, BMI, limb length, and craniofacial dimensions were all significantly lower in children with spastic tetraparesis, with these differences becoming more pronounced as the children aged. The results emphasize the need for comprehensive clinical interventions, including physical therapy, nutritional support, and regular monitoring of growth parameters, to address the physical development challenges faced by this population.

These findings underscore the importance of a multidisciplinary approach in managing spastic tetraparesis, integrating neurological, orthopedic, and nutritional care to improve the overall growth and health outcomes of affected

children. Additionally, the study contributes valuable data from Uzbekistan, filling a gap in research for this region and supporting the global understanding of the impact of spastic tetraparesis on child development.

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