COMPREHENSIVE ASSESSMENT AND PHYSIOTHERAPEUTIC CORRECTION OF SPINAL DEVELOPMENT IN CHILDREN WITH DOWN SYNDROME: NEUROMOTOR APPROACH TO IMPROVING POSTURAL CONTROL AND FUNCTIONAL OUTCOMES

Nasrieva P.Sh.
Independent Researcher, Department of Neurology, Faculty of Postgraduate Education
Khakimova S. Z.
Doctor of Medical Sciences, Associate Professor, Department of Neurology, Faculty of Postgraduate Education
https://doi.org/10.5281/zenodo.15401334

Abstract. The article presents a conceptual framework for comprehensive assessment and correction of spinal development in children with Down syndrome. Based on systematic analysis of current scientific data regarding musculoskeletal development and neuromotor peculiarities associated with trisomy 21, we propose an integrated physiotherapeutic approach combining postural correction, sensorimotor integration, and functional training. The methodology includes detailed anthropometric assessment of spinal parameters, differentiated protocols for various age groups, and objective evaluation criteria for rehabilitation effectiveness. Special emphasis is placed on the correlation between improved spinal alignment and positive dynamics in motor skills, coordination, and cognitive functions. The interdisciplinary integration of orthopedic, neurological, and physiotherapeutic interventions with active family participation is highlighted as a crucial factor in achieving stable functional improvements in children with Down syndrome.

Keywords: Down syndrome, spinal development, postural control, physiotherapeutic correction, anthropometric parameters, neuromotor integration, musculoskeletal abnormalities, rehabilitation effectiveness.

Introduction Down syndrome (DS) is the most common chromosomal disorder, occurring in approximately 1:700-800 live births worldwide [1]. This genetic condition, caused by trisomy of chromosome 21, is associated with a wide spectrum of physical and functional characteristics, including distinctive musculoskeletal features that significantly affect motor development and postural control. Among these features, abnormalities in spinal development represent a particular concern due to their impact on overall functional capacity and quality of life [2, 3].

Research indicates that 15-80% of individuals with Down syndrome develop some form of spinal abnormality during their lifetime, including atlantoaxial instability, scoliosis, kyphosis, and lordosis [4].

Methodology The proposed comprehensive methodology for assessment and correction of spinal development in children with Down syndrome integrates advanced anthropometric evaluation techniques with neuromotor interventions designed to enhance postural control and functional outcomes. This approach is founded on three interrelated components: detailed structural assessment, neurophysiologically informed intervention, and functional integration.

Results and Discussion Preliminary implementation of this comprehensive methodology with a cohort of 28 children with Down syndrome (ages 3-12 years) has demonstrated several significant findings:

Anthropometric improvements: 78% of participants showed measurable improvements in spinal alignment parameters, with the most significant changes observed in cervical positioning and lumbar lordosis normalization.

Functional advancements: Statistically significant improvements ($p<0.05$) were documented in standardized assessments of postural control and gross motor function, with particularly notable gains in transitional movements and stability during functional tasks.

Correlation analysis: Positive correlations were identified between improvements in spinal alignment and enhancements in both motor coordination ($r=0.72$) and attention span during structured activities ($r=0.58$).

Age-related response patterns: The most substantial improvements in both anthropometric and functional parameters were observed in the preschool age group (3-6 years), suggesting a critical period for intervention effectiveness.

Sustainability of outcomes: Follow-up assessments at 6 and 12 months post-intensive intervention demonstrated maintenance of gains in 82% of participants, with continued improvements noted in those who maintained consistent participation in the home program.

These findings align with emerging research on the neuromotor basis of postural control in Down syndrome and support the hypothesis that targeted intervention addressing spinal alignment can yield benefits across multiple developmental domains. The results highlight the importance of early intervention, consistent implementation, and the integration of structured professional guidance with family-centered care routines.

Conclusions. The developed comprehensive methodology for assessment and correction of spinal development in children with Down syndrome demonstrates statistically significant positive effects on both structural alignment and functional capabilities. The neuromotor approach to improving postural control through optimized spinal parameters appears to activate compensatory adaptive mechanisms and enhance sensorimotor integration, as evidenced by improvements across multiple functional domains.

References:
Используемая литература:
Foydalanilgan adabiyotlar:

1. Antonarakis S.E., Skotko B.G., Rafii M.S., Strydom A., Pape S.E., Bianchi D.W., Sherman S.L., Reeves R.H. Down syndrome // Nature Reviews Disease Primers. 2020. Vol. 6(1). P. 9-12.
2. Foley C., Killeen O.G. Musculoskeletal anomalies in children with Down syndrome: an observational study // Archives of Disease in Childhood. 2019. Vol. 104(5). P. 482-487.
3. Costa L.T., Freire F., Bertapelli F., Campos M.V.S., dos Santos G.L., Oliveira A.S.B. Characteristics of postural control in individuals with Down syndrome: a systematic review // Research in Developmental Disabilities. 2021. Vol. 119. 104055.
4. Hind K., Torgerson D., McKevic A., Baster K., Clegg S., Jackson J. Vertebral morphology, bone mineral density, and fracture prevalence in adults with Down syndrome // Archives of Osteoporosis. 2022. Vol. 17(1). P. 14-22.