https://doi.org/10.7251/SSH2402173M
Original scientific paper

UDC: 612.84-053.2:376-056.262
Originalni naučni rad

The Effects of Adapted Physical Exercise on Gross Motor Function and Motor Abilities in Child With Multiple Disabilities

Doris Molnar[1], Romana Romanov[1], Zoran Milić[2]
[1]Faculty of Sports and Psychology Novi Sad, University Educons, Republic of Serbia
[2]Faculty of Education, Sremska Kamenica, University Educons, Republic of Serbia

Correspondence:
Zoran Milić, Faculty of Education, Sremska Kamenica, University Educons, Republic of Serbia
zoranmilic@yahoo.com

Abstract: *This case study aims to determine the effects of adapted physical exercise on gross motor function and motor abilities in a child with multiple disabilities. The subject is a 12-year-old boy diagnosed with a multiple disabilities with limitations identified within physical, mental and sensory integrity. The applied experimental treatment, defined according to his needs and abilities, consisted of an exercise program implemented for 4 months, twice a week for 45 minutes and is programmed with the aim of myofascial relaxation, passive stretching, corrective-compensatory effects and the development of gross motor skills and strength. The instruments used to test the initial and final state are the clinical test for assessing the gross motor function of children with cerebral palsy "GMFM-Gross motor functional movement measure-88" and the Eurofit battery test for assessing motor abilities. Variables based on a specific group of GMFM test items indicate that the gross motor function assessed at the final measurement were improved by 6% compared to the initial measurement. In the measured variables of the Eurofit battery test, positive changes in the results were achieved in the standing broad jump, sit and reach, plate tapping, sit ups in 30 seconds, while the result of the bent arm hang test remained unchanged. The results in this study suggest that the application of the experimental program had a positive effect on the motor abilities and gross motor function of child with multiple disabilities.*

Keywords: *adapted physical exercise, multiple disabilties, cerebral palsy, gross motor function.*

INTRODUCTION

UNICEF data (2021) indicates that around 240 million children globally have a developmental disability, emphasizing the need to address this issue and provide support through a multidisciplinary approach. From the perspective of the kinesiology field, one form of support can be provided through adapted physical activity programs. The term "developmental disability" refers to the limitation of the opportunity to participate in the community life of a typical population under the same conditions as other members of that community, impacting physical, mental, sensory, speech-language, and socio-emotional functions and behavior. When a child is affected by the combined impact of two or more disabilities on their functional status (Rapaić, 2016), it is referred to as multiple disabilities (MD). The presence of difficulties including speech, learning, compromised mental and physical integrity, sensory impairments, and challenges with behavior and social skills, along with several associated disorders, infers cerebral palsy as a contributing factor to multiple disabilities in children (Milićević, 2016). Cerebral palsy (CP) is a term used to describe a non-progressive group of disorders resulting from permanent damage during the prenatal, natal, or early postnatal period to the white and gray matter of the cerebrum, basal ganglia, cerebellum, and brain stem (Romanov, 2020). Characteristics of CP visible in accordance with the kinesiology status are the presence of paralysis or paresis, involuntary movements, impairment of intellectual integrity, epilepsy (Rapaić, 2016), reduced mobility due to impairment of muscle tone, muscle atrophy or hypertrophy, ataxia, loss of elasticity of ligaments and tendons, shortening of spastic muscles. Due to various limitations, the quality of life of children with MD, primarily CP, greatly relies on societal support. Adapted physical exercise (APE) plays a significant role in improving motor status and enhancing psycho-social abilities, offering children with developmental disabilities opportunities for advancement (Mensch et al., 2019; Salapura, 2018). This study aims to determine the effects of APE on motor abilities and gross motor function in a child with MD.

Research Design

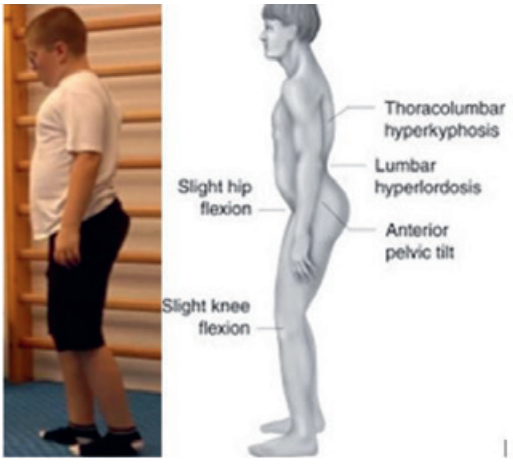
This experimental research was carried out using a case study method, involving data collection at two distinct time points.

Case description

The subject is a 12-year-old boy with multiple disabilities, primarily cerebral palsy. According to the "Gross Motor Function Classification System" his impairment is graded as GMFCS II-second level. Aside from physical education classes, he has never had additional programmed physical activity. The subject's parents confirmed their child's participation in the research through written consent.

The primary diagnosis of the subject includes multiple disabilities, encompassing:

- Cerebral palsy - non-specific G809,
- Impairment of intellectual integrity, categorized as "moderate intellectual disability F71.1" according to the "International Classification of Diseases" (ICD-10, Version: 2019),
- Visual impairment- Hyperopia (+2.0 and +9.5); binocular vision disorder; Horizontal Nystagmus; Torticollis (ocular torticollis); Mixed astigmatism,
- Obesity due to excess calories E66.



Picture 1: *Characteristics of the Lower Cross syndrome according to Professor Janda's approach in participant*

In the subject's postural status, characteristics of scoliosis, lumbar lordosis and pes planus are visible. His locomotor pattern aligns with individuals diagnosed with Lower Cross Syndrome (Picture 1), as outlined by Professor Janda V. (Page et al., 2010).

Experimental treatment

The experimental program is a form of APE, structured according to the findings of initial assessments. The treatment lasted for 4 months, with one session conducted twice a week for 45 minutes each. Each training session began with myofascial relaxation, followed by walking with gradually increasing intensity, warm-up and corrective exercises. The exercises in the main part of the training, which varied by the level of assistance provided, adaptation, and intensity are presented in Table 1.

Table 1. *Exercise plan (4 months)*

Exercise	1st month	2nd month	3rd month	4th month
Maintaining balance on unstable surface	Until falling	Until falling	-	-
Walking between lines separated by 20cm	x10 times	x10 times	-	-
Walking between lines separated by 10cm	-	-	x10 times	-
Walking on short beam	-	-	-	x10 times
Placing the foot on 20cm stepper	10 times each leg, 3 sets	15 times each leg, 3 sets	-	-
Stepping up and down the stepper	-	-	8 times each leg, 3 sets	15 times each leg, 3 sets
Climbing up and down the stairs	-	-	-	10 steps up and down, 4 sets
Assisted squats	8x3 sets	10x3 sets	10x3 sets-no assistance	12x3 sets no assistance
Leg extensions	12x3 sets	15x3 sets	1kg weight, 12x3 sets	1kg weight, 15x3 sets
Adapted plank hold	5sec x 4 sets	8sec x 4 sets	10sec x4 sets	15sec x 4 sets
Modified push ups	-	-	5 x 3 sets	8 x 3 sets

Instruments

For the assessment of gross motor skills, the standardized clinical test for children with CP, „Gross Motor Function Measure-88 (GMFM-88)" was used. This battery consists of a total of 88 tests grouped into 5 variables based on body position: A-lying and rolling (17 tests); B-sitting (20 tests); C-crawling and kneeling (14 tests); D-standing (13 tests); E-walking, running, jumping (24 tests). To evaluate motor abilities, the standardized "Eurofit" test battery (Council of Europe, 1988) was used, which is valuable from the perspective of the kinesiology profession. This test is recommended for school-age children of typical development and is applicable to children with developmental disabilities that match the subject's profile (Golubović et al., 2012; Erol et al., 2022). For this study, 5 out of 8 tests were selected based on the participant's capabilities, focusing on assessments of speed and coordination of limb movement (plate tapping), flexibility (sit and reach), muscle strength and endurance (sit-up, bent arm hang), and explosive strength (standing broad jump). The results of these tests are expressed in measured units, specifically in centimeters, seconds, or the number of repetitions completed.

Data analysis

As this study followed a case study method, the collected data was analyzed across two time points and presented in both textual and tabular formats.

RESULTS

The overall GMFM-88 test score increased by 6%, and the results of the initial and final measurements, along with their differences, are presented in Figure 1. The figure illustrates a noticeable percentage variance between the two measurements across all assessed variables, except for variable A, which assesses the skill of lying and rolling (initial and final = 96.08%). The largest difference is identified in variable E, which increased by 11.11% after treatment. The values of variable B increased by 6.67%, variable C by 7.15%, and variable D by 5.12%.

The motor abilities tested by the Eurofit battery test are presented in Table 1. A difference between the two measurements was noted in all measured variables, except for the variable "bent arm hang".

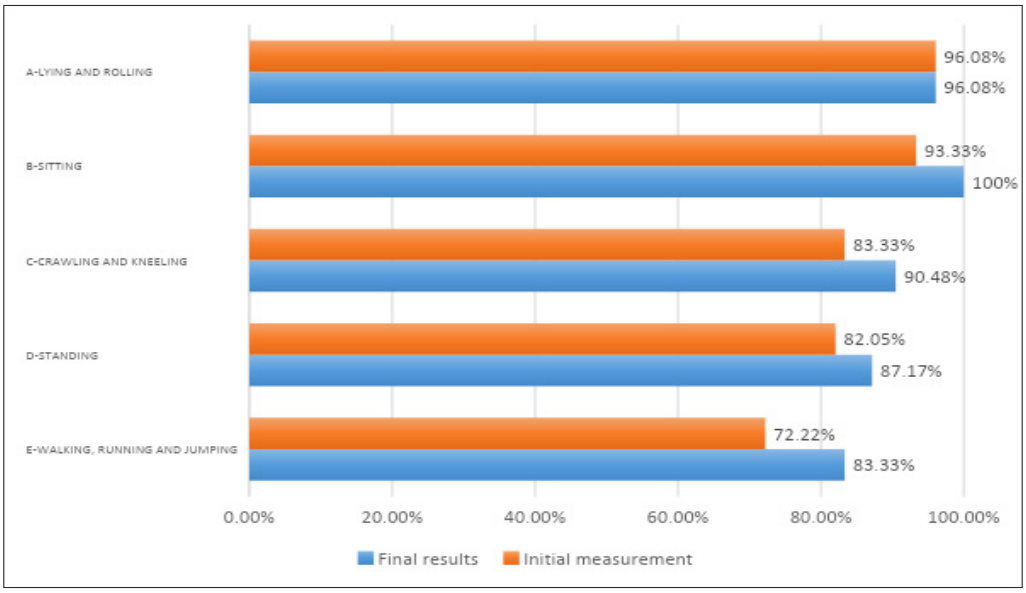


Figure 1. *Gross motor funtional measure „GMFM-88"- initial and final measurement*

Table 2. *Results of two measurements of the Eurofit battery test*

Test	Initial measurement	Final measurement
Standing broad jump	44.2 cm	67 cm
Plate tapping	16 rep	18 rep
Sit-ups	0 rep	7 rep
Bent arm hang	0 s	0 s
Sit-and-reach	-19 cm	-8 cm

cm-centimeters; rep-number of repetition; s-seconds

DISCUSSION

The purpose of this study was to determine the effects of this program based on APE, on gross motor function and motor abilities of child with MD, where CP is the primary condition. According to available literature, there are various programs of APE that can influence motor abilities and gross motor function in children experiencing similar impairments to the participant (Salapura, 2018; Kwon et al., 2015;). In this study, the primary focus was on an individualized approach, adapting the training process according to participant's needs, abilities and improvement, while changes were evident over the course of the study. Positive changes in gross motor function, observed in 4 out of 5 variables of the GMFM-88 test with an overall 6% increase, affirm previous findings that structured physical exercise influences gross motor functions, which is supported by Bhutia et al. (2015). In the study of Lee, Sung and Yoo (2008), it is noticed that it is not necessary to test the variables in participants with high level of functionality. In this study, a high level of functionality was identified for variable A, and significant differences in variables D and E were confirmed as in the previously mentioned study.

Enhanced outcomes in Variable B were noted specifically in trunk muscle strength, leading to improved gross motor function in transitioning from lying to sitting position. Based on the difference in results between the two measurements of Variable C, which assessed crawling and kneeling skills, there is a noticeable improvement. The participant's visual impairments, such as astigmatism affecting image distortion and orientation perception, result in difficulties in tasks such as crawling upstairs. In addition to foot and lower limb deformities, these impairments also affect the skills measured by variable D, which are related to maintaining balance while standing. The achieved benefit is significant, considering that CP is predominantly characterized by changes in the neuro-muscular status of the lower limbs, as confirmed by Dewer et al. (2015), which indicates poor postural control and static as well as dynamic balance.

People with CP encounter difficulties in everyday activities such as walking and stair climbing due to a combination of neuromuscular impairments, including spasticity, muscle weakness, decreased joint flexibility, and poor

coordination. These factors collectively impact their mobility and independence. Recognizing this, the program incorporated exercises aimed at developing core stability, with the goal of enhancing the nervous system's ability to respond to balance loss by activating trunk muscles for proprioceptive stimulation. This resulted in a significant outcome where the participant successfully accomplished independent climbing and descending stairs unaided (Picture 2), greatly enhancing his motor independence and facilitating daily tasks. The results of this study are consistent with the results of the Dodd, Taylor and Graham (2003) study, which indicate that the applied program of APE in the domain of muscle strength gave the best results for the variable E.

Picture 2. *Difference in climbing stairs with alternating steps between initial and final measurement*

For the evaluation of motor skills, an adapted version of the Eurofit test battery was used, encompassing tests applicable to subjects condition. The following motor skills were tested: plate tapping, standing broad jump, bent arm hang, sit and reach, and sit-ups. Even though abilities such as coordination and movement frequency were not targeted in this treatment, the results of "plate tapping" have improved. This test is well-suited for assessing coordination in individuals with the impairments that the subject has, as it does not require a high level of precision or comprehension. An example of this is a study that assessed upper extremity coordination in children with CP, which could not be used in this case due to the subject's visual impairment (Abdullah et al., 2014). Additionally, it is commonly used in kinesiology for children of typical development at subjects age. Coordination is commonly deficient in this population, due to brain damage causing disruptions in reflexes, which manifest as challenges in coordinating and integrating fundamental movement patterns (Winnick & Porretta, 2016, p. 517). The ability to perform the maximum range of motion, or flexibility, was also improved by the program, specifically through passive stretching during the warm-up and cool-down phases of the training. The application of muscle stretching is based on the assumption that it will increase muscle flexibility, preserve joint flexibility for efficient movement, and prevent or delay the need for orthopedic surgical interventions. The variable for assessing strong endurance of abdominal muscles, "sit-up," is another reflection of treatment effectiveness. Strength is an important aspect of normal motor functioning, which is deficient in individuals with CP, even in those at high functional levels, which may be due to disrupted neuronal mechanisms and changes in muscle tissue. In the past, strength training in individuals with CP was considered inadequate due to the belief that it would contribute to increased muscle tone and abnormal movement patterns. Today, strength training in individuals with CP is part of physical therapy and aims to address muscle weakness, balance, walking speed, and gross motor skilss (Merino-Andrés et al., 2022). The participant's capacity for strong endurance in the arms and shoulder area is not sufficiently developed under the influence of treatment for the participant to independently maintain the body in position for bent arm hang test. Tests of explosive strength, such as the standing broad jump, are rarely utilized in studies focusing on the motor abilities of children with CP. Still, they can complement testing by providing additional insights into motor function. Based on the final outcomes of the standing broad jump test within the Eurofit battery test and Variable E (walking, running, and jumping) from GMFM-88, it is evident that the treatment has positively influenced the explosive strength of the lower limbs. While

explosive strength is equally significant as maximum muscle strength for overall motor function, it is often overlooked in assessments, leading to a scarcity of literature on the subject. It is assumed it is not heavily emphasized because the primary goal of therapy for children with cerebral palsy is to improve motor functions necessary for daily activities.

CONCLUSION

The positive effects of the experimental program on gross motor function and motor abilities in subject are evident, particularly in standing, walking, jumping, and running (variable D and E), with notable improvements in stair climbing skills. This study confirms the findings of previous studies, it is not necessary to do a retest for variables in which the respondent shows a high level of functionality. The results of this case study can be a good basis for research that by its nature has a similar goal and would refer to a larger number of participants, where it would certainly be important to include a control group. Nevertheless, the results of this study can be used only for practical purposes as an example in which adapted physical exercise can be applied to a person with very similar conditions, ie locomotor skills in multiple disabilities.

REFERENCES

Abdullah, N. M., Akhir, N. H. M., Tumijan, W., Hamid, N. A., Parnabas, V., Nazarudin, M. N., & Fauzee, M. S. O. (2014). The Assessment of Motor Performance Using Two Coordination Tests on Students with Cerebral Palsy-A Preliminary Study. *Media Ilmu Keolahragaan Indonesia*, 4(1).

Bhutia, C. D., Nair, U. S., & Surujlal, J. (2015). Effect of physical exercise programme on gross motor function of children with cerebral palsy: physical activity and health. *African Journal for Physical Health Education, Recreation and Dance*, 21(sup-1), 1-13.

Council of Europe, Committee for the Development of Sport (1988). *Handbook of EUROFIT tests of physical fitness.* Rome: Edigraf Editoriale Grafica.

Dewar, R., Love, S., & Johnston, L. M. (2015). Exercise interventions improve postural control in children with cerebral palsy: a systematic review. *Developmental Medicine & Child Neurology*, 57(6), 504-520. doi: 10.1111/dmcn.12660

Dodd, K. J., Taylor, N. F., & Graham, H. K. (2003). A randomized clinical trial of strength training in young people with cerebral palsy. *Developmental Medicine & Child Neurology*, 45(10), 652-657.

Erol, H., Sertel, M., Alpcan, A., & Arslan, M. (2022). The Evaluation of Physical Activity and Physical Fitness Levels in Adolescent Individuals with Cerebral Palsy. *Kırıkkale* Üniversitesi *Tıp Fakültesi Dergisi,* 24(1), 73-82.

Golubović, Š., Maksimović, J., Golubović, B., & Glumbić, N. (2012). Effects of exercise on physical fitness in children with intellectual disability. *Research in developmental disabilities*, 33(2), 608-614.

Kwon, J. Y., Chang, H. J., Yi, S. H., Lee, J. Y., Shin, H. Y., & Kim, Y. H. (2015). Effect of hippotherapy on gross motor function in children with cerebral palsy: a randomized controlled trial. *The Journal of Alternative and Complementary Medicine*, *21*(1), 15-21.

Lee, J. H., Sung, I. Y., & Yoo, J. Y. (2008). Therapeutic effects of strengthening exercise on gait function of cerebral palsy. *Disability and Rehabilitation*, 30(19): 1439–1444.

Mensch, S. M., Echteld, M. A., Lemmens, R., Oppewal, A., Evenhuis, H. M., & Rameckers, E. A. A. (2019) The relationship between motor abilities and quality of life in children with severe multiple disabilities. *Journal of Intellectual Disability Research*, 63: 100–112.

Merino-Andrés, J., García de Mateos-López, A., Damiano, D. L., Sánchez-Sierra, A. (2022) Effect of muscle strength training in children and adolescents with spastic cerebral palsy: A systematic review and meta-analysis. *Clinical rehabilitation;* 36(1):4-14.

Milićević, M. (2016). Cerebralna paraliza–Šta nam literatura govori o složenosti ovog stanja. *Beogradska defektološka* škola, 22(3), 53-71 [in Serbian]

Page, P., Frank, C. C., & Lardner, R. (2010). *Assessment and treatment of muscle imbalance: The Janda approach*. Human Kinetics.

Rapaić, D. (2016). *Teorijska i praktična razmatranja specijalne edukacije i rehabilitacije.* Univerzitet u Beogradu, Fakultet za specijalnu edukaciju i rehabilitaciju, CIDD. [in Serbian]

Romanov, R. (2020). *Koncept invalidnosti i kategorizacija sportista sa invaliditetom.* Fakultet za sport i turizam. Educons Univerzitet. Pokrajinski sekretarijat za sport i omladinu. [in Serbian]

Russell, D. J., Rosenbaum, P.L., Cadman, D.T., Gowland, C., Hardy, S., Jarvis, S. (1989) The Gross Motor Function Measure: a means to evaluate the effects of physical therapy. *Developmental medicine and child neurology*. 31, 341-352.

Salapura, S. (2018). *Efekti adaptiranog karate programa u tretmanu osoba sa smetnjama u razvoju.* Doktorska disertacija, Novi Sad: Univerzitet Educons [in Serbian]

United Nations Children's Fund, The world's nearly 240 million children living with disabilities are being denied basic rights, *UNICEF*, New York, 2021. Preuzeto sa: https://www.unicef.org/turkiye/en/press-releases/fact-sheet-worlds-nearly-240-million-children-living-disabilities-are-being-denied

Winnick, J. P., & Porretta, D. L. (2016). *Adapted physical education and sport* (6th ed., p. 517). Human Kinetics.

Primljen: 8. maj 2024. / Received: May 8, 2024
Izmjene primljene: 20. avgust 2024. / Changes Received: August 20, 2024
Prihvaćen: 29. avgust 2024. / Accepted: August 29, 2024