EFFECTS OF PHYSICAL EXERCISE ON MOTOR SKILLS OF CHILDREN WITH INTELLECTUAL DISORDERS: SYSTEMATIC REVIEW

Đorđević Stefan, Jorgić Bojan, Hadžović Miljan, Milenković Saša, Stojanović Stefan, Popović Miodrag
Faculty of Sport and Physical Education, University of Niš, Serbia

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Abstract: *The aim of this research was to determine, on the basis of a systematic review of previous research, whether and to what extent physical exercise affects the motor abilities of persons with intellectual disabilities. The sample of respondents were people with intellectual deficits, male and female, a total of 1203 respondents. The criteria for the analysis of the papers were as follows: the time period of publishing the papers from 2010 to 2020, that the respondents were persons with an intellectual deficit. Based on the set criteria, 14 papers were included in the final analysis, which were analyzed and presented. The experimental exercise program consisted of exercises to develop and improve balance, coordination, strength, manual dexterity, running speed, and agility. The results of the research, programs that lasted 8 or more weeks, with trainings at intervals of 3 to 5 times a week and lasted 20 or more minutes give positive results in terms of development of basic motor characteristics, speed, coordination, balance and strength, while physical activity generally has a positive effect on childhood development. The impact of physical exercise in children with a normal intellectual level is more pronounced in relation to children with developmental disabilities. The significance of this research is that it provides information on the effects of physical exercise on the motor abilities of children with intellectual disabilities, provides information on the complexity of the approach to planning and organizing physical activity for the development of motor skills of children with diagnosed intellectual disabilities.*
Key words: *Physical exercise, power, speed, motor skills.*

INTRODUCTION

Individuals with disabilities belong to a vulnerable segment of the population, and unfortunately, they may exhibit variations in intellectual and physical attributes compared to the general population. These variations exist across a spectrum, necessitating specific measures for enhancement in both intellectual and physical aspects. In today's fast-paced society, there's a tendency to skim over a lot of information, leaving limited time and community spirit to address the needs of marginalized groups. Consequently, people with disabilities, constituting around 10% of the population, often face neglect from both the government and social institutions (Popović, 2015). Disabled individuals can be broadly categorized into three groups: those with physical disabilities, sensory impairments, and intellectual challenges (Đurašković and Živković, 2009). Individuals with intellectual disabilities constitute a minority within the larger group of people with disabilities, specifically representing approximately 2% of the global population (American Association on Mental Retardation, 1992). It is typically discernible that intellectual disabilities manifest from birth, and the diagnostic criteria are reliant on an IQ threshold of 70 units, categorizing them based on varying intelligence quotients (Szymanski & King, 1999). The distinguishing features that set apart individuals diagnosed with intellectual disabilities from those without diagnosed disabilities encompass diminished physical capabilities, including impaired motor control and challenges in maintaining balance and coordinating movements, as well as reduced cognitive and conative abilities. These challenges are often accompanied by delayed speech development and pronounced difficulties in speech articulation, as well as the frequent occurrence of sensory disturbances (Bojanin, Kolar, & Kolar, 2002).

Engaging in physical activity is imperative for individuals with disabilities, primarily for health reasons as it contributes to preserving and enhancing the body's functional abilities. Moreover, from a sociological perspective, individuals with disabilities indirectly find support and a sense of community with others facing similar challenges. The growing emphasis on organized and purposeful fitness exercise programs has also led to the development of specialized physical activity programs tailored to the unique needs of people with disabilities (Đurašković and Živković, 2009). When it comes to

individuals with intellectual disabilities, organized physical activity programs offer a broad spectrum of possibilities, as their locomotor systems are typically fully functional and free of anomalies. The focus of physical activity for individuals with intellectual disabilities should primarily revolve around enhancing and sustaining fundamental motor skills, including balance, movement coordination, and strength (Stanišić, 2013; Popović, 2015). Individuals with diagnosed intellectual disabilities, particularly during their formative years, require expert and well-structured guidance to help them reach their full potential in terms of their health and overall physical and social development. Moreover, when organizing physical activities for children with intellectual disabilities, it's crucial to align them not only with health and functional considerations but also with their specific interests. These activities should be engaging enough to provide an extra incentive for them to participate, fostering their creative expression while instilling a positive attitude towards physical fitness. This encouragement plays a pivotal role in encouraging these individuals to incorporate physical activities into their daily lives and overall lifestyle (Pejčić, 2015).

Previous research on structured physical activity for children with mild intellectual disabilities reveals the existence of various exercise programs, both with and without equipment, encompassing fitness routines and sports games (Maiano, Ninot, & Errais, 2001; Ninot, Bilard, Delignieres, & Sokolowski, 2005; Hemayattalab & Movahedi, 2010; Stanišić, Berić, Bojić, Nurkić, & Kocić, 2012; Alruwaih, 2015; Chen, Tsai, Wang, & Wuang, 2015; Altszuler, Morrow, Merrill, Bressler, Macphee, Gnagy, & Pelham, 2017). These programs offer valuable insights into various aspects, such as the total exercise duration, training duration, methods for assessing progress in motor skills, and subcategories within specific motor skills (Maiano, et al., 2001; Ninot, et al., 2005; Hemayattalab & Movahedi, 2010; Stanišić, et al., 2012; Alruwaih, 2015; Chen, et al., 2015; Altszuler, et al., 2017). Motor abilities are influenced by a variety of factors, including gender, age, individual characteristics, genetics, developmental stage, opportunities for enhancement through training, and more. This paper focuses on this important topic, aiming to explore the established principles of motor skills development by analyzing previous research. The goal is to identify patterns and rules that govern the level of motor skills development in individuals with disabilities. This analysis aims to provide valuable insights for enhancing the system of motor skills development for these vulnerable groups.

RESEARCH METHODS

This systematic research was conducted using various methods, including descriptive analysis, systematization, and critical analysis. The paper primarily utilizes a descriptive method, and the information was sourced from existing literature. The literature was gathered through searches in electronic databases of scientific journals, such as Google Scholar, SCIndex, Hrčak, KoBson, Mendeley, and PubMeb. The search spanned from 2010 to 2020, and relevant papers (including abstracts and full papers) were reviewed and analyzed. To be eligible for inclusion in the final analysis, studies had to meet two specific criteria: they must be of an experimental nature, and the participants should be individuals under the age of 18 with intellectual disabilities. The search in the databases used the following keywords: "physical activity," "motoric abilities," and "intellectual disabilities." Only studies that fulfilled these criteria and provided comprehensive descriptions of the research and presented clear conclusions were considered for inclusion in the analysis.

Scientific publications included in this analysis were chosen based on specific criteria: they were published between 2010 and 2020, written in either English or Serbian, involved participants under the age of 18 diagnosed with mild intellectual disability, featured an experimental intervention involving physical exercise, and conducted an assessment of the participants' motor skills.

The eligible scientific publications were categorized and assessed based on various parameters, which included the reference (comprising the primary author's last name and the research publication year), the diagnosis of intellectual disability, the research design, characteristics of the subject sample (such as the number of participants, their age, gender, and the number of subject groups), details of the experimental intervention (program and duration), the assessment tools utilized for evaluating motor skills, and the outcomes presented in the scientific publications.

RESULTS

From the initial pool of 1814 papers identified using relevant keywords, papers were excluded if they did not pertain to individuals with intellectual disabilities, and some were further excluded based on title, abstract, or topics that were not relevant to the impact of physical exercise on motor skills in children with intellectual disabilities. After this screening process, a total of 14 experimental studies were included in the final analysis. These studies were thoroughly analyzed and categorized based on the methods and parameters mentioned earlier.

Chart 1 Procedure of collection, analysis and elimination of works

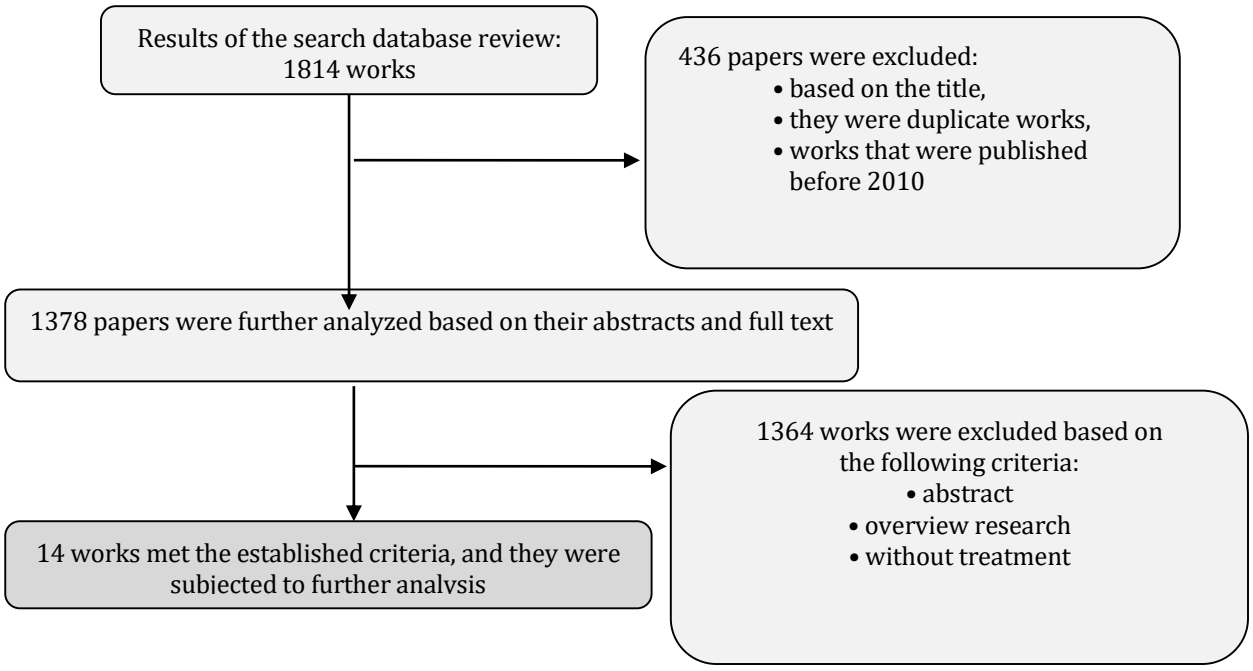

Table 1 presents fourteen papers that fulfilled the predetermined conditions. These papers were published after 2010 and were all research studies. The research involved children of varying ages, encompassing both those engaged in regular training and those who were not, and both sexes were included in the studies. Each research paper aimed to investigate the extent of motor ability differences and potential improvements.

Table 1 Detailed analysis of papers

First author and year	Sample of participants					Experimental treatment	Measuring instruments Tests	Monitored Motor Abilities	Research results
	The no. of the respondents	Age	Gender	Degree of intellectual disability	No. of groups				
Vuijk, et all (2010)	170 **M (109)** F (61)	7–12 years	M, F	MID	1E (n=55) 2E (n=115)	MD BS	MABC MAT	C, P, S, B	1E, group - sig.↑ (p <0.01); 2E group - sig.↑ (p <0.01) C- sig.↑; P- sig.↑; S- sig.↑; B- sig.↑

Young, et all (2010)	24 M (14) F (10)	8-16 years	M,F	MID	1E(n=24)	TPD- 10 weeks T,C, RHSB, JO	MSPG	S, C, P	P, C, B - sig.↑ E group - sig.↑ (p <0,01)
Westendopp, et all (2011)	411 M (242) F (169)	7-12 years	M ,F	1E- MID 1K- NIN	1E (n=156); 1 C (n=255)	TPD – 10 weeks WF- 2h weekly; DOIT-60 min. Two-handed kick, run, catch, overhand throw, jump, slide, reel	TGMD	C,C,S	1.2. P, C, B - sig.↑ 1K group - P, C, B - sig. ↑↑↑ (p <0,01);
Golubović, et all (2012)	87 M (52) F (35)	6-12 years	M, F	MID	1 E (n=21); 2 E (n=21); 1 C (n=45)	TPD – 24 weeks WF- 3x weekly; DOIT-45 min. Balance on one leg on the beam. Long jump with a run start of 2 m As many abs as possible in 30 seconds Running	EUBT FBT SBJT BAHT SUT MST20	P,C,S	1.E - P,P,S - sig.↑ 2.E - P,P,S - sig.↑ 1K group - sig.↑ ↑↑ (p <0,01);
Jankowicz-Szymanska et all (2012)	40 DS M (20) F (20)	16-18 years	M, F	MID	1E(n=20); 1C(n=20)	TPD- 12 weeks WF- 2 times a week; DOIT-45 min. ERBAB SOBLEC	BPT EDB CREET	B	B - sig.↑ E gruop - sig.↑ (p <0,01) in relation to the K group
Giagazoglou, et all (2012)	19	15.3±2.1 years	M, F	MID	1E(n=10) 1 C(n=9)	TPD-10 weeks WF- 2 times a week; DOIT-30 min. TBSR – SOBLEC IHSSP	EPP HIP	B,S	B,P - sig.↑ E group - sig.↑ (p <0,01) in relation to the K group
Stanish et all (2012)	20 M (10) F (10)	15-21 years	M, F	MID	1E(n=20)	TPD-15 weeks WF- 2 times a weeks; DOIT-60 min. AE, WTS	TUFP, YMCA	S, P,G	E group – P, S. sig.↑ E group - sig.↑ (p <0,01)
Giagazoglou, et all (2013)	18 M (14) F (4)	10.3±1.6 years	M, F	MID	1E(n=9) C(n=9)	TPD-12 weeks WF- 5 times a week; DOIT-20 min. TPH SM	12-week program on the trampoline EPP EUBT	B,P	E group – B,P - sig.↑ E gruop - sig.↑ (p <0,01)

Wuang, et all (2013)	114 M (64) F (50)	6-12 years	M, F	MID	1E(n=57) C(n=57)	TPD-20 weeks WF- 5 times a week; DOIT-15 min. WDOME	OTHP, BOT ,	P	E group – P -sig.↑ E group - sig.↑ (p <0,01)
Станишић, (2013)	60 M (38) F (22)	13-17 years.	M, F	MID	1E(n=30) 1C(n=30)	TPD-8 weeks WF- 4 times a week; DOIT-30 min. BT	BTB	P, P, C	E group – P, B, P - sig.↑ (p <0,01)
Baran, et all (2013)	71	12-15 years	M	MID	1E(n=23) 2E(n=23) C(n=15)	TPD-8 weeks WF- 3 times a week; DOIT-90 min. PDSCCEB	TRG- TRG program UNS BPT TRG	C,S, P, STAM	1E group- C, P, P, STAM - sig.↑ 2 Egrupa- C, P, P, STAM - sig.↑ 1E, 2E group - sig.↑ (p <0,01)
Top (2015)	30 M (19) F (11)	15-18 years	M, F	MID	1E(n=14) C(n=16)	TPD-10 weeks WF- 3 times a week; DOIT-60 min. SOBLEC	SEP БОТ2	S,A,C,P,B	1E, group – S,АК,C,P-sig.↑ 1E, group - sig.↑ (p>0.05)
Kachouri, et all (2016)	20	11.4 ± 1x.2 years	M	MID	1E(n=10) C(n=10)	TPD-8 weeks WF- 3 times a week; DOIT-45 min. CSPTBMS	CSPT MMCT	S,B	1E, group –C, P-sig.↑ 1E, group - sig.↑ (p <0,01) in relation to the K group
Stojanović, (2018)	41 M (27) F (14)	17.44±1.34 years	M, F	MID	1E(n=21) 1C(n=20)	TPD-12 weeks WF- 2 times a week; DOIT-45 min.	BOT2	B,C,S,P	1E, group – S,АК,C, P-sig.↑ 1E, group- sig.↑ (p =0,01)

M – male respondent; F – female respondent; 1E – the first experimental group; 2E – the second experimental group; 1К – control group; sig.↑ – statistically significant improvement in results; TPD – total program duration; WF – weekly frequency; DOIT – duration of individual training; 6 WT – the six-minute walk test, MID - Mild intellectual disability, NIN- normal intellectual level, MABC - Movement Assessment Battery for Children (MABC; 1st edition), C - Coordination, MAT - movement assessment test, TGMD - The Test of Gross Motor Development-2 and a self-report measure , MD- Manual Dexterity (Speed and accuracy of each hand separately and hand-eye coordination), BS - Ball skills (catching moving objects and aiming at the target), CREET- The cardio-respiratory endurance test starts with walking and ends with fast running, BPT- Balance Platform Test, EDB-Emi duo balance, EUBT - Eurofit battery test , FBT- Flamingo balance test, SBJT -Standing Broad Jump Test, BAHT- Bent Arm Hang Test, SUT-Sit-up Test, MST20- Multistage 20 m Shuttle Run Test, DS- Down's syndrome , ERBAB- exercises with rehabilitation balls and air bags, SOBLEC - standing on one leg on the limb chosen by the participant, first with eyes open and then with eyes closed, IHSSP - Isometric half squats from a seated position, TBSR- test of balance and strength by riding, EPP- Electronic pressure platform, HIP- Hippotherapy intervention program, AE - aerobic exercise, WTS- weight training and stretching, YMCA programme (Peer Exercise Training Program for Improving Health-Related Physical Fitness Among Adolescents with Intellectual Disabilities), BOT2 - Test of Motor Proficiency Second Edition; TUFP- Team Up For Fitness programme, SM-, Strength measurements - three maximal isometric half squats from a seated position (knee joint at 90 °), WDOME- Writing, drawing and object manipulation exercises, OTHP-Occupational therapy home program (OTHP)Canadian Occupational Performance, BOT-Bruininks–Oseretsky Test of Motor Proficiency-Second Edition, and The Children's Assessment of Participation and Enjoyment scores at 10 and 20 weeks, BTB - Basketball test battery, UNS- Unified Sport (UNS) soccer, PDSCCEB - Passing, dribbling, shooting, running, stretching, coordination, exercises with and without the ball, SEP- Swimming exercise Program, CSPT - CSPT program, MMCT- Maximum Muscle Contraction Test., CSPTBMS- Combined strength and proprioception training for balance and muscle strength, TRG- TRG program, P- Precision, S- speed, B- balance, P -Power, A- agility, STAM - stamina, T-Throwing, C-catching, RHSB- rolling and hitting soft balls, JO- jumping over, MSPG - Multi sports program in the gym,, (IQ 50-55 do 70 – 75).

DISCUSSION

This paper includes fourteen studies published between 2010 and 2020. The most recent work was authored by Stojanović in 2018, followed by a study conducted by Kachouri et al. in 2016. One paper from 2015 (Tor, 2015), four from 2013 (Baran et al., 2013; Stanišić, 2013; Wuang et al., 2013; Giagazoglou et al., 2013), four from 2012 (Stanish et al., 2012; Giagazoglou et al., 2012; Jankowicz-Szymanska et al., 2012; Golubović et al., 2012), one from 2011 (Westendorp et al., 2011), and the oldest papers included in this review are from 2010 (Vuijk et al., 2010; Young, Browne, & Pearce, 2010).

In the studies analyzed, respondents of both sexes were predominantly included. Regardless of gender, significant improvements in morphological characteristics and motor skills were observed in both boys and girls. The research involved a total of 1,130 children, comprising 719 boys and 406 girls. The number of participants in each study varied between 18 and 411 respondents, all meeting the criteria related to the impact of different physical activities on the development of morphological characteristics and motor skills. The age of the respondents ranged from a minimum of 6 years to a maximum of 21 years. Notably, the studies mainly focused on two age groups: one group encompassed respondents aged 7 to 12 years, and the other group consisted of individuals aged 12 to 18 years. In one study (Westendorp et al., 2011), there was a control group comprising individuals with normal intellectual development, while in the other studies, control groups consisted of individuals with intellectual disabilities.

The authors employed various motor tests to evaluate motor skills in their research. The research duration varied across studies, with durations of 3 to 8 weeks (Stanišić, 2013; Baran, et al., 2013; Kachouri, et al., 2016), 4 to 12 weeks, 15 weeks (Stanish et al., 2012), 20 weeks (Wuang, et al., 2013), and 24 weeks (Golubović, et al., 2012). The systematic review indicates that a minimum of 8 weeks is necessary to observe improvements in motor skills among children with intellectual deficits (Kachouri, et al., 2016; Stanišić, 2013). Training frequency ranged from twice a week (Jankowicz-Szymanska, et al., 2012; Giagazoglou, et al., 2012; Stanish, et al., 2012) to three times a week (Golubović, et al., 2012; Baran, et al., 2013; Top, 2015; Kachouri, et al., 2016), and in some cases, four to five times a week (Giagazoglou, et al., 2013). Additionally, the session duration varied from 15, 20, 30, and 45 minutes (Kachouri, et al., 2016) to 60 minutes (Westendorp, et al., 2011; Stanish, et al., 2012). On average, participants engaged in two to three training sessions per week.

The experimental treatments consisted of a variety of exercises and tests, often used in combination. These included movement assessment tests, assessments of general motor abilities, tests for hand coordination and dexterity, as well as tests involving props such as balls to assess object coordination and grasping ability. Some studies also involved cardio-respiratory endurance tests, balance exercises, strength tests, and specific exercise programs like the YMCA program and Team Up for Fitness program. Additionally, there were strength measurements, isometric half-squats, activities involving writing, drawing, and object manipulation, occupational therapy exercises for home settings, and sports-specific assessments such as basketball and football tests covering passing, dribbling, shooting, running, stretching, and coordination exercises, both with and without a ball. A multi-sport program in the gym was also implemented in some cases.

A notable observation is that most of the programs mentioned are typically applied during the development of healthy children and are considered standard across various age groups. Examining the studies presented in the table, it's evident that the development of basic motor characteristics was assessed. Specifically, coordination (C) was evaluated in seven studies, power (P) in eleven, balance (B) in nine studies, mobility (M) in five studies, and speed (S) in six. In one study (Baran, et al., 2013), fitness development (STAM) was tested, and flexibility (F) was assessed in the study conducted by Stanish et al. (2012). Notably, the same components were examined in both experimental and control groups in the research

The results indicated that children with diagnosed intellectual disabilities who participated in active-sports programs generally exhibited better motor skills compared to control groups who did not engage in such activities. These physically active children consistently outperformed their non-participating peers in all the analyzed tests. Programs lasting 8 weeks or longer, with training sessions occurring 3 to

5 times a week and lasting at least 20 minutes, yielded positive results in terms of improving fundamental motor characteristics, including speed, coordination, balance, and strength. Physical activity, in general, had a positive impact on the overall development of children. Notably, the influence of physical exercise was more significant in children with typical intellectual development than in children with intellectual disabilities.

CONCLUSION

This paper underscores the significance of various parameters in designing programs aimed at enhancing motor skill development in children with intellectual disabilities. The research outcomes demonstrated a diverse array of organized physical activities that produced statistically significant positive effects on the motor skill development of individuals diagnosed with mild intellectual disabilities. Moreover, the results indicated ample opportunities for future research dedicated to furthering the understanding of motor skill development in children with intellectual disabilities.

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ЕФЕКТИ ФИЗИЧКОГ ВЕЖБАЊА НА МОТОРИЧКЕ СПОСОБНОСТИ ДЕЦЕ СА ИНТЕЛЕКТУАЛНИМ СМЕТЊАМА: СИСТЕМАТСКО ПРЕГЛЕДНО ИСТРАЖИВАЊЕ

Đorđević Stefan, Jorgić Bojan, Hadžović Miljan, Milenković Saša, Stojanović Stefan, Popović Miodrag

Сажетак: *Циљ овог истраживања био је да се на основу систематског прегледа досадашњих истраживања утврди да ли и у којој мери физичко вежбање утиче на моторичке способности особа са интелектуалним инвалидитетом. Узорак испитаника биле су особе са интелектуалним инвалидитетом, мушког и женског пола укупно 1203 испитаника. Критеријуми за анализу научних радова били су следећи: временски период објављивања радова од 2010. до 2020. године, да су испитаници особе са благим интелектуалним инвалидитетом узраста до 18 година, да су имали одређен програм вежбања. У коначну анализу је на основу постављених критеријума ушло 14 научних радова који су анализирани и приказани. Експериментални програм вежбања састојао се од вежби за развој и побољшање равнотеже, координације, снаге, мануалне спретности, брзине трчања и агилности. На основу резултата истраживања, програми који су имали дужину трајања од 8 и више недеља, са тренинзима у интервалима од 3 до 5 пута недељно и трајању од 20 и више минута дају позитивне резулатет у смислу развоја основних моторичких карактеристика, брзине, координације, равнотеже и снаге, док физичка активност генерално позитивно утиче на развој у дечијем узрасту. Утицај физичког вежбања код деце са нормалним интелектуалним нивоом израженији је у односу на децу са сметњама у развоју. Значај овог истраживања је у томе што пружа информације о ефектима физичког вежбања на моторичке способности деце са интелектуалним сметњама, пружа информације о сложености приступа планирања и организације физичке активности за развој мототирчких способности деце са дијагностикованим интелектуалним инвалидитетом.*

Кључне речи: *Физичко вежбање, снага, брзина, интелектуални инвалидитет, моторика*