

Sladana S. Stanković

<https://orcid.org/0000-0002-7320-6822>

Jelena S. Jančić

<https://orcid.org/0009-0008-1192-1338>

University of Kragujevac

Faculty of Education, Jagodina

Department for Didactics and Methodology

УДК 796.012.1-053.4

DOI [10.46793/Uzdanica23.2.103S](https://doi.org/10.46793/Uzdanica23.2.103S)

Оригинални научни рад

Примљен: 6. јун 2026.

Прихваћен: 6. јул 2026.

AEROBIC EXERCISE AS A DETERMINANT OF COORDINATION DEVELOPMENT IN EARLY CHILDHOOD

Abstract: Motor skill development in early childhood provides the foundation for an individual's later functional abilities and overall health. Coordination occupies a central position within the structure of motor abilities, as it determines the efficiency of performing complex movement tasks. The aim of this study was to examine the effects of an aerobic exercise program on the development of coordination in young children. The study was conducted on a sample of 30 children aged five to six years. An experimental design with pre-test and post-test measurements was employed, using the BOT-2 (Bruininks–Oseretsky Test of Motor Proficiency, Second Edition), specifically the test battery for assessing bilateral coordination. The aerobic exercise program lasted 12 weeks, with children participating in 30-minute exercise sessions three times per week. The results indicate a statistically significant improvement in coordination following the implementation of the program. The results show that aerobic exercise is an important factor in enhancing the motor development of preschool children.

Keywords: aerobic exercise, bilateral coordination, preschool children, motor development.

INTRODUCTION

Early childhood represents the most developmentally sensitive period, during which intensive processes of growth and maturation occur, particularly within the central nervous system, enabling the rapid formation and differentiation of motor patterns (Bala et al. 2009). Owing to the pronounced neuroplasticity at this developmental stage, functional connections are established among various physiological systems, with motor development occupying a central role in the child's overall psychophysical development (Stanković 2025). Contemporary theoretical perspectives emphasize that motor development is not an isolated phenomenon but rather occurs in close interaction with cognitive, emotional, and social development. In this context, motor competence plays a significant mediating role in the

development of self-confidence, social integration, and children's overall adaptation (Stodden et al. 2008; Robinson et al. 2015).

Within the domain of motor abilities, coordination is recognized as one of the most complex and essential motor capacities. It refers to the ability to efficiently control movements in time and space while ensuring optimal economy and precision of performance (Đurković 1995; Stanković 2025). Unlike individual motor abilities, coordination has an integrative nature because it encompasses the interaction of multiple functional systems, including the nervous, muscular, and sensory systems (Iveković 2013). Consequently, coordination is increasingly interpreted as a form of *motor intelligence*, as it involves processes of movement perception, analysis, and adaptation under dynamic conditions (Marković 2017). Previous research has shown that the level of coordination developed during early childhood is a significant predictor of later motor performance and participation in physical activities (Vandorpe et al. 2011; Barnett et al. 2016).

The development of coordination depends on both biological maturation and the richness of children's motor experiences. Diverse forms of movement are particularly important because they enable children to acquire and refine motor patterns. In this regard, bilateral coordination—the ability to synchronize movements of the left and right sides of the body—is of particular importance, as it is associated with the functional integration of the cerebral hemispheres and the development of more complex cognitive functions (Kambas et al. 2004; Karambe et al. 2017). Insufficiently developed coordination has been identified as a risk factor for reduced motor competence and decreased participation in physical activity (Stodden et al. 2008; Vandorpe et al. 2011).

Contemporary lifestyles have substantially altered the conditions under which children's motor development takes place. Urbanization, reduced access to outdoor play spaces, and the increasing dominance of digital media have contributed to lower levels of spontaneous physical activity (Tremblay et al. 2014). According to the World Health Organization (2020), many children fail to achieve the recommended levels of daily physical activity, which has adverse consequences for their motor, functional, and overall health status. Insufficient physical activity during early childhood has been associated not only with delayed motor development but also with an increased risk of numerous health-related problems (Janssen, LeBlanc 2010). Under these circumstances, organized forms of physical activity have become increasingly important as compensatory mechanisms.

Aerobic exercise, defined as a structured form of physical activity involving continuous engagement of large muscle groups with predominantly aerobic energy metabolism, represents one of the most effective approaches for improving both functional and motor abilities (LaMonte, Nichaman 2004; Kemp, Pienaar 2013). In addition to its well-established benefits for cardiorespiratory fitness and overall health, aerobic exercise exerts significant effects on the central nervous system. Research has demonstrated that physical activity stimulates the release of neu-

rotrophic factors, particularly brain-derived neurotrophic factor (BDNF), which plays a crucial role in neurogenesis and synaptic plasticity (Schmolesky et al. 2013; Hillman et al. 2014). These neurophysiological processes provide the foundation for improvements in motor control and motor learning.

Furthermore, contemporary studies have demonstrated a strong association between aerobic exercise and cognitive functioning, including attention, executive functions, and information-processing speed (Donnelly et al. 2016; Basso, Suzuki 2017). In preschool children, aerobic exercise is most commonly used through play-based activities, and, thus, promotes the integrated development of motor, cognitive, and social competencies (Gallahue, Ozmun 2012).

Research examining the effects of physical activity programs consistently indicates that structured and continuous interventions have a significant positive impact on the development of children's motor competence (Derri et al. 2001; Venetsanou, Kambas 2004; Logan et al. 2021). In particular, programs incorporating rhythmic and coordination-based activities have been shown to improve coordination and motor control. The theoretical model proposed by Stodden et al. (2008) suggests a reciprocal relationship between motor competence and physical activity, whereby better-developed coordination promotes greater participation in physical activity, which in turn further enhances motor development.

Although the influence of physical activity on child development has been extensively investigated, systematic research examining the effects of aerobic exercise on specific motor abilities, particularly coordination during early childhood, remains relatively limited. Accordingly, the primary aim of the present study was to examine the effects of an aerobic exercise program on the development of coordination in young children, with the intention of contributing to the further theoretical understanding of this topic and to the improvement of educational practice in early childhood settings.

METHODOLOGY

The aims to examine the effects of a structured aerobic program on the development of coordination abilities in young children. It was designed as a longitudinal experimental investigation with a one-group pre-test/post-test model, in order to monitor the changes in motor performance following the implementation of the experimental intervention.

The exercise program was implemented at the “Pionir” Preschool in Jagodina, Serbia. The intervention lasted for 12 weeks. The children participated in three 30-minute exercise sessions per week. The program was designed in accordance with contemporary theoretical and empirical knowledge concerning physical activity in preschool children, as well as the recommendations of relevant international organizations (Baquet et al. 2003; World Health Organization 2010; Fahey 2013).

The activities were structured to promote the development of coordination through moderate-intensity aerobic exercise conducted within play-based and rhythmic contexts appropriate to the children's developmental characteristics.

The study sample consisted of 30 children aged five to six years, including both boys and girls, who were enrolled in a regular preschool education program. A convenience sampling method was employed, and only children without medical contraindications to physical activity were included. Ethical standards were observed by informing parents about the study procedures and obtaining their written informed consent for their children's participation.

Coordination was assessed using the Bruininks–Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Bruininks, Bruininks 2010), one of the most reliable and widely used standardized instruments for evaluating children's motor abilities. The study specifically focused on bilateral coordination, operationalized through a series of motor tasks requiring synchronized movements of different body segments, temporal coordination, and precise motor control (Bruininks 2005). This instrument was selected because of its strong psychometric properties and its suitability for use with young children, owing to the play-based nature of the tasks and their motivational appeal.

Assessments were conducted at two time points, immediately before and after the implementation of the experimental program, under standardized and controlled conditions. This procedure ensured the reliability and comparability of the collected data, providing a sound basis for the valid interpretation of the intervention effects.

The data were analyzed using appropriate statistical procedures. Descriptive statistics included measures of central tendency and variability (Mean, SD, Minimum, and Maximum), as well as indicators of distribution shape (skewness and kurtosis). The normality of the data distribution was assessed using the Kolmogorov–Smirnov test. As the data deviated from the assumption of normality, differences between the pre-test and post-test measurements were analyzed using the non-parametric Mann–Whitney *U* test. Statistical significance was established at $p < .05$, in accordance with the accepted standards of empirical research in the field of physical education.

RESULTS AND DISCUSSION

This section presents and interprets the findings of the empirical study in accordance with the research aim and the predefined research objectives. The data were analyzed systematically, following the logical sequence of the applied statistical procedures, in order to provide a clear overview of the effects of the experimental intervention on the investigated motor abilities.

Descriptive statistics were first calculated for all analyzed variables, providing insight into measures of central tendency, variability, and the characteristics of score distributions. Particular attention was given to assessing the normality of data distribution using the Kolmogorov–Smirnov test, which served as the basis for selecting the appropriate inferential statistical procedures.

Since deviations from normality were observed for several variables, the non-parametric Mann–Whitney *U* test was used to examine differences between the pre-test and post-test measurements. This approach enabled a reliable evaluation of the effects of the aerobic exercise program on the development of coordination in the study population.

The results are presented in tabular form and accompanied by appropriate interpretation to highlight the direction and magnitude of changes in the observed variables, as well as their statistical significance, thereby providing the basis for the subsequent discussion and conclusions.

Table 1. Descriptive Statistics for the Pre-test Assessment

	N	Min.	Max.	Mean	SD	Skew.	Kurt.		
TNWIFCE	30	1.00	4.00	3.90	.54772	-5.477	.427	30.000	.833
JJ	30	.00	3.00	1.9000	.92289	-.073	.427	-1.297	.833
JIPSSS	30	.00	3.00	2.1667	1.20583	-1.100	.427	-.473	.833
JIPOSS	30	.00	3.00	.6333	1.06620	1.547	.427	1.005	.833
PTAIF	30	.00	3.00	1.3000	1.14921	.529	.427	-1.148	.833
TFAFSSS	30	.00	4.00	3.5333	1.07425	-2.685	.427	6.813	.833
TFAFOSS	30	.00	4.00	1.3667	1.47352	.765	.427	-.724	.833
TOTAL	30	8.00	24.00	14.8000	4.11390	.242	.427	-.740	.833
Valid N (listwise)	30								

Legend: N – number of participants; Min. – minimum score; Max. – maximum score; Mean – arithmetic mean; SD – standard deviation; Skew. – skewness coefficient; Kurt. – kurtosis coefficient.

The data in Table 1 reveal a differentiated structure of the participants' motor abilities at the pre-test, indicating varying levels of development across different aspects of coordination. The highest mean scores were observed in tasks involving relatively simple movement organization and lower levels of intersegmental coordination, such as the Touching the Nose with the Index Finger with Eyes Closed test (Mean = 3.90). This finding suggests that the participants had relatively well-developed sensorimotor control, consistent with previous studies indicating that fundamental forms of coordination develop during the early stages of motor development (Gallahue, Ozmun 2006; Payne, Isaacs 2017).

In contrast, the lowest scores were recorded for variables requiring more complex bilateral coordination and synchronization of opposite limbs (e.g., JIPOSS: Mean = 0.63), indicating a relatively limited level of development of higher-order coordination mechanisms. This finding is expected, given that bilateral coordination

develops gradually through the functional integration of the central nervous system and the progressive refinement of motor patterns (Haywood, Getchell 2014). Similar findings have been reported in previous studies demonstrating that preschool children experience considerable difficulty performing tasks requiring synchronized movements of opposite sides of the body (Logan et al. 2018).

The analysis of score variability indicates substantial individual differences within the sample, reflected by relatively high standard deviation values for several variables. These differences may be attributed to variations in children’s motor experience, levels of participation in physical activity, and individual rates of neuromuscular maturation, which is consistent with previous findings (Robinson et al. 2015).

The distributional characteristics further clarify the structure of the results. Pronounced negative skewness in variables such as TNWIFCE and TFAFSSS indicates that most participants achieved relatively high scores, suggesting that tasks of lower coordination complexity were successfully performed by the majority of children. Correspondingly, high kurtosis values indicate leptokurtic distributions, reflecting a greater concentration of scores around the mean. Conversely, variables representing more complex coordination tasks exhibited slight positive skewness, indicating a predominance of lower scores and further confirming the greater motor demands of these tasks.

Overall, the pre-test results suggest that basic forms of coordination were relatively well established in the participating children, whereas more complex coordination skills, particularly those involving bilateral synchronization and spatiotemporal precision, remained less developed. This pattern is fully consistent with developmental models of motor learning and motor control, which propose that complex coordination skills emerge gradually through systematic and appropriately structured physical practice (Clark, Metcalfe 2002). Consequently, a structured aerobic exercise program may provide an effective stimulus for enhancing coordination abilities during early childhood.

Table 2. Descriptive Statistics for the Post-test Assessment

	N	Min.	Max.	Mean	SD	Skew.			Kurt.	
TNWIFCE	30	4.00	4.00	4.0000	.00000	.	.	.	.	.
JJ	30	3.00	3.00	3.0000	.00000	.	.	.	.	.
JIPSSS	30	3.00	3.00	3.0000	.00000	.	.	.	.	.
JIPOSS	30	.00	3.00	2.5667	.85836	-2.149	.427	4.017	.833	
PTAIF	30	.00	3.00	2.6000	.81368	-2.403	.427	5.637	.833	
TFAFSSS	30	4.00	4.00	4.0000	.00000	.	.	.	.	.
TFAFOSS	30	2.00	4.00	3.6000	.56324	-1.042	.427	.176	.833	
TOTAL	30	19.00	24.00	22.7667	1.59056	-1.187	.427	.416	.833	
Valid N (listwise)	30									

Legend: N – number of participants; Min. – minimum score; Max. – maximum score; Mean – arithmetic mean; SD – standard deviation; Skew. – skewness coefficient; Kurt. – kurtosis coefficient.

The descriptive statistics for the follow-up of the experimental program is presented in Table 2. The data indicate substantial improvements across all analyzed variables, accompanied by greater homogeneity of performance within the study group. Notably, participants achieved maximum scores with no observed variability ($SD = 0.00$) in several tests (TNWIFCE, JJ, JIPSSS, and TFAFSSS), suggesting complete mastery of these motor tasks. These findings indicate that coordination tasks of low and moderate complexity were successfully acquired as a direct consequence of systematic and appropriately structured exercise.

Particularly noteworthy is the substantial reduction in the number of variables exhibiting minimum scores (0.00) compared with the pre-test assessment. This finding indicates fewer unsuccessful task performances and an overall improvement in participants' motor efficiency, supporting previous research demonstrating that systematic physical activity contributes to reduced variability in children's motor performance (Robinson et al. 2015).

Performance on more demanding coordination tasks (JIPOSS, PTAIF, and TFAFOSS) also improved considerably, as reflected by higher mean scores (e.g., JIPOSS: Mean = 2.56; PTAIF: Mean = 2.60; TFAFOSS: Mean = 3.60). Although some variability remained for these variables, it was substantially lower than at baseline, suggesting greater stability of motor patterns and improved movement control.

The distributional indices further support this trend. Pronounced negative skewness for most variables indicates clustering of scores at the upper end of the scale, reflecting a predominance of successful performances. Likewise, elevated kurtosis values for several tests indicate leptokurtic distributions, suggesting greater homogeneity of performance and fewer extreme scores.

Overall, the post-test findings demonstrate a marked transformation of the participants' motor abilities, characterized by improved coordination, reduced variability, and more uniform performance. These findings are consistent with previous research demonstrating that structured aerobic exercise programs have significant positive effects on the development of motor abilities, particularly coordination, among preschool children (Lubans et al. 2016; Logan et al. 2018).

Comparison of the pre-test and post-test assessments clearly shows that the greatest improvements occurred in the variables that represented the greatest motor challenges at baseline, further supporting the effectiveness of the implemented aerobic exercise program.

Table 3. One-Sample Kolmogorov–Smirnov Test (Assessment of Data Normality)

	TNWIFCE	JJ	JIPSSS	JIPOSS	PTAIF	TFAFSSS	TFAFOSS	TOTAL
N	60	60	60	60	60	60	60	60
Kolmogorov-Smirnov Z	4.142	3.155	3.645	2.171	2.418	3.870	1.795	1.320
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.003	.061

Legend: Z – Kolmogorov–Smirnov test statistic; Sig. – significance level (p -value).

The results of the Kolmogorov–Smirnov test are presented in Table 3. They indicate that most variables significantly deviated from a normal distribution ($p < .05$). This finding suggests that the score distributions were asymmetric, which is commonly observed in studies of children’s motor abilities, particularly following intervention programs that tend to produce clustering of scores at the upper end of the distribution (Thomas et al. 2015). Only the composite (“Total”) score did not show a statistically significant deviation from normality ($p = .061$), indicating a relatively stable overall measure.

Table 4. Mann–Whitney *U* Test Results

	TNWIFCE	JJ	JIPSSS	JIPOSS	PTAIF	TFAFSSS	TFAFOSS	TOTAL
Z	-1.000	-5.319	-3.815	-5.333	-4.132	-2.786	-5.219	-6.211
Asymp. Sig. (2-tailed)	.317	.000	.000	.000	.000	.005	.000	.000
Effect size	0.03	0.94	0.48	0.94	0.57	0.25	0.91	1.28

Given the observed violations of the normality assumption, the application of the non-parametric Mann–Whitney *U* test (Table 4) was considered appropriate for examining differences between the pre-test and post-test assessments. The results indicate statistically significant differences ($p \leq .05$) for the majority of variables, providing strong evidence for the effectiveness of the aerobic exercise program.

The only exception was the Touching the Nose with the Index Finger with Eyes Closed test ($p = .317$), for which no statistically significant difference was found. This finding may be explained by the fact that the test primarily assesses proprioceptive control and kinesthetic sensitivity, abilities that typically develop more gradually and require more specific forms of stimulation than those predominantly included in the implemented aerobic exercise program (Gallahue et al. 2012).

Conversely, statistically significant improvements were observed for all remaining variables, with substantial effect sizes indicating not only statistical significance but also practical relevance. Particularly pronounced improvements were found in variables assessing bilateral coordination, confirming that aerobic exercise programs incorporating rhythmic and coordination-demanding movements effectively enhance the integration of movements involving the left and right sides of the body.

These findings are consistent with those reported by Carmonsio et al. (2014), who demonstrated that structured physical exercise programs significantly improve bilateral coordination in children, although proprioceptive tasks do not always exhibit statistically significant changes. Similarly, Uzunović et al. (2017), using the BOT-2 assessment battery, found that children in experimental groups achieved

significantly better results in tasks involving whole-body coordination and movement synchronization.

The present findings are further supported by the study of Katanić et al. (2021), who reported significant improvements in coordination abilities following a 12-week exercise intervention. Comparable results have also been documented by Lubans et al. (2016), who emphasized that systematic physical activity exerts multidimensional effects on children's motor development, including improvements in coordination, balance, and movement control.

The importance of promoting coordination through physical activity has also been confirmed in numerous other studies (Mitrović, Stević 2018; Radanović 2018; Šalaj et al. 2019), all of which identify early childhood as a critical period for the development of motor abilities. In this context, the present findings are particularly valuable, as they demonstrate that a carefully designed aerobic exercise program can substantially improve the motor competence of young children.

Some previous studies have also highlighted the influence of additional factors, such as nutritional status (Chowdhury et al. 2017) and socioeconomic conditions (Matarma et al. 2020), on the development of coordination, suggesting that motor development should be understood as the product of multiple interacting factors. Nevertheless, despite these influences, physical activity remains one of the most important and most direct determinants of children's motor development.

Taken together, the findings of the present study indicate that the implemented aerobic exercise program had both statistically significant and practically meaningful effects on the development of coordination in young children, thereby supporting the general research hypothesis.

CONCLUSION

Starting from the established research framework and the obtained empirical findings, it can be concluded that a systematically designed aerobic exercise program represents an effective approach to improving coordination abilities in preschool children. The observed changes in the participants' motor performance profile, reflected in statistically significant improvements across the majority of the analyzed variables, indicate a high degree of adaptability of the motor system under conditions of appropriately dosed and methodically structured physical activity. These findings not only confirm the proposed hypothesis but also contribute to a more comprehensive understanding of the mechanisms underlying the development of coordination during early childhood.

The most pronounced effects were observed in the domain of bilateral coordination, particularly in tasks requiring complex spatiotemporal organization of movement and synchronization of different body segments. This pattern of results suggests that the implemented program primarily influenced those components

of motor control that constitute the functional foundation for the development of more complex motor skills. Conversely, the absence of statistically significant changes in certain variables indicates that individual coordination mechanisms differ in their sensitivity to the type, intensity, and structure of the applied stimulus, providing an important methodological consideration for the design of future intervention programs.

The observed reduction in performance variability and the increased consistency of participants' achievements indicate a process of motor pattern stabilization, which is consistent with contemporary theories of motor learning describing the gradual transition from variable to functionally optimized movement patterns. From this perspective, aerobic exercise can be regarded not only as a means of enhancing physical fitness but also as an important factor in improving the organization and efficiency of motor control.

From a practical standpoint, the findings demonstrate that relatively simple, yet methodologically well-designed aerobic exercise programs can be successfully integrated into preschool educational settings without substantial organizational or material requirements. Furthermore, the use of standardized assessment instruments, such as the Bruininks–Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), enables objective monitoring of motor development and provides a reliable basis for planning, implementing, and evaluating physical activity interventions.

From a scientific perspective, this study contributes to the growing body of knowledge on the effects of aerobic exercise on motor development in preschool children, particularly within the context of Serbian research, where studies of this kind remain relatively scarce. Moreover, the findings highlight the need for future research examining different intervention models, their duration and intensity, as well as the interactions among motor, cognitive, social, and environmental factors involved in child development.

Overall, the findings indicate that a systematically designed aerobic exercise program, grounded in contemporary scientific knowledge and implemented through appropriate methodological principles, represents an effective, feasible, and evidence-based approach to improving coordination abilities in preschool children. The positive effects identified in this study suggest that such programs have the potential not only to enhance motor development directly but also to establish favorable conditions for children's long-term functional, physical, and overall psychomotor development.

REFERENCES

Bala, G., Jakšić, D., Popović, B. (2009). Trend relacija morfoloških karakteristika i motoričkih sposobnosti predškolske dece. In: Bala, G. (Ed.), *Relacije antropoloških ka-*

rakteristika i sposobnosti predškolske dece. Novi Sad: Fakultet sporta i fizičkog vaspitanja, 61–112.

Barnett, L. M., Lubans, D. R., Timperio, K. L., Salmon, J., Ridgers, K., Okely, A. D., Cairney, J., Pate, J. W. (2016). Motor competence and physical activity participation. *Sports Medicine*, 46(9), 1273–1284. DOI: [10.1007/s40279-016-0493-4](https://doi.org/10.1007/s40279-016-0493-4).

Basso, J. C., Suzuki, W. A. (2017). Effects of acute exercise on cognition and neurophysiology. *Brain Plasticity*, 2(2), 127–152.

Baquet, G., Van Praagh, E., Berthoin, S. (2003). Endurance training in youth. *Sports Medicine*, 33(15), 1127–1143.

Bruininks, R. H., Bruininks, B. D. (2005). *Bruininks-Oseretsky Test of Motor Proficiency* (2nd ed.). Minneapolis: Pearson.

Bruininks, R. H., Bruininks, B. D. (2010). *BOT-2 Manual*. Minneapolis: Pearson.

Carmonsio, K., Grzeszczak, A., McMurray, K., Olivo, A., Slutz, B., Zoll, B., Donahoe-Fillmore, B., Brahler, J. (2014). Test Items in the Complete and Short Forms of the BOT-2 that Contribute Substantially to Motor Performance Assessments in Typically Developing Children 6–10 Years of Age. *Journal of Student Physical Therapy Research*, 7(2), 32–43.

Carmonsio, K., Grzeszczak, A., McMurray, K. et al. (2014). BOT-2 motor performance. *Journal of Student Physical Therapy Research*, 7(2), 32–43.

Chowdhury, S., Wrotniak, B., Ghosh, T. (2017). Association Between Body Mass Index and Motor Competence in Santal Children of Purulia District. *Journal of Motor Behavior*, 49(3), 349–354. DOI: [10.1080/00222895.2016.1191429](https://doi.org/10.1080/00222895.2016.1191429).

Clark, J. E., Metcalfe, J. S. (2002). The mountain of motor development. In: J. E. Clark, J. H. Humphrey (Eds.), *Motor development: Research and reviews*. Reston, VA: National Association for Sport and Physical Education, 163–190.

Derri, V., Tsapakidou, A., Zachopoulou, E., Kioumourtoglou, E. (2001). Music and movement programs. *European Journal of Physical Education*, 6(1), 16–25.

Donnelly, J. E., Hillman, C. H., Castelli, D. et al. (2016) Physical activity, fitness, cognitive function. *Medicine & Science in Sports & Exercise*, 48(6), 1197–1222.

Đurković, R. (1995). *Koordinacija u sportu*. Beograd: Fakultet fizičke kulture.

Fahey, T. D. (2013). *Fitness and wellness*. New York: McGraw-Hill.

Gallahue, D. L., Ozmun, J. C. (2006). *Understanding motor development*. New York: McGraw-Hill.

Haywood, K. M., Getchell, N. (2014). *Life span motor development*. Champaign: Human Kinetics.

Hillman, C. H., Erickson, K. I., Kramer, A. F. (2014). Be smart, exercise your heart. *Nature Reviews Neuroscience*, 9(1), 58–65. DOI: [10.1038/nrn2298](https://doi.org/10.1038/nrn2298).

Iveković, T. (2013). Utjecaj motoričkog planiranja, koordinacije i sukcesivnih sposobnosti na motorički razvoj i društveno ponašanje djece s teškoćama u razvoju. *Hrvatski športskomedicinski vjesnik*, 28(2), 99–107.

Janssen, I., LeBlanc, A. G. (2010). Health benefits of physical activity. *International Journal of Behavioral Nutrition and Physical Activity*, 7, 40. DOI: [10.1186/1479-5868-7-40](https://doi.org/10.1186/1479-5868-7-40).

Karambe, P., Dhote, S. N., Palekar, T. J. (2017). Assessment of bilateral coordination using Bruininks–Oseretsky test of motor proficiency (BOT- 2), in 5 to 15 years school going children. *International Journal Physiother Reserch*, 5(3), 2026–2030.

Katanić, B., Veljković, A., Stojilković, N., Stanković, S., Mitić, P. (2021). Effects of a 12-week aerobic training program on the cognitive and motor abilities of preschool children. *Facta Universitatis, Series: Physical Education and Sport*, 19(3), 223–232. DOI: [10.22190/FUPES2103223K](https://doi.org/10.22190/FUPES2103223K).

Kambas, A., Aggeloussis, N. (2004). Construct validity of the Bruininks-Oseretsky test of motor proficiency-short form for a sample of Greek preschool and primary school children. *Perceptual and Motor Skills*, 102, 65–72.

Kemp, C., Pienaar, A. (2013). Relationship between the body composition and motor and physical competence of Grade 1 learners in South Africa. *The journal of sports medicine and physical fitness*, 53(6), 635–643. DOI: [10.23736/S0022-4707.13.02979-9](https://doi.org/10.23736/S0022-4707.13.02979-9)

LaMonte, M. J., Nichaman, M. Z. (2004). Physical activity recommendations. *American Journal of Clinical Nutrition*, 79(5), 913–920. DOI: [10.1093/ajcn/79.5.913S](https://doi.org/10.1093/ajcn/79.5.913S)

Logan, S. W., Robinson, L. E., Wilson, A. E., Lucas, W. A. (2021). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. *Sports Medicine*, 51(6), 1127–1137. DOI: [10.1007/s40279-021-01445-9](https://doi.org/10.1007/s40279-021-01445-9).

Lubans, D. R., Morgan, P. J., Clifton, P., Barnett, L. M., Okely, A. D. (2016). Fundamental movement skills in children and adolescents. *Sports Medicine*, 40(12), 1019–1035. DOI: [10.2165/11536850-000000000-00000](https://doi.org/10.2165/11536850-000000000-00000)

Marković, Ž. (2017). Марковић, Ж., *Теорија и методика наставе физичког васпитања*. Јагодина: Факултет педагошких наука Универзитета у Крагујевцу.

Matarma, T., Lagström, H., Löyttyniemi, E., Koski, P. (2020). Family correlates. *Perceptual and Motor Skills*, 127(2), 367–385. DOI: [10.1177/0031512519899885](https://doi.org/10.1177/0031512519899885).

Mitrović, N., Stević, D. (2018). Efekti vežbanja. *Sport i zdravlje*, 13(1), 65–73.

Payne, V. G., Isaacs, L. D. (2017). *Human motor development*. New York: Routledge.

Radanović, D. (2018). *Program razvojne gimnastike*. Doktorska disertacija, Univerzitet u Novom Sadu, Fakultet za sport i fizičko vaspitanje.

Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan, S. W., Rodrigues, L. P., D'Hondt, E. (2015). Motor competence and its effect on positive developmental trajectories of health. *Sports Medicine*, 45(9), 1273–1284. DOI: [10.1007/s40279-015-0351-6](https://doi.org/10.1007/s40279-015-0351-6).

Schmolesky, M. T., Webb, D. L., Hansen, R. A. (2013). Aerobic exercise and BDNF. *Journal of Sports Science & Medicine*, 12(3), 502–511.

Stanković, S. (2025). *Motor development in early childhood*. Јагодина: Fakultet pedagoških nauka Univerziteta u Krajujevcu.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Robertson, M. A., Rudisill, M. E., Garcia, C., Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity. *Quest*, 60(2), 290–306. DOI: [10.1080/00336297.2008.10483582](https://doi.org/10.1080/00336297.2008.10483582).

Šalaj, S., Milčić, L., Šimunović, I. (2019). Motor skills differences. *Kinesiology*, 51(1), 133–140.

Thomas, J. R., Nelson, J. K., Silverman, S. J. (2015). *Research methods in physical activity*. Champaign: Human Kinetics.

Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., Colley, R. C., Gorber, S. C. (2014). Sedentary behaviour. *International Journal of Behavioral Nutrition and Physical Activity*, 11, 98. DOI: [10.1186/s12966-014-0098-0](https://doi.org/10.1186/s12966-014-0098-0).

Uzunović, S., Đorđević, N., Nikolić, D., Stojanović, M., Stojanović, T. (2018). Effects of kindergarten sports school on motor abilities of preschool children. *Physical Education and Sport*, 15(3), 481–491.

Vandorpe, B., Vandendriessche, J., Lefèvre, J. et al. (2011). Motor coordination norms. *Scandinavian Journal of Medicine & Science in Sports*, 21(3), 378–388. DOI: [10.1111/j.1600-0838.2009.01067](https://doi.org/10.1111/j.1600-0838.2009.01067).

Venetsanou, F., Kambas, A. (2004). Dance programs and motor skills. *Research in Dance Education*, 5(2), 127–138. DOI: [10.1080/1464789042000190874](https://doi.org/10.1080/1464789042000190874).

World Health Organization (2010). *Global recommendations on physical activity for health*. Geneva: World Health Organization.

World Health Organization (2020). *Guidelines on physical activity and sedentary behaviour*. Geneva: World Health Organization.

Слађана С. Станковић

Јелена С. Јанчић

Универзитет у Крагујевцу

Факултет педагошких наука у Јагодини

Катедра за дидактичко-методичке науке

АЕРОБНО ВЕЖБАЊЕ КАО ДЕТЕРМИНАНТА РАЗВОЈА КООРДИНАЦИЈЕ КОД ДЕЦЕ РАНОГ УЗРАСТА

Резиме: Развој моторичких способности у раном детињству представља основу за касније функционално и здравствено стање појединца. Посебно место у структури моторичких способности заузима координација, која условљава ефикасност извођења сложених кретних активности. Циљ овог рада био је да се испита утицај програма аеробног вежбања на развој координације код деце раног узраста. Истраживање је реализовано на узорку од 30 испитаника узраста пет до шест година. Примењен је експериментални програм са иницијалним и финалним мерењем, уз употребу BOT-2 (Bruinkins–Oseretsky Test of Motor Proficiency, Second Edition) – батерија тестова за процену развоја билатералне координације. Програм аеробног вежбања је трајао 12 недеља, са децом се вежбало три пута недељно у трајању од по 30 минута. Резултати указују на статистички значајно побољшање координације након примене програма. Добијени резултати потврђују да аеробно вежбање представља значајан фактор унапређења моторичког развоја деце предшколског узраста.

Кључне речи: аеробно вежбање, билатерална координација, деца предшколског узраста, моторички развој.