International Journal of Academic Health and Medical Research (IJAHMR)
ISSN: 2643-9824
Vol. 9 Issue 11 November - 2025, Pages: 26-31

The Effects Of Eight-Week Plyometrics Training On The Development Of Motor Skills In Secondary School Students

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Abstract: *The aim of this study was to examine the effects of an eight-week plyometric training program on the development of motor skills in secondary school students. The study included 49 participants (aged 14–16 years) divided into an experimental group (n=25) and a control group (n=24). The experimental group performed a structured plyometric training program twice a week in addition to regular physical education classes, while the control group participated only in standard physical education activities. Motor performance was assessed using a battery of tests: standing long jump (SLJ), countermovement jump (CMJ), 20 m sprint, and T-test. The results showed significant improvements ($p<0.05$) in explosive power (SLJ, CMJ) and agility (T-test) in the experimental group compared to the control group, while no significant changes were observed in sprint performance. These findings suggest that an eight-week plyometric training program conducted twice a week can effectively enhance specific components of motor performance, particularly explosive power and agility, in secondary school students.*

Keywords - plyometric training, motor skills, agility, explosive power, secondary school students

INTRODUCTION

Physical education as a part of integral education occupies an important place in the system of education and upbringing of young generations. Exercise plays a very important role in the growth and life of children and adults. Since a person grows and develops from an early age, it is important to exercise in accordance with the characteristics of growth and development and in accordance with the characteristics and abilities. Physical activity plays an important role in health status, regardless of whether it is a physical or mental component, and life without movement is not possible for a long time and cannot occur without it (Wilmore, Costill & Kenney, 2008). The physical impact of exercise is reflected in a harmoniously developed body, a high level of development of motor skills, numerous motor habits, harmonious functioning of organs, organ systems, etc.

One of the most important tasks of physical education teaching should be to encourage physical development and improve motor skills of students. Only an appropriate level of motor skills allows for successful learning of more complex motor tasks, acquisition of knowledge and formation of habits (Višnjić et al., 2004). In modern societies, physical activity and development of motor skills are key aspects of healthy growth of young people. Especially in the secondary school period, when students face numerous physical and psychological changes, it is important to provide them with adequate programs that will support their development. One such program is strength training, which is increasingly recognized as an effective method for improving various aspects of physical fitness.

In the context of high school students, this period is crucial for the development of basic motor skills that will influence their physical activity in adulthood. In addition, improving these skills can also have a positive impact on academic performance and general well-being. Research has shown that there is a correlation between the level of motor skills and academic success in high school students (Chaabene et al., 2020). Also, it is marked by accelerated physiological and hormonal changes, the importance of strength training becomes even more pronounced. Adolescents are at a stage where they can achieve large increases in muscle strength and endurance, which has a direct impact on their motor skills such as sprinting, jumping and agility (Behringer et al., 2011). Systematic reviews have shown that supervised strength programs in high school students lead to significant improvements in physical fitness, with the greatest effects observed in lower extremity strength, explosiveness, and overall functional ability (Granacher et al., 2023). Research has shown that programs that combine strength training with basic motor activities as part of physical education classes lead to significant improvements in coordination, speed, and explosive power in children ages 7 to 12 (Lin et al., 2022). Such programs not only promote physical development, but also reduce the risk of injury and encourage the adoption of healthy lifestyle habits at an early age (León-Reyes et al., 2025).

The aim of this study is to examine the effects of an eight-week plyometric training program on the development of motor skills in high school students. The results of this study may provide valuable information for educators and coaches in creating effective physical activity programs that will support the comprehensive development of young people.

METHOD

A sample of respondents

The research included 49 (N=49) students from the Secondary School Center "Foča", aged 14–16 years. The subjects were divided into two groups, an experimental group of 24 (n=24) students and a control group of 20 (n=25). All participants were healthy, without injuries and regularly attended physical education classes, and the experimental group had, for 8 weeks, additional plyometric training twice a week as part of the basketball and volleyball sections. All subjects voluntarily agreed to participate in the experiment.

A sample of measuring instruments

The basic anthropometric characteristics of the sample of respondents were defined by the following variables: Body height /BH/ in cm, Body mass /BM/ in kg, Body mass index /BMI/ in kg/m2.

Two tests were used to assess lower extremity explosive strength: Standing long jump /SLJ/ in cm Countermovement Jump /CMJ/ in cm.

The following was used to estimate the sprint: Sprint speed at 20m /S20m/ in s.

To estimate the speed of change of direction, the following was used: T test /Tt/ in s.

Statistical data processing

Based on the stated subject, problem, goal, tasks and hypotheses of this research, all collected data were analyzed using the Statistical Package for Social Sciences, version 20.0 (IBM SPSS 20.0, SPSS Inc, Chicago, USA). Data collected during the initial and final measurements were presented in the form of descriptive statistics (arithmetic mean, standard deviation, minimum and maximum values). The normality of the distribution was tested using the Shapiro–Wilk test, in order to determine whether the data meet the conditions for the application of parametric tests. To determine the differences between the initial and final measurements within each group, a paired t-test was applied, while an independent t-test was applied to examine the differences between the experimental and control groups in the final measurement. The statistical significance level was set at $p < 0.05$. In addition, to determine the practical significance of the differences obtained, the effect size (Cohen's d) was calculated: 0.20–0.49 → small effect, 0.50–0.79 → medium effect, 0.80 → large effect.

Experimental program

The experimental group conducted plyometric training twice a week for eight weeks, along with the usual physical education classes that took place twice a week. The control group attended only regular physical education classes during the same period, without additional strength training. The aim of the experimental program was to examine the impact of plyometric training on the development of explosive strength, speed and agility in high school students. The training was adapted to the age of the subjects, conducted in the physical education hall, under the supervision of a physical education teacher. Each training session lasted between 45 and 60 minutes (through additional classes, basketball and volleyball sections) and consisted of three parts: an introductory part (warm-up, preparation of muscles and joints), the main part (plyometric exercises), and the final part (stretching and relaxation exercises).

RESULTS

Table 1 shows descriptive statistics of the anthropometric characteristics of the students included in the study. The mean height of the subjects in the experimental group was 176.4 ± 6.3 cm, while in the control group it was 175.8 ± 6.9 cm, indicating a similar growth profile of both groups. The mean body mass was 68.7 ± 7.5 kg in the experimental group and 69.4 ± 8.1 kg in the control group, while the mean body mass index (BMI) was 22.1 ± 1.9 in the E group and 22.4 ± 2.1 in the K group. These results show that the groups were relatively uniform in anthropometric parameters at the beginning of the experiment, which allows for a reliable analysis of the effects of the experimental treatment on the motor abilities of the students.

Table 1.Descriptive statistics of anthropometric characteristics of respondents

Group	Variable	Min.	Max	Mean	SD
E (n=24)	BH	165.2	188.1	176.4	6.3
	BM	55.4	82.3	68.7	7.5
	BMI	18.9	25.4	22.1	1.9
K (n=25)	BH	163.8	187.0	175.8	6.9

	BM	56.2	83.1	69.4	8.1
	BMI	19.1	26.0	22.4	2.1

Legend: E – experimental group; K – control group; Min – minimum; Max – maximum; Mean – mean value; SD – standard deviation; BH – body height; BM – body mass; BMI – body mass index.

Table 2 shows the results of the paired t-test for the experimental group, illustrating the differences between the initial and final measurements after eight weeks of plyometric training. The results show significant improvements in explosive power: the standing long jump (SLJ) has a medium effect ($t = 4.88$, $p = 0.001$, $d = 0.76$), while the squat jump with preparation (CMJ) shows a large effect ($t = 5.74$, $p < 0.001$, $d = 0.91$). No statistically significant change was observed in sprinting abilities, indicating the innate stability of short sprint abilities. On the other hand, the rapid change of direction test (Tt) showed a medium improvement effect (Tt: $t = -2.87$, $p = 0.008$, $d = 0.53$), indicating a positive impact of plyometric training on abilities that require explosiveness and rapid changes of direction of movement. Overall, the results confirm that the experimental treatment significantly affects motor abilities specific to sports activities such as jumping and changing direction.

Table 2.Experimental group (Paired Samples t-test)

Variables	**t**	**p**	**Cohen's d**	**Effect**
SLJ	4.88	0.001	0.76	medium
CMJ	5.74	0.000	0.91	large
S20	-1.21	0.237	0.15	no
Tt	-2.87	0.008	0.53	medium

Legend: SLJ - standing long jump; CMJ - prepared squat jump; S20 - 20m sprint speed; Tt - T test; t - differences between mean values; p - significance level $p < 0.05$; Cohen's d - effect size 0.20–0.49 → small effect, 0.50–0.79 → medium effect, ≥ 0.80 → large effect

Table 3 shows the results of the paired t-test for the control group, illustrating the differences between the initial and final measurements without the application of plyometric training. The results show that in explosive power there were only small improvement effects: standing long jump (SLJ, $d = 0.20$) and squat jump with preparation (CMJ, $d = 0.22$), which are not statistically significant. Sprinting abilities did not show any changes, indicating the stability of these innate abilities. In the rapid change of direction test (Tt), small effects were also observed ($d = 0.38$), but without statistical significance. Overall, the results of the control group confirm that a regular physical education curriculum, without specific plyometric training, leads to minimal changes in the motor abilities of high school students.

Table 3.Control group (Paired Samples t-test)

Variables	**t**	**p**	**Cohen's d**	**Effect**
SLJ	1.21	0.236	0.20	small
CMJ	1.08	0.287	0.22	small
S20	-1.05	0.305	0.10	no
Tt	-.141	0.170	0.38	small

Legend: SLJ - standing long jump; CMJ - prepared squat jump; S20 - 20m sprint speed; Tt - T test; t - differences between mean values; p - significance level $p < 0.05$; Cohen's d - effect size 0.20–0.49 → small effect, 0.50–0.79 → medium effect, ≥ 0.80 → large effect

Table 4 shows the results of an independent t-test comparing the motor abilities of the experimental and control groups at the final measurement. The results show that the experimental group, which performed plyometric training, achieved statistically significantly better results in explosive power: standing long jump (SLJ, $d = 1.09$) and squat jump with preparation (CMJ, $d = 1.32$), both with a large effect size. Sprinting abilities did not show significant differences between the groups, indicating the stability of innate speed. However, in the rapid change of direction test (Tt), a mean difference in favor of the experimental group was observed, indicating the positive impact of plyometric training on the ability to quickly change direction. These results confirm the effectiveness of the plyometric program in improving key motor abilities of secondary school students within the framework of physical education units.

Table 4.Differences between E and K groups at final measurement (Independent Samples t-test)

Variables	t	p	Cohen's d	Effect
SLJ	3.42	0.001	1.09	large
CMJ	4.05	0.000	1.32	large
S20	-1.90	0.065	0.54	no
Tt	-3.25	0.002	0.68	medium

Legend: SLJ - standing long jump; CMJ - prepared squat jump; S20 - 20m sprint speed; Tt - T test; t - differences between mean values; p - significance level $p < 0.05$; Cohen's d - effect size 0.20–0.49 → small effect, 0.50–0.79 → medium effect, ≥ 0.80 → large effect

DISCUSSION

The main objective of this study was to examine the effects of plyometric training on the motor skills of high school students. The study was conducted to determine the extent to which specific forms of training, based on different methodological approaches to strength development, can improve explosive strength, speed, and agility as key components of the motor skills of young people in their developmental years.

The results obtained in this study confirmed the initial hypothesis, as the subjects who were included in the specific strength training program showed significant improvements in tests measuring explosive strength of the lower extremities (Standing Long Jump, Countermovement Jump), as well as in the test assessing the ability to change direction of movement (T-test). On the other hand, no statistically significant improvement was found in the test assessing linear speed (20-meter sprint), which indicates that the applied program had a greater impact on abilities involving explosive strength and coordination than on abilities dependent on maximum movement frequency. This can be explained by the fact that speed is largely determined by hereditary factors and that its development requires specific sprinting methods, such as short sections of maximum intensity, step technique and running frequency, which were not in the foreground in this program.

These findings are consistent with the results of numerous studies (Markovic & Mikulic, 2010; Saez de Villarreal et al., 2015), which confirm that plyometric and functional forms of strength training have a pronounced effect on the development of explosive strength and agility, while their impact on pure sprint speed is of lower intensity. This confirms that different types of strength training, when properly dosed and implemented in accordance with the principles of progressive loading and individualization, represent an effective method for improving motor skills in high school students. For example, Faigenbaum et al. (2009) found that an eight-week functional strength training program leads to significant improvements in vertical jump and agility tests in students aged 14–16. Similarly, Granacher et al. (2011) have shown that a combination of dynamic strength training and stabilization exercises leads to an increase in lower extremity explosive power and improved movement control in tests such as the T-test and Illinois Agility Test. Also, the results of our study confirm the findings of Behm et al. (2017), who point out that strength training in young people can produce significant neuromuscular adaptations and improve explosiveness and coordination, even when maximal loads are not used. However, in accordance with this work, the authors also state that the effect on running speed remains limited if the program is not focused on specific speed stimuli. A typical plyometric program includes CMJ, DJ and SJ which can be combined or used separately, but the combination of these jumps gives better results than their separate use (Zelenović et al., 2020). Similar results were obtained by Santos & Janeira (2008), who, using a sample of basketball players aged 14-15, determined that complex training lasting 10 weeks (2x per week) leads to improved results on the SJ test. Also, studies that dealt with young basketball players have highlighted the relevance of anthropometric (BH, BM, etc.) and functional attributes (speed, agility, jumping ability, etc.) in the performance of young players (Torres-Unda et al., 2013, 2016; Ramos et al., 2019, 2020).

The results of the differences between the experimental and control groups after the plyometric training intervention show significant changes. The subjects in the experimental group achieved significantly better results in the standing long jump (SLJ) and the squat jump with preparation (CMJ), with large effect sizes (Cohen's d = 1.09 and 1.32). These results support the claim that plyometric training significantly improves the explosive power of the lower extremities. Similar results were obtained by Marković and Mikulić (2010), who showed that plyometric interventions increase vertical jumps in adolescents, as well as de Villarreal et al., (2009) who emphasize the effectiveness of this type of training for explosive movements of the leg muscles. Increasing jump height is logical, because plyometric exercises such as Squat Jump, Countermovement Jump, and Lunge Jump directly activate the posterior chain muscles and improve speed-explosive abilities.

On the other hand, the results of the speed of direction change test, T-test (Tt), show a statistically significant advantage of the experimental group over the control group, with medium effect sizes (Cohen's d = 0.68). This indicates that plyometric exercises, which involve fast and explosive jumps in different directions, increase the abilities necessary for agility, coordination and body

stability during rapid direction changes. The results are consistent with the works of Marković & Mikulić (2010) and Luz et al. (2019), which state that plyometric training has a positive effect on motor skills that require controlled direction changes and explosive movements.

CONCLUSION

In summary, the findings confirm that plyometric training has a specific and significant effect on explosive power and agility in high school students, while pure sprint speed remains relatively stable. This is rational, as plyometric exercises directly activate the muscles and neural patterns necessary for fast and explosive movements, but are not sufficiently focused on the specifics of running over shorter distances.

This study has several limitations that should be considered. The sample was relatively small (N=49) and included students from only one high school, which limits the possibility of generalizing the results. The subjects had different levels of extracurricular physical activity, which could have affected the results of the explosive strength and agility tests. The experimental program lasted eight weeks, which is enough to detect initial changes, but not to evaluate long-term adaptations. Assessment of motor abilities was based on a limited number of tests (SLJ, CMJ, sprint, LAD, T-test), without including biomechanical or laboratory indicators. Finally, the research was conducted on students aged 14–16 years, so the results cannot be directly applied to other age groups or populations with different levels of physical activity.

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