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Educational Approach to Testing with New Technology in Junior Javelin Throwing

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Abstract: *The event of javelin throw has always been one of the most spectacular and unique moments in the national and international competitions since the beginning of the official meetings. Due to its rules and regulations this event creates a great atmosphere and excitement because of its six attempts, and it has often been the case of deciding the winner in the final round. As it is a highly technical event it takes a lot of struggle and continuous practice to master the run-up and the final effort. During the run-up the athlete builds up momentum and it takes a lot of skill to manage to transfer that momentum throughout the entire body to the javelin and thus to achieve a great throw. In the junior level this is an ongoing process and sometimes exertion to get it right. In order to have an effective and successful attempt the timing has to be perfect. At the age of 15-18 years the stage of consolidation is usually taking place which is then followed by perfection. Using new technology and specific equipment we applied some particular tests, and the aim of the study is to find the efficiency of new technology in testing and acquiring awareness of the movement; also the positive effect of the experimental training program used to improve the overall technique and specific qualities and nevertheless to find some correlation between the tests. The participants are 6 girl athletes, junior level, and the statistical analysis was performed with the T test and also Pearson correlation for some of the tests applied. The findings reveal that the experimental training program was successful and thus the improvement appeared, and the participants gained awareness of their own technique and specific skills.*

Keywords: *javelin throw; junior level; new technology; specific skills; experimental program.*

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Introduction

The javelin throw has been and continues to be one of the most spectacular events in athletics, and within the throwing events group, it is considered by many specialists to be one of the most technically demanding. It differs from the other three events in its category both through the long run-up (over 15-20 meters for juniors and over 30 meters for seniors) and through the size of the implement (the javelin), which is over 2 meters long. In competitions, athletes are generally allowed 6 attempts, but if there are more than 8 participants, after the first 3 throws, a ranking is made, and only the best 8 throwers are given 3 more attempts. Being a very spectacular event, it draws great interest and attention from spectators, which is why at European and World Championships, the final takes place in the last days of the program. Additionally, while a few years ago the world leaders were from Europe, in recent years, athletes from Asian countries such as India and Pakistan have risen to the top of the rankings.

Through this article we intend to bring some practical insight about the importance of using new technology in testing at junior level, in the event of javelin throw, and likewise using specific equipment during training to enhance awareness regarding the global movement and the sequential parts but also regarding the coordination, as well as the direct relationship and influence that the body exerts in connection with the javelin. Through the tests employed we aim to validate the hypothesis that explosive strength (power) and speed training improve the performance in javelin throw. This paper enriches the literature in the field and provides data concerning the junior category given the lack of research conducted on the junior girls` category, both at the national and international level.

One of the ongoing subject to debate among national coaches is the overtraining of the junior athletes, in search of immediate results and national or international medals therefore, it is appropriate to state that our approach emphasizes the natural development of athletes, with training stages tailored to their individual capacities. Previous articles show that arthritic alterations and degenerative lesions appear in the shoulder area of senior javelin throwers (Schmitt et al., 2001). Additionally in high performance junior throwers it is shown to appear some morphological and biomechanical changes (Beitzel et al., 2012; 2016). Nonetheless certain studies in other overhead throwing sports indicate that some preventive exercises for the shoulder can be effective but only if they are performed at a regular basis (Lintner et al., 2007; Aldridge et al., 2012).

Theoretical aspects

The throwing technique in this event consists of a cyclic and an acyclic phase. The cyclic phase involves the running stage, during which speed is accumulated, while the acyclic phase consists of a sequence of cross-steps culminating in the moment of javelin release and recovery (Tidow, 1996).

For a throw to be efficient and for the motor act to be translated into a beneficial result, it is essential to understand and apply the fundamental principles governing the specific movement. These include the principle of initial force, the principle of optimal acceleration, and the principle of impulse conservation (Crişan, 2016).

Many specialists in the field assert that the technical complexity of this event is high, making it a demanding and challenging discipline for the entire body (Best et al., 1996). The forces and speeds generated are significant and a high core strength and stability is needed (Bartonietz, 2006). Which is why excellent synchronization and coordination are required according to Terauds (1985) and Liu et al. (2010). All these along with agility and specific skills developed from the junior stage are essential in order to transfer the accumulated speed to the javelin and achieve an optimal trajectory for a desirable performance (Krantz, 2006).

Regarding testing and control trials for throwers, the specialized literature states that they serve as a suitable tool for assessing athletes' fitness levels and predicting results in upcoming official competitions. Additionally, specialists including Ivan & Anton (2016), argue that due to time efficiency and economic considerations, there has been greater interest in forecasting (in advance) through testing and control trials rather than post-event diagnosis. Advance testing provides a more precise set of information regarding the level of preparation for future competitions. However, in certain circumstances, particularly at the elite performance level, some control norms and tests used to assess performance capacity and predict competition results have not proven to be as effective as initially assumed (Ivan & Anton, 2016).

The aim of this study is to highlight the effectiveness of specific training at the junior level, with a focus on movement awareness and the correlation between certain specific tests and the javelin throw using a cross-step, a fundamental element of the throwing technique in this event. The junior category represents a stage of technical consolidation, which is developed both sequentially (through specific phases of the run-up) and globally (through full run-up throws). Our hypothesis is that if training includes methods specifically targeting explosive strength and speed, with an

emphasis on segmented phases of the run-up, there will be an improvement in both physical and technical aspects.

As a spectacular event within an individual sports discipline, any positive result enhances self-esteem and the desire to continue, thereby improving the quality of life for participants. Consequently, many individuals who wish to practice a sport gravitate toward individual disciplines, where they can directly quantify their results and thus achieve a higher quality of life (Păunescu et al., 2018). Moreover, those who reach the elite performance level demonstrate ethics, fair play, and adherence to sporting values (Mindrescu et al., 2024). However, it is important to consider that while the entire body is engaged in performing the movement, only one arm executes the throw. Therefore, special attention must be given to the preparation and posture of the upper body to prevent imbalances, which sometimes occur in certain athletic events that place greater strain on specific body parts (Radu & Petrea, 2022).

The effectiveness of training methods can be observed in competition results, while testing is used to assess the level of preparation (Anton, 2018). The focus is on identifying tests that help maximize the training process to optimize the time required for neuromuscular recovery, whose revitalization is directly proportional to competition performance. And later, for training sessions to be effective, it is essential to apply methods and techniques specific to the movement and the type of motor qualities involved. If a rigorous program specifically designed to improve speed is implemented, this quality will undoubtedly improve (Georgescu et al., 2019). Also, when designing the training plan, the athlete's current preparation level and the most important upcoming competition are taken into account. Training adaptability is tailored to each athlete individually and to the conditions in which the training sessions take place (Szabo, 2024).

As a short-duration event, the nature of the effort is anaerobic-alactic, relying on explosive strength, where synchronization plays a crucial role in achieving a successful execution (Bompa et al. 2021; Bota, 2000). This motor quality directly depends on the level and mobility of the neuromuscular system (Manolachi et al., 2023) and various types of training can be used to develop explosive strength, one effective method being the combination of specific plyometrics and electrostimulation (Calfa & Mihăilescu, 2024; Popescu et al., 2022). At the junior age, technique is reinforced through a high number of repetitions, focusing primarily on specific phases of the run-up. As performance improves, both the coach and the athlete seek methods for further enhancement, often turning to digital technology to facilitate the desired results (Enoiu et al., 2023).

The success of a valid and long throw relies on meeting the principles of classical mechanics, specifically ballistics. Specialist authors such as Liebenberg et al. (2016) state that internal ballistics refers to the athlete's movements and execution during the run-up, before the javelin leaves the hand, while external ballistics involves the javelin's flight phase. The throwing distance is influenced by both internal and external factors, such as wind, gravitational force, and the material from which the javelin is made.

Internal factors refer to the release parameters at the moment the javelin leaves the thrower's hand, which include: release speed, release angle, attack angle, lateral deviation angle, and release height. The release speed is considered to be the most important parameter, as it can be influenced and maximized by the athlete's actions (Bartonietz, 2009). Valleala (2015) states that release speed is the sum of all forces applied to the javelin, which in proportion 70-80% of these forces generated by the contraction and coordination of the entire body's muscles, the distance and duration of force application on the javelin before release, as well as the role of the blocking leg and hip rotation.

Methods and technology

A group of six female javelin throwers, aged 15 to 18, three of them part of the national team and the other three participants at national competitions, underwent initial testing before following an experimental training plan over two months. After completing the experimental program, they performed the final tests. The parents or legal guardians were informed about the entire testing procedure and provided their written consent. Throughout the two-month period we maintained communication with the athletes` coaches, who supervised them directly, and all participants successfully completed the training program. Five tests were used: the first two—consecutive jumps in six seconds and the countermovement jump—were conducted using the Optojump system. The third test, throwing ball velocity, was measured with the SpeedTrack X Radar Gun. The last two tests—two-handed medicine ball throw and javelin throw with a cross-step—were measured traditionally using a measuring tape.

Optojump is an optical measurement system consisting of a transmission bar and a reception bar. Each of these bars contains 96 LEDs (with a resolution of 1.0416 cm). The LEDs on the transmission bar continuously communicate with those on the reception bar. The system detects any interruptions in communication between the bars and calculates their duration. The system's ability to detect and calculate the duration of

interruptions makes it possible to measure flight and contact times during a series of jumps with an accuracy of 1/1000th of a second. Based on these fundamental data, the dedicated software enables the collection of a series of parameters related to the athlete's performance with maximum accuracy and in real time. The absence of moving mechanical parts ensures high precision and reliability. Therefore, in the first test, the focus was on the jump rhythm, while in the second test, the height of the jump was measured.

The SpeedTrac X Radar Gun Hands-Free device is a speed measurement tool, ideal for various sports disciplines. It functions as a radar gun, with a built-in LED display showing three digits, and can be mounted on any stand for hands-free operation. This combination allows the radar gun to be used by a single person, recording and displaying the speed of an object passing over it, in real time. It shows the speed in km/hour and it was placed in front of the girls to record the throwing ball velocity immediately after it left the hand so that the accuracy can be as good as possible. The junior athletes threw a small ball using a cross-step; every girl had three attempts and the best performance was recorded for analysis.

For the last two tests, a measuring tape was used to measure the throwing distance. The medicine ball throw was performed using a cross-step, holding the ball with both hands above the head, with the ball weighing 2 kg. The javelin throw was also executed with a cross-step, which is part of the complete run-up for the throw.

For the statistical processing of the data in the study, the software IBM SPSS Statistics for Windows, NY: IBM Corp. was used. Nominal data were presented as absolute frequency and percentage, while continuous variables were expressed by mean value and standard deviation. To compare two sets of dependent or paired data, we used the paired T-test. This test is used in research protocols that involve repeated measurements on the same individuals or on individuals with similar characteristics (even twins) (Field, 2017). The data are considered paired because for each value, there is a corresponding paired value. The test evaluates the difference score within each pair, so the subjects are compared only with themselves or with their pair.

The T-test of the difference of means for two dependent samples allows for the assessment of the significance of variation in a specific characteristic for the same individuals in two different situations, for example, "before" and "after" the action of a specific condition, or in two different contexts, regardless of when they occur. The major advantage of this statistical model is that it captures the variation known as "intrasubject"

by using the difference between the two values for each individual as the basis for calculation (Rosner, 2020).

To evaluate the correlation, we chose the Pearson correlation coefficient, a measurement that quantifies the strength of the association between two variables (Cohen et al. 2013; Hinkle et al. 2003).

To select the predictors of a specific dependent variable based on statistical criteria, we used stepwise multiple regression. Multiple linear regression is essentially a method for making predictions, that is, to estimate the value of a variable Y when we have a value for the associated variable(s) X (Tabachnick et al., 2019). Multiple regression can serve various purposes, such as: predicting a dependent variable based on several independent variables; explaining the dependent variable based on independent variables; identifying a set of independent variables that is most effective in estimating the dependent variable; providing an answer to the question of whether including a specific independent variable in the model adds explanatory value for the dependent variable (Draper & Smith, 1998). The choice of stepwise multiple regression as the calculation procedure was justified by the number of predictors, for which the exact contribution of each to the overall correlation with the dependent variable is unknown.

A value of the statistical significance coefficient $p<0,05$ was considered significant.

Results and discussion

Although the initial intention was to include a control group in order to better highlight the effectiveness of the experimental training compared to traditional methods, this was not feasible due to the limited number of female athletes practicing this event. Javelin throwing is a niche sport and, unfortunately, the total number of participants at the national level has been continuously declining over the past ten years, often with fewer than 15 competitors (juniors and seniors also) taking part in competitions. Regarding the testing procedures, the participants were first shown how each test should be performed and then they were given two or three shots, with the best repetition being recorded. During the experimental training period (although it lasted only two months because of some personal problems of two of them) the athletes were daily reminded of the importance of performing the exercises at high speed and with maximum focus, particularly those targeting the development of specific strength and the consolidation and refinement of throwing execution. Mirror work was employed, training sessions were recorded and the footage was shown to the athletes

immediately. All these methods aimed to enhance their awareness of both sequential and global movement patterns.

The consecutive jumps test within 6 seconds, evaluated using the Optojump system, had the rhythm (pace) as the parameter of interest. The results indicate a significant improvement in the jumps rhythm between the initial testing (T1) and the final testing (T2), with the athletes being able to perform more steps per second in T2, and the average rhythm increasing to 3.05067 steps per second.

Table 1. Consecutive jumps in 6 seconds – Pace

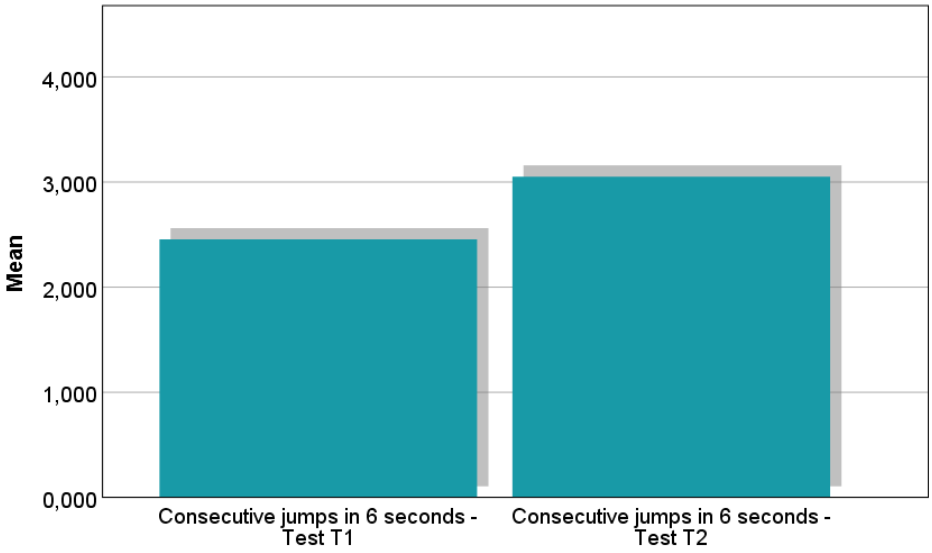
		Mean	**N**	**Standard deviation**	**p**	**Cohen`s d**
Pair 1	Consecutive jumps in 6 seconds - Pace[step/s] - T1	2.45417	6	0.151073	0,025	-1.28
	Consecutive jumps in 6 seconds -Pace[step/s] - T2	3.05067	6	0.364891		

Source: author's own contribution

A higher standard deviation at T2 indicates greater variability in the participants' performances at this time, meaning that there were larger differences between the individual rhythms of the participants at T2 compared to T1. The p-value is 0.025, which means that the difference between the two measurements is statistically significant. In general, a p-value lower than 0.05 indicates that the observed difference is significant and is not the result of chance.

The Cohen's d index is -1.28, suggesting a very large effect size. A Cohen's d greater than 0.8 is considered to reflect a large effect. The negative value indicates that the improvement is significant in the desired direction, meaning the jump rhythm increased from T1 to T2.

Figure 1. Consecutive jumps in 6 seconds Test – Pace



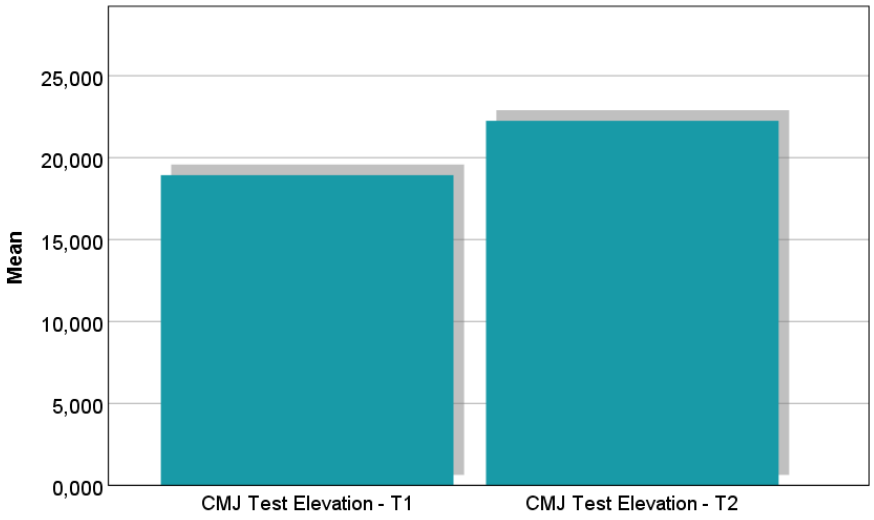
Source: author's own contribution

Regarding the Countermovement Jump (CMJ) test, which was also evaluated using Optojump, the parameter of interest was the height of the jump. The results from the final testing showed improvements. The average increased from 18.93333 cm to 22.25000 cm, an increase of approximately 3.32 cm. The values of the standard deviation indicate a slight increase in the variability of individual performances. The p-value of 0.201 indicates that the difference between T1 and T2 is not statistically significant, and the Cohen's d index indicates a moderate difference between the two measurements. The negative value suggests that the difference is in the desired direction (an increase in jump height from T1 to T2), but the magnitude of the change is moderate.

Table 2. Countermovement jump Test (CMJ)

		Mean	N	Standard deviation	p	Cohen`s d
Pair 1	Test CMJ - Elevation - T1	18,93333	6	4,316326	0,201	-0,60
	Test CMJ - Elevation - T2	22,25000	6	5,055195		

Figure 2. Countermovement jump – Elevation



Source: author's own contribution

Thus, although the jump height increased from T1 to T2, the difference is not statistically significant (p = 0.201). However, the Cohen's d index (-0.60) suggests that this increase has a moderate effect size, meaning that the improvement may have practical relevance, even though it is not statistically significant. The increase of approximately 3.32 cm in jump height could be significant for the participants' performance, but more data would be needed to confirm statistical significance.

The individual results can be seen in the table below, for both of the tests mentioned above.

Table 3. Individual results for consecutive jumps and CMJ

Name	**Consecutive jumps in 6 seconds (Pace-steps/sec)**		**Countermovement jump – CMJ (elevation- cm)**	
	T1	T2	T1	T2
A.A	2.65	3.14	14.8	29.2
S.D	2.49	2.83	24.4	24.3
R.A	2.47	2.83	18.3	19.5
P.A	2.54	2.59	21.8	24.6
B.M	2.36	3.58	13.2	14.4
C.D	2.22	3.32	21.1	24.3

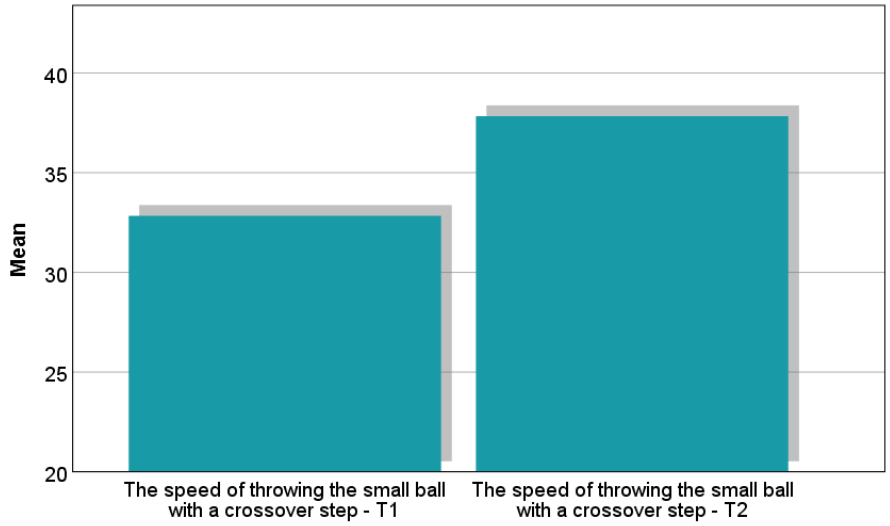
Source: author's own contribution

The throwing ball velocity test was performed by the athletes, both from a stationary position and with a crossover step, with the values for the crossover step being taken into account. As seen in the table, both the mean and standard deviation increased at the final testing, and the p-value is statistically significant ($p < 0.05$), indicating a significant difference between the two measurement periods. The Cohen's d index suggests a very large effect, in the negative direction, indicating a considerable difference between the two tests.

Table 4. Throwing ball velocity Test

		Mean	N	Standard deviation	p	Cohen`s d
Pair 1	Throwing ball velocity in crossover step - T1	32.83	6	6.047	0.009	-1.68
	Throwing ball velocity in crossover step - T2	37.83	6	8.377		

Figure 3. Throwing ball velocity



Source: author's own contribution

We can therefore state that the javelin throwers demonstrated a significant improvement in the speed of throwing the ball between the two testing moments, suggesting that specific training had a positive effect.

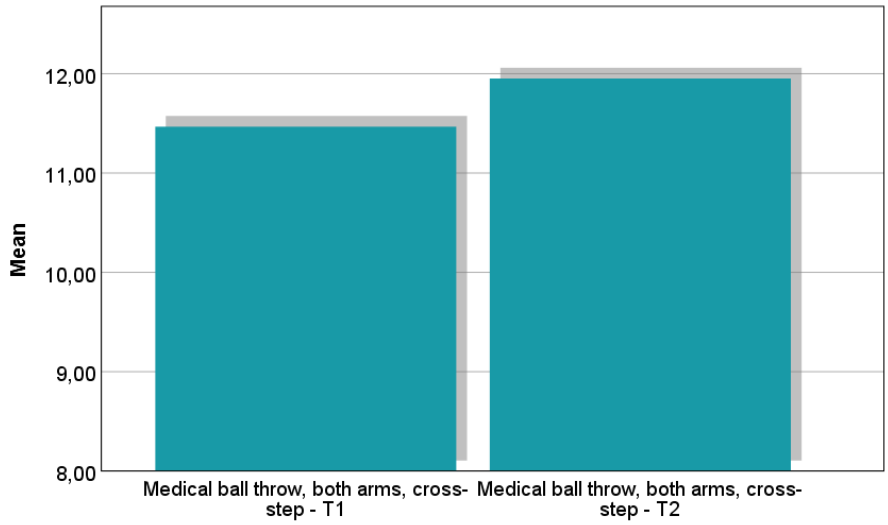
Regarding the test for the medical ball throw with both arms, it was performed with a cross-step to benefit from the accumulated inertia, and the ball was thrown with both arms above the head. Classic measurement with a

tape measure was used. Here, the differences between the mean throws and the standard deviation are not very large, with the mean for the final test being 11.9517 compared to the initial value of 11.4667, and the standard deviation indicating 2.47095 compared to 2.27391. The p-value is close to the significance threshold of 0.05, but slightly higher. Thus, the difference between the measurements is not statistically significant at a 5% level. Although the Cohen's d index shows a large effect of the difference between the two testing moments, suggesting a notable difference, the difference is not statistically significant.

Table 5. Test 2 arms medicine ball throw

		Mean	N	Standard deviation	p	Cohen`s d
Pair 1	2 arms medicine ball throw - T1	11.4667	6	2.27391	0.057	-1.00
	2 arms medicine ball throw - T2	11.9517	6	2.47095		

Figure 4. 2 arms medicine ball throw



Source: author's own contribution

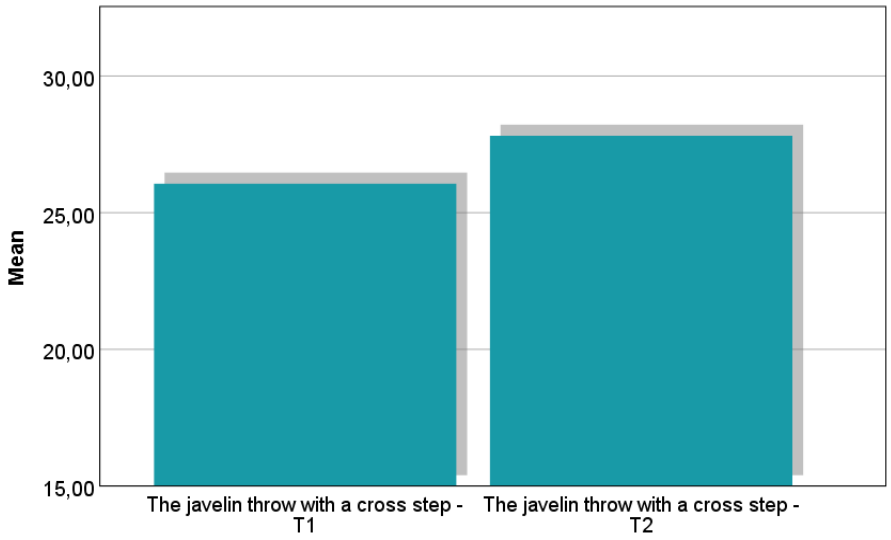
The final test was the javelin throw with a cross-step, and the analyzed parameters indicate a significant improvement. The average throwing distance increased from 26.0583 meters to 27.8133 meters after two months of training, and the standard deviation decreased from 7.47599 to 7.26754, indicating a similar variability in the performance of the

participants in both measurements. The p-value is 0.001, indicating a very significant statistical difference between the initial and final test measurements. Generally, a p-value below 0.05 is considered significant, and p = 0.001 indicates an extremely low probability that this difference is due to chance. Cohen's d index is -2.80, indicating a very large effect size. Typically, a Cohen's d greater than 0.8 indicates a strong effect. The negative value suggests that the improvement is significant in the desired direction, i.e., an increase in throwing distance between the two testing moments.

Table 6. Test Javelin throw crossover step

		Mean	N	Standard deviation	p	Cohen`s d
Pair 1	Javelin throw crossover step - T1	26.0583	6	7.47599	0.001	-2,80
	Javelin throw crossover step - T2	27.8133	6	7.26754		

Figure 5. Javelin throw crossover step



Source: author's own contribution

The results show a statistically significant improvement in javelin throwing performance and also, the Cohen's d index (-2.80) suggests an extremely large effect size, indicating that the observed difference is not only statistically significant but also practically significant. This reflects an increase

in performance in javelin throwing with a cross step between the two measurement points.

The individual results can be observed in the following table.

Table 7. Individual results for ball velocity, 2 arms medicine ball and javelin throw

Name	Throwing ball velocity (km/h)		2 arms medicine ball throw (m)		Javelin throw cross-step (m)	
	T1	T2	T1	T2	T1	T2
A.A	27	31	10,70	11,25	25,00	27,88
S.D	38	47	14,00	15,36	35,05	36,50
R.A	39	45	13,20	13,60	32,40	33,70
P.A	38	44	12,90	12.80	29,00	30,30
B.M	28	28	9,90	10,20	17,90	20,00
C.D	27	32	8,10	8,50	17,00	18,50

Source: author's own contribution

Below, we can further observe the correlations between the throwing tests in the final assessment (T2), specifically the correlation between the throwing ball velocity and the javelin throws with a cross step, as well as the correlation between the two-handed medicine ball throw and the javelin throw with a cross step.

Correlation Between Throwing ball velocity and Javelin Throw with a Cross Step - T2

Pearson Correlation: 0.880 indicates a very strong and positive correlation between ball throwing speed - T2 and the javelin throw with a cross step - T2. This means that participants who performed well in the small ball throw also achieved very good results in the javelin throw.

The p-value of 0.021 is lower than 0.05, indicating that this correlation is statistically significant at a significance level of 0.05.

Correlation Between the Two Arms Medicine Ball Throw and the Javelin Throw with a Crossover Step - T2:

Pearson Correlation: 0.971 indicates an extremely strong and positive correlation between the two-handed medicine ball throw and the javelin throw. This suggests that performance in these two tests is highly correlated, meaning that a participant who performs well in one test is likely to perform well in the other.

The p-value of 0.001 is very low, smaller than 0.01, indicating that this correlation is highly statistically significant at a significance level of 0.01

Table 8. Correlations

		Javelin throw crossover step - T2
Throwing ball velocity in crossover step throw - T2	Pearson Correlation	0.880*
	p	0.021
	N	6
2 arms medicine ball crossover step throw - T2	Pearson Correlation	0.971**
	p	0.001
	N	6

*. The correlation is significant at a significance threshold of 0.05
**. The correlation is significant at a significance threshold of 0.01
(source: author's own contribution)

The small throwing ball velocity with a crossover step - T2 has a very strong and statistically significant correlation with the javelin throw with a crossover step - T2 (Pearson Correlation = 0.880, p = 0.021), indicating a close association between the two skills.

The two-arms medicine ball throw with a cross step - T2 has an extremely strong and highly statistically significant correlation with the javelin throw with a cross step - T2 (Pearson Correlation = 0.971, p = 0.001), suggesting a strong relationship between these two tests.

Further, the cumulative effect of the potential predictor factor "Two-Arms Medicine Ball Throw" on the variable "Javelin Throw with a Crossover Step" can be observed.

Model summary (Regression Model Summary)

- Model 1 includes only the Two-Arms Medicine Ball Throw with a Crossover Step - T2 as a predictor:
  - R Square = 0.943, meaning that 94.3% of the variation in javelin throw performance can be explained by performance in the two-handed medicine ball throw.
  - The F value is 66.541, with p = 0.001, indicating that the model is statistically significant.

Table 9. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df 1	df 2	p
1	0.971[a]	0.943	0.929	1.93487	0.943	66.541	1	4	0.001
a. Predictors: (Constant), 2 arms medicine ball throw crossover step - T2									

Source: author's own contribution

Therefore, the two-arms medicine ball throw with a crossover step - T2 is a very strong predictor for the javelin throw with a crossover step - T2 (R Square of 94.3%).

Coefficients (Regression Coefficients)

This shows the impact of each independent variable on the dependent variable javelin throw with a crossover step - T2:

- The two-arms medicine ball throw with a crossover step - T2 has a B coefficient of 2.857, with a t of 8.157 and p = 0.001, meaning it is a significant predictor.

Table 10. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	Std. Error	Beta		
1	(Constant)	-6.328	4.259	0.971	-1.486	0.212
	2 arms medicine ball throw crossover step - T2	2.857	0.350		8.157	0.001
a. Dependent Variable: Javelin throw crossover step - T2						

Source: author's own contribution

It can therefore be concluded that the two-arms medicine ball throw is a very good predictor for the results in the javelin throw, both being executed with a crossover step.

Next, we present two types of training that are included in the experimental training plan.

Practice 1

Level: Advanced
Location: Stadion; athletics hall
Materials: Stopwatch, elastic bands, javelins,
Duration: 90 min
Subject:
Coordinative abilities development
Strength

Day: Monday
Precompetitive Phase
Specific training
Intensity: 85% - 90%
Objectives:
Specific skill development
Strength development

No.	Workout structure	Means of action	Dosing			Methodical instructions
			No. of Repetitions	Duration	Rest	
1	Preparing the body for effort (15')	Worming up -Standing worming-up exercises for the upper and lower part of the body	2x10/ ex	15' 5' 5'		-The exercises are performed individually, carefully, minding for every aspect of the movement.
2		-Jogging -Arm exercises with elastic band for muscle activation -Launched run (80-100m)	2x50 2x	2' 3'	1'	
	Fundamental part (60') T1- Coordinative abilities Ob.1- Specific skill	-Exercises imitating the final bow-shape phase, with the javelin: - Standing arching the arm for	3x20	15'	30"	The javelin is heavier than the usual one. Attention on the position of the segments of the body. Mirror working for better

	developme nt T2- Strength Ob.2- Strength developme nt	flexibility; - Repetitions of the bow-shape phase (left arm also) - 1 crossover step; - 2 crossover steps; -Strength exercises: -Snatch -Squads -Triceps -Bench press	3x10 (3x8) 3x10 3x8 5x5 5x5 5x10 5x5	 45’ 12’ 12’ 10’ 11’ 10’	 2’/set 3’/ex	understanding the action. At least one set from each exercise is filmed and then shown to the athlete to see the technique and speed of the movement.
3	Body recovery after workout (15’)	-Walking or easy jogging -Stretching		3’ 12’		Conscious stretching on tense areas.

Practice 2

Level: Advanced
Location: Stadion; athletics hall
Materials: Stopwatch, elastic bands, medicine balls
Duration: 105 min
Subject:
Speed and plyometrics
Specific throwing strength

Day: Tuesday
Precompetitive Phase
Specific training
Intensity: 85% - 90%
Objectives:
Speed and plyometric development
Specific strength development

No.	Workout structure	Means of action	Dosing			Methodical instructions
			No. of rep	Duration	Rest	
1	Preparing the body for effort (25')	Worming up -Standing worming-up exercises for the upper and lower part of the body -Jogging -Arm exercises with elastic band for muscle activation -Running and jumping drills -Launched run (80-100m) -Speed run (50-60m)	 2x10/ ex 2x50 1x 2x 1x	25' 5' 7' 2' 6' 3' 2'	 30"-1'	-The exercises are performed individually, carefully, minding for every aspect of the movement. Attention to running technique.
2	Fundamental part (70') T1-Speed and plyometrics Ob.1- Speed and plyometrics development T2-Specific throwing strength Ob.2- Specific strength development with medicine balls (Mb)	Speed -30m sprint, standing start Long jump plyos -standing long jump -standing triple jump -standing penta jump -5 hops on both legs -2 arms throws Mb 3kg from the chest Mb 3kg above head Mb 2kg arch position Mb 3kg backwards -1 arm throws Ball 0.4-0.5kg right arm Ball 0.4-0.5kg left arm	 2x4 3x 3x 2x 2x 4x10 4x10 4x8 4x10 4x8 4x10	25' 45'	2'-2'30" 30"-1' 30"-1' 1' 1'-1'30" 2'30" 2'30" 2' 2' 1' 1'	-Fast reaction at starting point. Maximizing each step and repetition. The throws are energetic, at a fast pace, against a wall using Speed Trac X Radar Gun to see the velocity of each throw.
3	Body recovery after workout (10')	-Stretching		10'		Conscious stretching on tense areas.

Conclusions and discussions

The junior category represents the age at which the javelin throwing technique is consolidated, and the entire body is strengthened through maturation and natural development, as well as through physical training, which is increasingly important and more personalized to the type of event and specific movement. However, individualization is necessary because each athlete is different, and attention and patience must be given to the deficiencies and errors that arise throughout training. Some javelin throwers may experience significant leaps in training and performance during this age period of 15-18 years, but then reach a plateau, while other athletes may experience small but consistent, gradual improvements.

Testing is relevant at any age category to assess the level of preparation, physical condition, fatigue, or to predict outcomes in upcoming competitions.

The present research has achieved its goal, as the results of the final tests were better than those of the initial testing, indicating that the proposed experimental training had the desired effect.

The results of the female javelin throwers showed statistically significant improvements in the Countermovement jump test, the throwing ball velocity, and the technique test, the javelin throw with a crossover step. Additionally, a positive and significant correlation was observed between the two-arms medicine ball throw and the javelin throw, meaning that any improvement in performance in one test automatically leads to improvement in the other. Similarly, the correlation between throwing ball velocity and the javelin throw with a crossover step suggests that these can be considered good predictors of performance in the javelin throw with a crossover step event.

Throughout the experimental program, the focus was placed on exercises that imitate the movement, both from a static position, standing still, and also with crossover steps. The athletes were filmed during the exercises, and the recordings were shown to them immediately after execution, both for technique and physical development exercises. Additionally, a radar gun device was used for measuring the throwing speed, and thus all the methods and tools employed contributed to raising awareness of the movement and correcting errors where necessary.

This study was conducted with the written consent of the legal guardians of the athletes and with the consent of the Bistriţa Sports High School, where the athletes train and also with the consent of the Interdisciplinary Doctoral School Transilvania, from Braşov Univeristy. It is

part of the research for the doctoral thesis titled "Study on the Biomechanics of the Run-up and Kinematic Transfer in the Javelin Throwing Event for Junior Female Athletes" from the Interdisciplinary Doctoral School, "Transilvania" University of Braşov.

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