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Optimizing physical and technical capacities in basketball through the implementation of coordination training programs and specialized information technologies

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Abstract
Background. This study focuses on the optimization of physical and technical capacities through coordination exercise programs. Recognizing the critical role of coordination skills in basketball performance, our research employs precise methods to unveil insights into the impact of these programs on basketball athletes.
Aims. The aim of the study is to develop and implement an exercise program that incorporates coordination-driven systems, with the goal of achieving superior indices of technical proficiency.
Methods. The research included a total of 19 female athletes, all belonging to a single group, the experimental group. This group consisted of athletes aged between 10-12 years old. The study took place over a period of 2 months, during which 4 assessments were conducted to track the progression of the athletes' performance of shots and the efficiency of their jumps in relation to shooting, which was monitored using Vert sensors.
Results. The subjects showed progress following the implementation of the program across all four coordination tests. Regarding the first coordination test, the number of successful throws increased by 3.157; in the second test, there was an increase of 3.473; for the third test, there was an increase of 2.894, while in the final test, a notable progress of 16.157 successful executions was recorded.
Conclusions. The obtained data lead us to conclusions suggesting that training activities in basketball can be enhanced through the implementation of a training program that includes coordination exercises, especially in relation to the effectiveness of jump execution.
Keywords: coordination training, basketball, MyVert sensors, training program, young athlethes.

Introduction

The game of basketball has been studied in many of its complex aspects, but the current trends require the implementation of specific technologies in the process of preparation, monitoring and evaluation of the physical and technical performances of athletes. Basketball is a team sport that requires multiple skills, largely dependent on players' abilities to move quickly, jump, and dribble the ball with coordinated movements of both the lower and upper limbs. Specifically, to achieve successful performances, basketball players need to employ proper shooting technique, dribbling, and regaining possession under time pressure while establishing a tight connection between footwork, hand movements, and eye coordination with the ball and opponents (Epure & Badau, 2021; Candra et al., 2017). Coordination is the basic motor ability to perform complex and varied motor actions (Malacko & Rađo, 2004; Stankovic et al., 2023). Coordination can also be defined as a person's ability in combining several movements into a unified and harmonious unity of motion caused by a reciprocal relationship between the nervous system and the means of movement in controlling impulses from the workings of muscles for the implementation of a movement (Putra, 2020). According to the experts in sport performance, coordination in sports can be classified into two types: general coordination, which involves the ability to perform different motor actions regardless of the sport, and specific coordination, which refers to the skill of smoothly and accurately carrying out various movements within a particular sport (Suryadi et al., 2023; Sheikh & Kanase, 2020; Kurniawan et al., 2019). One of the most important aspects of coordination in basketball is foot-eye coordination (Novriansyah et al., 2020; Marta & Neldi, 2023). Additionally, hand-eye coordination plays a very

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important role in the execution of shooting. The hand eye coordination is the ability to coordinate movements between the eyes and hands to manipulate tools or objects (Szabo et al., 2020; Ceylan & Saygin, 2015; Badau & Badau, 2022). The researchers consider that coordination is the ability of combining several abilities with right and controlled rhythms to produce effective and efficient motion (Novriansyah et al., 2020). The novelty aspects of the present study derive from the implementation of a specialized process of preparing the coordination specific to the game of basketball and evaluating the impact on the coordination by means of specialized information technologies.

Hypothesis

Starting from the assumption that by designing a training program consisting of coordination exercises and implementing it, one can contribute to optimizing and improving overall coordination indices under conditions specific to the technical aspects of basketball.

Material and methods

a) Period and place of the study

The study took place over a period of 2 months, from October 2022 to December 2022. It comprised two assessments: the initial testing (IT) conducted at the beginning of the training period over one week, and the final testing (FT) performed at the end of the training period over one week. Both assessments and the training sessions occurred at the sports facility of the Sibiu School Club, equipped with a standard FIBA basketball court. The subjects participating in this study did so voluntarily.

b) Subjects and groups

The research involved a total of 19 female athletes, all belonging to a single group known as the experimental group. This group comprised members of the basketball team affiliated with the School Sports Club, with ages ranging from 10 to 12 years.

c) Applied tests

The study involved conducting four non-standardized tests, designed by us, to assess the general coordination of players during basketball shooting in various in-game situations. The first test required the execution of 10 mid-range jump shots after receiving a pass, the second test was designed to monitor mid-range jump shots performed from a stationary position, with subjects making 10 attempts. The third test involved shooting mid-range jump shots preceded by dribbling, and the final test required subjects to perform as many volleyballs of the backboard as possible with a basketball within one minute. For the first three tests, the parameters monitored were the number of successful shots and jump height, while for the last test, the parameters included the number of successful executions and the number of jumps performed.

The parameters monitoring the jumps performed by subjects during the tests were calculated using MyVert sensors. The Vert device is a wearable sensor designed to track and analyze an athlete's vertical jump performance. These sensors can be valuable tools in various sports training programs, including basketball. By monitoring and analyzing metrics related to jumps and coordination, athletes and coaches can gain insights into an individual's performance, progress, and areas for improvement. This data-driven approach can contribute to more effective training regimens tailored to the specific needs of the athletes. This system consists of a belt, sensor, and a mobile application. The sensor is attached to the belt, which is secured around the subject's waist. Subsequently, the sensor is connected via Bluetooth to the mobile application, and each jump was recorded in the app.

d) Statistical processing

Statistical analysis was conducted using the SPSS program, and the following statistical indices were monitored: the arithmetic mean (x), standard deviation (SD), confidence interval with upper and lower limits (CI), Student's t-test (t), statistical significance level (p) where p=0.05, and the size effect (Cohen's d).

Results

In the following table, we present the most representative results and statistical parameters recorded in the study.

Table I

First test results centralized.

Parameter	Test	Min.	Max.	X	SD	CV (%)
Height (cm)	Ti	19.50	29.20	24.421	3.122	12.78
	TF	24.30	34.20	29.995	2.855	9.52
Number of shots made	Ti	.00	5.00	2.368	.461	19.46
	TF	4.00	7.00	5.526	1.073	19.42

TI -initial testing; TF - final testing; MIN - minimum; MAX - maximum; X - Arithmetic mean; SD - standard deviation; CV - Coefficient of variation.

In the experiment (Table I & Table II), the difference in arithmetic means recorded between the two testing sessions highlighted a statistically significant progress for the parameter of the number of successful throws, with a p-value of 0.000. The effect size induced by the implementation of the preliminary training program had a large impact on the number of successful throws, with an effect size of 1.86 for height and 3.82 for the number of shots made.

Table II

Statistical analysis of the results in the first Test.

Parameter	X	SD	95% CI		t	p	Cohen`s-d
			Inferior	Superior			
Height (cm) Tf-Ti	5.573	1.043	5.070	6.076	23.284	.000	1.86
Number of shots made Tf-Ti	3.157	1.537	2.417	3.898	8.955	.000	3.82

X - arithmetic mean; SD - standard deviation; CI - confidence interval; t - Student's t-test; p - statistical significance level; Cohen's d - Size Effect.

Table III
Second test results centralized.

Parameter	Test	Min.	Max.	X	SD	CV (%)
Height (cm)	Ti	19.50	32.10	27.411	3.321	12.12
	TF	27.50	36.00	32.742	2.754	8.41
Number of shots made	Ti	.00	4.00	1.895	.529	27.92
	TF	4.00	7.00	5.368	1.116	20.79

TI - initial testing; TF - final testing; MIN - minimum; MAX - maximum; X - arithmetic mean; SD - standard deviation; CV - Coefficient of variation.

For the second test, the difference in arithmetic means recorded between the initial and final testing sessions highlighted a statistically significant progress for the parameter of the number of successful throws, where the significance threshold p=0.000. The effect size induced by the implementation of the preliminary program had a large impact on the number of successful throws, with an effect size of 1.74 for height and 3.97 for the number of shots made (Table III & Table IV).

Table V
Third test results centralized.

Parameter	Test	Min.	Max.	X	SD	CV (%)
Height (cm)	Ti	21.00	32.80	26.774	3.441	12.85
	TF	27.30	36.90	32.947	2.706	8.21
Number of shots made	Ti	.00	4.00	2.053	.681	33.20
	TF	4.00	7.00	4.947	.970	19.61

TI - initial testing; TF - final testing; MIN - minimum; MAX - maximum; X - arithmetic mean; SD - standard deviation; CV - Coefficient of variation.

The difference in arithmetic means recorded in the third test, between the two testing sessions highlighted a statistically significant progress for the parameter of the number of successful throws, where the significance threshold was $p < 0.05$. The effect size induced by the implementation of the experimental training program had a large impact on the number of successful throws, with an effect size of 1,99 for height and 3,45 for the number of shots made (Table V & Table VI).

Table VII
Fourth test results centralized.

Parameter	Test	Min.	Max.	X	SD	CV (%)
Height (cm)	Ti	9.00	21.00	14.263	3.229	22.64
	TF	20.00	28.00	24.421	1.924	7.88
Number of shots made	Ti	.00	14.00	5.316	1.529	28.75
	TF	18.00	26.00	21.474	2.170	10.10

TI - initial testing; TF - final testing; MIN - minimum; MAX - maximum; X - arithmetic mean; SD - standard deviation; CV - Coefficient of variation.

The difference in arithmetic means recorded in the Volleyball Test during the final experiment between the initial and final testing sessions highlighted a statistically significant progress for the parameter of the number of successful executions, where the significance threshold was $p < 0.05$. The effect size induced by the implementation of the preliminary training program had a large impact on the number of successful executions, with an effect size of 3,82 for the jumps made and 10,99 for the number of successful executions (Table VII & Table VIII).

Table IV
Statistical analysis of the results in the second Test.

Parameter	X	SD	95% CI		t	p	Cohen`s-d
			Inferior	Superior			
Height (cm) Tf-Ti	5.331	1.098	4.802	5.861	21.156	.000	1.74
Number of shots made Tf-Ti	3.473	1.836	2.588	4.359	8.243	.000	3.97

X - arithmetic mean; SD - standard deviation; CI - confidence interval; t - Student's t-test; p - statistical significance level; Cohen's d - Size Effect.

Table VI
Statistical analysis of the results in the third Test.

Parameter	X	SD	95% CI		t	p	Cohen`s-d
			Inferior	Superior			
Height (cm) Tf-Ti	6.173	1.135	5.626	6.721	23.695	.000	1.99
Number of shots made Tf-Ti	2.894	1.328	2.254	3.535	9.495	.000	3.45

X - arithmetic mean; SD - standard deviation; CI - confidence interval; t - Student's t-test; p - statistical significance level; Cohen's d - Size Effect.

Table VIII
Statistical analysis of the results in the fourth Test.

Parameter	X	SD	95% CI		t	p	Cohen`s-d
			Inferior	Superior			
Jumps made Tf-Ti	10.157	4.072	8.195	12.120	10.872	.000	3.82
Number of successful executions Tf-Ti	16.157	4.705	13.889	18.425	14.968	.000	10.99

X - arithmetic mean; SD - standard deviation; CI - confidence interval; t - Student's t-test; p - statistical significance level; Cohen's d - Size Effect.

Discussion

The results of the study, as analyzed through various tests, revealed significant improvement of coordination skills among the participants. In analyzing the results of the four tests conducted over the two-month period, the implemented training program has demonstrated a statistically significant positive impact on various parameters related to basketball skills and coordination. The findings indicate substantial progress in both the height of jumps and the number of successful throws made by the participants.

Baso et al. (2023) consider that hand-eye coordination skills play a crucial role in basketball, particularly when executing various movements, such as shooting. The ability to synchronize eye and hand movements is recognized as one of the key physical skills in basketball. Moreover, coordination, involving the precise synchronization of various body segments, is a critical factor influencing the accuracy, stability, and overall success of basketball shots (Galina et al., 2020). Muhammad Ishak et al. (2018) cited by Candra (2019) observed that there is a significant relationship between hand-eye coordination and lay up shoot.

Another study, carried out by Novriansyah et al. (2020), demonstrated that there is a positive and significant relationship between the strength of leg muscle and the ability to shoot free throws, there is also a positive and significant impact regarding the hand-eye coordination and the ability to shoot free throws and there is a positive and significant effect concerning the strength of leg muscle and hand-eye coordination towards the ability to shoot free throws. The complex analysis of how the development of coordination contributes to the improvement of basketball players' performance requires interdisciplinary approaches (Tudor et al., 2014; Nechita, 2012; Badau et al, 2010; Cojanu et al, 2022, Muhammad et al., 2018). The optimization of the determined factors of the sports performance contributes to the improvement of the performance capacity and to the achievement of sports successes in relation to the particularities of the athletes and the specifics of the practiced sport (Martoma, 2009; Gherghel et al., 2022; Martoma, 2011; Badau et al., 2022; Martoma, 2010; Drugau, 2017).

The limitations of the study: the study spans only a two-month period, which may limit the ability to observe long-term effects or account for potential variations in performance over extended training periods; the absence of a control group makes it challenging to ascertain whether observed improvements are solely due to the coordination training program or influenced by external factors; the study focuses on a specific age group (10-12 years), limiting the generalizability of the findings to athletes outside this range; the study exclusively involves female athletes, potentially limiting the generalizability of the results to male counterparts.

The strengths of the study were: the use of MyVert sensors for monitoring and analyzing vertical jump performance adds a technological dimension, enhancing the depth of data collection; the study's findings suggest significant progress in coordination skills, specifically in jump height and the number of successful throws, which can contribute valuable insights to the field of sports science.

Conclusions

1. The findings from the implemented training program, spanning a two-month period, demonstrated significant improvements in coordination skills, specifically in jump height and the number of successful throws made by the participants.

2. The positive outcomes observed in jump height and successful throws underscore the effectiveness of the implemented training program. The statistically significant progress, as indicated by the calculated effect sizes, suggests that tailored coordination exercises have a substantial impact on improving athletic performance in young female basketball players.

3. The integration of MyVert sensors allowed for a data-driven approach, providing valuable metrics related to jumps and coordination. This technology, alongside traditional statistical analyses, offers a comprehensive understanding of individual performance, aiding coaches and athletes in refining training regimens based on specific needs.

Conflict of interests

None to declare.

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