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The impact of a 12-week intervention training program on gross motor coordination and strength in children playing Basketball

Ledina Koci[1]*, Natasha Kotorri[1], Afrim Bilali[2]
[1]Sports University of Tirana, Faculty of Movement Sciences Tirana, Albania; lkoci@ust.edu.al (L.K.)
[2]Sports University of Tirana, Faculty of Physical Activity and Recreation Tirana, Albania.

Abstract: This study investigates the effects of a 12-week coordination training program on gross motor coordination and strength in youth basketball players aged 10–12 years. A total of 96 participants (mean age = 11.3 ± 1.16 years) were divided into an intervention group (IG) and a control group (CG). The IG completed a structured coordination training program (15 minutes per session after the warm-up phase), in three sessions per week, while the CG followed their regular training routine (three sessions per week, routine training). Motor coordination was assessed using the KTK test battery and drop jump tests, while anthropometric measurements were also recorded. Results showed no significant differences in anthropometric measurements between the groups. However, the IG demonstrated significant improvements in motor coordination, particularly in lateral jumping, balance beam, and one-leg jumping tests ($p < 0.05$). Additionally, enhancements in lower-limb strength and power were observed, as reflected in improved drop jump Fmax, contact time, jumping height, and standing long jump performance tests ($p < 0.05$). These findings suggest that a targeted coordination training program can effectively enhance motor coordination, balance, agility, and lower-body strength in young basketball players, providing valuable insights for training and talent development in youth sports.
Keywords: *Agility, Lower-limb strength, Motor coordination, Training program, Youth basketball.*

1. Introduction

Basketball is considerate a popular game which includes technical, tactical, emotional and physical elements [1]. Success depends on many factors such as control the body weight, pay attention to time, quickly react and quickly perceive & analyze the information in order to make right decision [1, 2]. One of the most important components in basketball is coordination, which is studies by many scientists [3, 4]. Coordination is defined as ability to change from executing one action to another one depending on circumstances [5]. According to Svetlichkina, et al. [6] the role of coordination is to coordinate the central nervous system' functions. The aim of coordination skill is to increase the motor experience through density and variability of movement control processes [7]. Coordination skills helps young basketball players to organize their energy resources wisely, use them efficiently by considering time, place and muscle group [8]. Every year basketball has higher and higher demands from basketball players in order to achieve better performance. According to Chicomban [9] and Dvejrina [10] the development of pupil's general motor skills is a crucial condition for the creation of applicative coordination abilities that offer them to perform their actions [11]. The technique of basketball required good performance of coordination and motor development of basketball players [12] Dribbling is a technical procedure in basketball that increase the space and condition sense, coordination and the peripheral vision as well as intellectual competencies [13]. Dribbling in basketball is considerate as complex coordinative action [14]. This is because dribbling contains different directions with different

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* Correspondence: lkoci@ust.edu.al

speed, control the ball without visual aspect. Basketball players should simultaneously, perform the dribbling action by using forearm, hand and finger in order to enable the ball to bounce up to the waist level [14]. There are many other motor actions in basketball who needs the following coordination 1) coordinated movement of the arms, legs, trunk and head, 2) the peripheral vision 3) the motor memory 4) the complex interdependence of cognitive and intellectual skills (thinking, creativity, imagination, memory, and attention) under the produced condition, which has an unexpected nature, and the choice of the best method to complete the motor task. According to the research of Demcenco [14] the technical process of many actions in basketball is the significant way to help athletes acquire the effective coordination skills that are so crucial in daily life and in sports performance. Age 12-15 years old is the best period of time to improve coordination [15]. The aim of the study is to determine the effect of training program in motor coordination of basketball players aged 10-12 years old.

2. Methods

2.1. Participants

The total number of participants was 96 youth basketball players. The mean age of participants was 11.3 years old (SD= 1.16). Measurements were performed in 2 groups of athletes- the intervention and the control group (4 teams); intervention group (pre and post measurements + 12 weeks' included coordination intervention exercises) and control group (pre and post measurements + 12 weeks included standard routine exercises)

The parents of the children received instruction on the study's protocols and asked to sign a written informed permission form before any measurements were taken. The subject's inclusion requirements were: (1) to play basketball; (2) to be between the ages of 11 and 13; and (3) to be in good health and free from injuries. Ethical approval was taken at Sports University of Tirana.

2.2. Anthropometric Measurements

Children were tested in the morning to ensure accurate statistics. Children were barefoot and wear light clothing during the measurements. The position of both feet were in the center of the apparatus (Health O meter digital scale) so that the weight was distributed evenly across both feet for the body-weight measurements. The athletes were standing with their eyes forward, their arms dangling at their sides, their feet together, and their backs straight. The athlete's head was fitted with the height rob. During the measures, children were not permitted to move.

2.3. KTK Gross Motor Coordination Test Battery [16]

Four standardized tests were administered to evaluate the motor abilities of participants. These assessments measure various facets of coordination, balance, agility, and motor control

1. The Balance Beam assessment measures dynamic stability (balance) and postural regulation;
2. Transference of Platforms assessment focusing on spatial-temporal organization, fine motor proficiency, rapidity, and agility and coordination of the lower and upper extremities;
3. The Lateral Jumping exam assesses agility, coordination, and lower limb strength;
4. The Jumping One Leg test evaluates unilateral lower-limb strength, coordination, and stability.

2.4. Drop Jump Test

The electronic platform "Leonardo Mechanography" is part of the group of medical devices (Sports University Laboratory). It consists of two platforms with 4 (four) sensors each. Its software contains a protocol with 17 different tests, from which numerous data are obtained. The age of the subjects being tested ranges from 3 to 99 years. It serves not only for the assessment and examination of physical condition for healthy and sporty subjects, but also for geriatric purposes (in advanced age), to prevent the risk of basic activities as a result of age. In this study research it was used:

1. DJ (Drop Jump) and Drop Jump / Ground Contact Time Test

With regard to explosive power of lower limb in youth were used standing long jump test.

2.5. Intervention Program

Circuit intervention training for 12 weeks (3 times/ week) with a duration of 15 minutes after warm up phase (each training session) were included in this study research. The intervention program for each training session consisted in four type of exercises aiming as follows:

1. Coordination (3 times x 1 min with 30 seconds rest)
2. Speed/ agility without the ball (3 times x 1 min with 30 seconds rest)
3. Speed/ agility with the ball (5 times x 30 seconds with 30 seconds rest)
4. Strength/ endurance (2 to 4 times x 1 min with 30 seconds rest)

2.6. Statistical Analysis

A descriptive analysis of the sample was conducted by determining the mean, standard deviation, minimum, and maximum of each study variable. The Kolmogorov–Smirnov test confirmed that all data were normally distributed. ANOVA was used to make comparisons between groups and to determine differences between measurements. The significance level was determined as $p < 0.05$. All the analysis was calculated using SPSS software 20.0.

3. Results

Table no 1 show the number of participants in control group and intervention group. The total numbers of subjects in this study was 94 participants (control group= 46 and intervention group= 48). The mean age of participants was 11.8 years old (SD 1.09).

Table 1.
Youth participation statistics take part in the study.

		N	Mean Age	Std. Deviation
Youth participants	Control	46	11.3	1.16
Basketball	Intervention	48	12.2	0.77
	Total	94	11.8	1.09

Table 2 show the mean and standard deviation of anthropometric parameters pre and post measurements. The mean of body height is 152.8 cm in pre-measurements and 154.2 cm in post-measurements. The mean of body-weight is presented with the value 48.5 kg in pre-measurements and 49.7 post-measurements in control group. Whereas, in experimental group the mean of body-height is 161.4 cm in pre-measurements and 162.7 cm in post-measurements. Body-weight has the mean 53.9 kg in pre-measurements and 55 kg in post-measurements.

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Table 2.
Descriptive statistics for anthropometric assessed in this study (pre and post by groups).

Type_Intervention		Mean	N	Std. Deviation	Std. Error Mean
Control	Body Height- pre	152.8	46	9.97	1.47
	Body Height- post	154.3	46	9.88	1.45
	Body Weight- pre	48.6	46	11.9	1.76
	Body Weight- post	49.7	46	11.9	1.75
	BMI- pre	7.6	46	3.48	.51
	BMI- post	7.2	46	3.15	.46
	Waist- pre	67.4	46	11.69	1.72
	Waist- post	68.0	46	11.15	1.64
Intervention	Body Height- pre	161.4	48	11.28	1.62
	Body Height- post	162.8	48	11.39	1.64
	Body Weight- pre	53.9	48	11.81	1.70
	Body Weight- post	55.1	48	11.19	1.61
	BMI- pre	6.4	48	3.11	.44
	BMI- post	5.9	48	2.51	.36
	Waist- pre	69.9	48	10.65	1.5
	Waist- post	70.8	48	10.7062	1.54

The Table 3 indicates the mean and SD of gross motor coordination (KTK) test in pre and post for control group and experimental group. The mean of lateral jump test in control group is 65.2 jumps in pre-measurements and 67.4 jumps in post-measurements. In experimental group the mean of lateral jump test is 72.1 jumps in pre-measurements and 78.8 jumps in post-measurements.

Table 3.
Descriptive statistics for gross motor coordination (KTK) tests assessed in this study (pre and post by groups).

Type_Intervention		Mean	N	Std. Deviation	Std. Error Mean
Control	Lateral Jumping- pre	65.28	46	10.23	1.50
	Lateral Jumping- post	67.41	46	9.78	1.44
	Balance Backward- pre	44.84	46	11.81	1.74
	Balance Backward- post	45.56	46	12.04	1.77
	Jumping one leg- pre	16.82	46	4.19	.61
	Jumping one leg- post	18.23	46	4.04	.59
	Moving with plates- pre	19.91	46	4.19	.61
	Moving with plates- post	21.80	46	4.17	.61
Intervention	Lateral Jumping- pre	72.16	48	9.89	1.42
	Lateral Jumping- post	78.81	48	8.21	1.18
	Balance Backward- pre	45.16	48	11.50	1.66
	Balance Backward- post	48.54	48	11.90	1.71
	Jumping one leg- pre	17.81	48	3.82	.55
	Jumping one leg- post	21.87	48	4.27	.61
	Moving with plates- pre	22.08	48	3.33	.48
	Moving with plates- post	24.27	48	3.20	.46

The Table 4 show the mean and SD for both important tests such as drop jump test and standing long jump test. In interventional group the mean of drop jump height is 33.1 cm in pre-measurements and in post-measurements the is 36.9 cm. Standing long jump test has the mean 156.4 cm in experimental group in pre-measurements and in post-measurements the mean was 161.4.

Table 4.
Descriptive statistics for Drop jump test and Standing Long Jump assessed in this study (pre and post by groups).

Type_Intervention		Mean	N	Std. Deviation	Std. Error Mean
Control	Drop jump- Fmax (kg)- pre	50.85	46	11.04	1.62
	Drop jump- Fmax (kg)- post	51.40	46	10.83	1.59
	Drop jump- Contact Time pre	.27	46	.05	.00
	Drop jump- Contact Time post	.28	46	.05	.00
	Drop Jump- Jumping Height pre	29.34	46	5.03	0.74
	Drop Jump- Jumping Height post	31.57	46	4.94	0.72
	Standing Long Jump- pre	156.40	48	25.13	3.62
	Standing Long Jump- post	161.4	48	24.72	3.56
Intervention	Drop jump- Fmax (kg)- pre	49.260	48	11.6920	1.68
	Drop jump- Fmax (kg)- post	52.21	48	9.8128	1.41
	Drop jump- Contact Time pre	.31	48	.4185	.06
	Drop jump- Contact Time post	.26	48	.2750	.03
	Drop Jump- Jumping Height pre	33.18	48	6.5156	0.94
	Drop Jump- Jumping Height post	36.91	48	5.5881	0.80
	Standing Long Jump- pre	156.40	48	25.1349	3.62
	Standing Long Jump- post	161.48	48	24.7269	3.56

Data results on table 5 show ANOVA comparison for the mean difference (post- pre) measurement between control and intervention group. The ANOVA results indicate no statistically significant differences between the intervention and control groups for any of the anthropometric measures (body height p = 0.58, body weight p = 0.943, BMI p = 0.972, and waist circumference p = 0.829) These findings imply that while the intervention may have influenced motor performance, it did not lead to significant changes in anthropometric characteristics over the study period.

Table 5.
Analysis of variance (ANOVA), between groups for anthopometric (mean difference post- pre).

Source- Type Intervention	Control		Intervention		Type III Sum of Squares	df	Mean Square	F	Sig.
	Mean	Std. Dev	Mean	Std. Dev					
Body Height	1.43	0.91	1.33	0.87	0.242	1	0.242	0.307	0.581
Body Weight	1.17	1.22	1.19	1.34	0.008	1	0.008	0.005	0.943
BMI	-0.37	0.51	-0.37	0.79	0.001	1	0.001	0.001	0.972
Waist	0.61	1.74	0.86	1.62	0.443	1	0.443	0.047	0.829

The ANOVA results in Table 6 indicate statistically significant improvements in gross motor coordination for the intervention group compared to the control group in three out of four tests. Significant differences were observed in lateral jumping (p = 0.005), balance backwards (p = 0.033), and jumping one leg (p = 0.000), suggesting that the intervention effectively enhanced coordination, balance, and agility. However, moving with plates (p = 0.533) did not show a significant difference, indicating that the intervention had little to no effect on this specific motor skill. These results highlight the intervention's overall positive impact on gross motor coordination, particularly in dynamic balance and jumping tasks.

Table 6.
Analysis of variance (ANOVA), between groups for gross motor coordination (KTK) tests (mean difference post- pre).

Source- Type Intervention	Control		Intervention		Type III Sum of Squares	df	Mean Square	F	Sig.
	Mean	Std. Dev	Mean	Std. Dev					
Lateral Jumping	2.1	7.6	6.7	7.8	478.920	1	478.920	8.126	0.005
Balance Backwards	0.7	3.9	3.4	7.4	165.903	1	165.903	4.667	0.033
Jumping one Leg	1.4	2.2	4.1	3.5	164.886	1	164.886	19.154	0.000
Moving with Plates	1.9	1.7	2.2	2.7	2.061	1	2.061	0.392	0.533

The Table 7 show significant difference between groups in all the parameters such as drop jump-Fmax (p = 0.005), drop jump-jumping height (p = 0.037). Statistical improvements were found also for standing long jump test (p = 0.000) suggesting enhanced lower-body strength and power. Additionally, Drop Jump - Contact Time (p = 0.000) was also significantly affected, indicating possible improvements in landing mechanics. These findings highlight the effectiveness of the intervention in enhancing motor performance, particularly in explosive power and jump-related abilities.

Table 7.
Analysis of variance (ANOVA), between groups for Drop jump test and Standing Long Jump (mean difference post- pre).

Source- Type Intervention	Control		Intervention		Type III Sum of Squares	df	Mean Square	F	Sig.
	Mean	Std. Dev	Mean	Std. Dev					
Drop jump- Fmax (kg)	0.6	3.2	2.9	4.7	135.515	1	135.515	8.305	0.005
Drop jump- Contact Time	0.0	0.0	-0.0	0.0	0.037	1	0.037	18.274	0.000
Drop Jump- Jumping Height	2.2	3	3.7	3.8	53.068	1	53.068	4.471	0.037
Standing Long Jump-cm	2.2	4.2	5.1	3.4	198.224	1	198.224	13.935	0.000

4. Discussion

The purpose of the study is to examine the impact of a training program on the motor coordination of basketball players aged 10 to 12 years old. Results indicated no statistically significant differences between the intervention and control groups for any of the anthropometric measures (body height, body weight, BMI, and waist circumference)

Significant improvements were found in gross motor coordination for the intervention group compared to the control group in three out of four tests (lateral jumping, balance backwards, and jumping one leg) suggesting that the intervention effectively enhanced coordination, balance, and agility. These results highlight the intervention's overall positive impact on gross motor coordination, particularly in dynamic balance and jumping tasks.

Significant difference was found for intervention group in all the parameters such as drop jump-Fmax (kg), drop jump-contact time, drop jump-jumping height and standing long jump (cm), suggesting enhanced lower-body strength and power.

These findings imply that while the intervention may have influenced motor performance, it did not lead to significant changes in anthropometric characteristics over the study period.

The study of Zaichenko [1] demonstrated an improvement of motor coordination abilities in young basketball players of 10-12 years old after the interventional training program. The importance of improving coordinative motor skills is a common topic in many studies analyzing their effects in athletes. Also, the importance of developing the nervous system during childhood is often mentions in many research papers. Childhood is the crucial period time when the structures of neurons and their connections increase most efficiently and can help to improve motor skills such as speed of nerve impulses [17]. Early development of coordination by basketball specialist prepares kids for potential careers in sport.

The limitation of the study: it is focused only in basketball discipline and the study sample included children from a particular geographic region and socioeconomic background.

Future studies may include additional tests to assess a broader variety of motor coordination abilities. Future research could involve a more varied sample of youngsters to improve the generalizability of the results. However, the study includes a considerable number of basketball players in total which increases the generalizability of the findings and the statistical power of the findings.

5. Conclusion

The finding of our experiment proves the hypothesis that the interventional training improved the motor coordination of basketball players 10-12 years old. These improvements help in athlete's future sports career.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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