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Impact of a structured training program on agility, strength, and sprint performance in U-13 soccer players

Andi Baze[1*], Bashkim Delia[1], Gentjan Muca[2], Laura Derhemi[3]
[1]Sports University of Tirana, Faculty of Physical Activity and Recreation Tirana, Albania; abaze@ust.edu.al (A.B.).
[2]FK Tirana, Tirana, Albania.
[3]Sports University of Tirana, Faculty of Movement Sciences Tirana, Albania.

Abstract: The aim of this study was to evaluate the effect of a 12-week intervention training program on motor skills and health parameters in youth soccer players (boys). A total of 57 participants (mean age = 12.5 years) in Tirana, Albania, were randomly assigned to an intervention group ($n = 28$) or a control group ($n = 29$). The intervention group followed a structured training program (3 times/week, 15 minutes per session) focusing on running technique, coordination, reaction time, jumping, and multidirectional sprinting, while the control group continued with their routine training. Anthropometric measurements (body weight, height, and waist circumference) and motor performance tests (agility 10 × 5m, agility T-test, sprint 10m and 20m, standing long jump, and standing high jump) were conducted pre- and post-intervention. Statistical analysis revealed no significant differences between groups in body height, weight, and BMI ($p > 0.05$), although a significant reduction in waist circumference was observed ($p = 0.024$). The intervention group showed significant improvements in agility (10 × 5m and T-test), sprint performance (20m sprint, $p < 0.05$), and lower limb strength (standing long jump, standing high jump, and countermovement jump, $p < 0.05$). No significant differences were found for the 10m sprint test. These findings suggest that a 12-week structured training program effectively enhances agility, sprint performance (20m), and lower limb strength in young soccer players.
Keywords: *Agility, Motor skills, Strength, Training intervention, Youth soccer.*

1. Introduction

Physical activity is known for the crucial role in children and adolescent everyday life because of it effect in physical and mental health [1, 2]. The other positive effects that come from physical activity are positive emotional, social and cognitive development [3]. In physical activity, motor skills are important for positive approach toward physical education, sports motivation, being physical active and having a better performance [4]. Motor skills involves fine and gross motor competence which contributes in physical development, school achievement, cognitive & social enhancement and increase self-esteem [5]. Physical education for children is crucial for development of motor skills because it helps in their improvements. Children should muster their gross and fine motor skills, in their early childhood classrooms [6].

In peoples 's life, movements form an important part [7]. According to Rodríguez, et al. [8] motor competences allows children to integrate thought, emotions, and socialization and to consider them as a way of communication, interpersonal relationship and expression. Motor competences not only have a great contribution in physical profile but also in improvements of mind and spirits. One of the most important motor skills in children is jumping. In order to perform jumping, children need to possess complex motor coordination of lower and upper limbs. Standing long jump test is a reliable indicator of motor skills such as sprint, isokinetic force and jumping performance [9]. A common indicator of

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* Correspondence: abaze@ust.edu.al

functional performance in both athletic and non-athletic populations is vertical jump. Vertical jump is a crucial component in motor skills. This is because vertical jump capacity is linked with success in many sports [10]. The significance of structured training programs in enhancing agility, strength, and sprint performance in U-13 soccer players is very important with regard to this age group. Villarreal in his study [11] highlighted that a strength and sprint training program significantly improved agility and shooting speed among adolescent soccer players, thus underlining the efficacy of such training interventions. Similarly, Mathisen [12] conducted a study focused specifically on 13-year-old male soccer players, finding that a combination of high-speed and plyometric training resulted in marked improvements in acceleration and agility performance upon completion of the training regimen. Additionally, the systematic review by Oliver, et al. [13] corroborates that strength training positively impacts physical performance in youth soccer players, supporting structured training as a crucial element for both strength gains and athletic performance improvements. The research by Muca [14] emphasizes key parameters such as agility, strength, speed, and coordination, aiming to elucidate how these attributes evolve with age and training experience in young athletes.

To the author knowledge there are lack studies in Albania that evaluate the impact of interventional training program in motor skills and health in young soccer players (boys). We assume that the model of training program implemented in the intervention group will improve the motor skills parameters. The aim of the study is to evaluate the effect of 12 weeks' intervention training program in motor skills and health parameters in youth soccer players.

2. Methods

2.1. Subject

Fifty-seven participants took part in the study. The participants were part of four soccer team's U 13 in Tirana the capital city of Albania. The mean age of the participants was 12.5 years old. They randomly were dividing into two groups, control group (two teams) and experimental group (two teams). The number of participants in intervention group was 28 children, where as in control group the number was 29 children. The participants were in optimal health and have not experienced any injuries in the past six months. Parental consent has been obtained for their participation in the study.

2.2. Protocols of the Tests

Anthropometric measurements (body-weight, waist-circumference and body- height) Body weight, waist-circumference and body-height were three anthropometric parameters that were measured in this study research. Anthropometric parameters were measured using the Health O meter scale. Before the tests started, the participants were briefed informed on the testing procedure. They were barefoot and dressed as sparsely as possible. To measure the waist-circumference it was used flexible tape measure.

2.3. Agility 10 x5 Test

The markers are placed five meters apart, either with cones or lines. In order to start, children should plant a foot at a single marker. The subject should run from one marker to the other, and returns to the starting line. Continue doing this five times without stopping to get fifty meters. At each marker, both feet must fully cross the line. To conduct this test, we need measuring tape, chronometer and marker.

2.4. Agility T-Test

The child starts the test with his feet shoulder-width apart, his knees slightly bent, and one foot on the starting line. When the command to continue is given, the child quickly runs toward cone B, then performs a lateral run toward cones C and D. He returns to cone B and runs back toward cone A, which is the end of the test. The tester positions himself in such a way that he has visibility throughout the test. When the child crosses his legs during the lateral run or fails to touch the cone as per the test protocol, the tester must stop the test and the child must restart his performance from the beginning.

2.5. Sprint 10m, 20m

To perform the test, you must perform a maximum sprint at a given distance by recording the time of completion. The test is carried out at different distances, such as 10, 20, meters, depending on what is required to be measured. The starting position is performed by standing still behind the starting line. Time gate was used to measure the time to run separate distances (10 and 20 m).

2.6. Standing Long Jump Test

The child stands behind a line marked on the ground with his feet slightly apart. A two-legged take-off and landing is used, with swinging of the arms and bending of the knees to provide forward motion. The athlete attempts to jump as far as possible, landing on both feet without falling backwards.

2.7. Standing High Jump: CMJ and on the Move with Steps.

The child stands next to the wall with one hand up and close to the wall. Keeping the feet flat on the ground, the point of the fingers of the hand is recorded or marked on the wall. This is called the height achieved from the place. The child then moves away from the wall and jumps vertically as high as possible using both hands and feet to help in throwing the body up. The attempt is made to touch the wall at the highest point. The distance between the height achieved in the place position and the height achieved from the maximum jump is the result that is used for further analysis.

2.8. Intervention Program

The control group included children who followed the normal training program (3 times a week and routine training). The intervention group included children who play soccer and were following the training program during a 3-month period (3 times a week x 15 min at the beginning of each session of training). The 12-week training period were divided into 4 three-week modules. In each three-week module, the gradual distribution of loads according to age characteristics were determined, also based on the results of the tests performed before the start of the training program. The training content in the 12-week program includes exercises: to improve running technique, coordination exercises, exercises to improve reactions, jumping, running in line and running with changes of direction. Stimulus duration (exercises) was implemented for 3-5 seconds, rest 1-1.5 minutes and rest between sets 3-5 minutes, effort level 3-5 sets of 8-10 repetitions [9].

2.9. Statistical Analysis

The values are presented as mean ± standard deviation (SD). The absolute dependability of test-retest was evaluated using the coefficient of Variation was computed, while relative reliability was assessed using the intraclass correlation coefficient (ICC) with a 95% confidence interval. The homogeneity of variance among groups was assessed using Levene's test, while the normality of the data distribution was evaluated with the Kolmogorov-Smirnov test. A repeated measure analysis of variance (ANOVA) was conducted for each variable. The significance level was established at ($p < 0.05$). All statistical analyses were conducted using the SPSS software package (version 20.0, Chicago, Illinois, USA).

3. Results

Table 1 show the mean of body-weight, body-height and waist-circumference in control group and interventional group. The mean of body height in control group was (1.6 m) and remained constant after the second measurements. Whereas, body weight was increased from 51.3 kg to 52.1 kg. Even in interventional group the body-weight was increased from 45 kg to 45.7 kg. Eventually, in experimental group, waist-circumference was increased from 67.8 cm in the first measurements to 68.2 cm in the second measurements.

Table 1.
Descriptive statistics for anthropometrics for pre and post measurement.

Type_Intervention		Mean	N	Std. Deviation	Std. Error Mean
Control	Body Height (pre- measurement)	1.6	29	0.11	0.02
	Body Height (post- measurement)	1.6	29	0.11	0.02
	Body Weight (pre- measurement)	51.3	29	15.15	2.81
	Body Weight (post- measurement)	52.1	29	14.95	2.78
	BMI (pre- measurement)	19.2	29	4.02	0.75
	BMI (post- measurement)	19.2	29	3.92	0.73
	Waist (pre- measurement)	72.0	30	10.72	1.96
	Waist (post- measurement)	71.6	30	10.90	1.99
Intervention	Body Height (pre- measurement)	1.5	28	0.09	0.02
	Body Height (post- measurement)	1.5	28	0.08	0.02
	Body Weight (pre- measurement)	45.0	28	10.42	1.97
	Body Weight (post- measurement)	45.7	28	10.98	2.07
	BMI (pre- measurement)	19.7	28	3.74	0.71
	BMI (post- measurement)	19.6	28	3.88	0.73
	Waist (pre- measurement)	67.8	27	6.33	1.22
	Waist (post- measurement)	68.2	27	6.49	1.25

Table 2 shows the mean (SD) and standard error mean of participants in agility and sprint performance. The mean of agility 10x5m test is 19.8 sec in pre-measurement while the mean post-measurement is 19.2 sec in control group. In interventional group the mean is 21.2 sec pre-measurements and 19.1 sec post-measurements.

Table 2.
Descriptive statistics for speed and agility for pre and post measurement.

Type_Intervention		Mean	N	Std. Deviation	Std. Error Mean
Control	Agility 10x5m (pre- measurement)	19.8	31	1.34	0.24
	Agility 10x5m (post- measurement)	19.2	31	1.18	0.21
	Agility T test (pre- measurement)	12.7	30	0.93	0.17
	Agility T test (post- measurement)	12.0	30	1.36	0.25
	Sprint 10m (pre- measurement)	1.7	31	0.37	0.07
	Sprint 10m (post- measurement)	1.7	31	0.36	0.06
	Sprint 20m (pre- measurement)	3.6	31	0.27	0.05
	Sprint 20m (post- measurement)	3.6	31	0.27	0.05
Intervention	Agility 10x5m (pre- measurement)	21.2	28	2.01	0.38
	Agility 10x5m (post- measurement)	19.1	28	1.80	0.34
	Agility T test (pre- measurement)	14.3	28	1.13	0.21
	Agility T test (post- measurement)	12.2	28	0.99	0.19
	Sprint 10m (pre- measurement)	1.7	28	0.11	0.02
	Sprint 10m (post- measurement)	1.6	28	0.13	0.03
	Sprint 20m (pre- measurement)	3.6	28	0.27	0.05
	Sprint 20m (post- measurement)	3.5	28	0.27	0.05

The table below show the mean and (SD) of standing long jump, standing high jump and CMJ in pre-measurement and post-measurement. The mean of standing long jump in pre-measurement is 174.4 cm while the mean in post-measurement is 180.7 cm in control group. The mean-results in interventional group for standing long jump is 155.3 pre-measurement and 166.9 post- measurement.

Table 3.
Descriptive statistics for strength of lower limbs for pre and post measurement.

Type_Intervention		Mean	N	Std. Deviation	Std. Error Mean
Control	Standing long jump (pre- measurement)	174.4	31	20.11	3.61
	Standing long jump (post- measurement)	180.7	31	19.15	3.44
	Standing High Jump CMJ (pre- measurement)	232.2	31	10.03	1.80
	Standing High Jump CMJ (post- measurement)	235.6	31	9.86	1.77
	Standing High Jump move (pre- measurement)	237.9	31	11.14	2.00
	Standing High Jump move (post- measurement)	240.5	31	10.10	1.81
Intervention	Standing long jump (pre- measurement)	155.3	28	18.28	3.45
	Standing long jump (post- measurement)	166.9	28	17.78	3.36
	Standing High Jump CMJ (pre- measurement)	229.5	28	11.09	2.10
	Standing High Jump CMJ (post- measurement)	235.7	28	12.32	2.33
	Standing High Jump move (pre- measurement)	235.1	28	12.57	2.37
	Standing High Jump move (post- measurement)	240.2	28	10.56	2.00

Table 4 presents the ANOVA results comparing anthropometric changes (post-pre measurements) between the intervention and control groups. The analysis revealed no statistically significant differences in body height, body weight, and BMI between the groups ($p > 0.05$). Specifically, body height showed an F-value of 2.195 ($p = 0.144$), body weight had an F-value of 0.128 ($p = 0.722$), and BMI presented an F-value of 0.963 ($p = 0.331$). However, a significant difference was observed in waist circumference ($F = 5.405$, $p = 0.024$).

Table 4.
ANOVA comparison by groups for anthopometrics (mean difference= post- pre-measurement).

		Sum of Squares	df	Mean Square	F	Sig.
Body Height (mean diff= post- pre) cm	Between Groups	0.000	1	0.000	2.195	0.144
	Within Groups	0.006	55	0.000		
	Total	0.006	56			
Body Weight (mean diff= post- pre) kg	Between Groups	0.330	1	0.330	0.128	0.722
	Within Groups	141.463	55	2.572		
	Total	141.793	56			
BMI (mean diff= post- pre) cm	Between Groups	0.461	1	0.461	0.963	0.331
	Within Groups	26.327	55	0.479		
	Total	26.788	56			
Waist (mean diff= post- pre) cm	Between Groups	9.298	1	9.298	5.405	0.024
	Within Groups	94.621	55	1.720		
	Total	103.919	56			

Table 5 presents the ANOVA results comparing speed and agility performance changes (post-pre measurements) between the intervention and control groups. The Agility 10 × 5m test showed a significant difference between groups ($F = 20.098$, $p < 0.001$), the Agility T-test demonstrated a highly significant improvement in the intervention group compared to the control group ($F = 35.287$, $p < 0.001$). The sprint 20m test also showed a significant difference between groups ($F = 4.256$, $p = 0.044$) while no significant difference was observed in the sprint 10m test ($F = 0.010$, $p = 0.919$).

Table 5.
ANOVA comparison by groups for speed and agility (mean difference= post- pre-measurement).

		Sum of Squares	df	Mean Square	F	Sig.
Agility 10x5m (mean diff= post- pre) seconds	Between Groups	36.825	1	36.825	20.098	0.000
	Within Groups	104.439	57	1.832		
	Total	141.263	58			
Agility T test (mean diff= post- pre) seconds	Between Groups	25.658	1	25.658	35.287	0.000
	Within Groups	40.719	56	0.727		
	Total	66.377	57			
Sprint_10m_diff_sec_post_pre	Between Groups	0.000	1	0.000	0.010	0.919
	Within Groups	1.185	57	0.021		
	Total	1.185	58			
Sprint 20m (mean diff= post- pre) seconds	Between Groups	0.092	1	0.092	4.256	0.044
	Within Groups	1.238	57	0.022		
	Total	1.330	58			

Table 6 presents the ANOVA results comparing lower limb strength performance changes (post-pre measurements) between the intervention and control groups. The analysis revealed statistically significant improvements in all three tests assessing lower-body strength and power: standing long jump test showed a significant difference between groups ($F = 8.553$, $p = 0.005$), standing high jump CMJ test (countermovement jump) also demonstrated a significant improvement in the intervention group compared to the control group ($F = 4.245$, $p = 0.044$), standing high jump on the move test showed a statistically significant difference between groups ($F = 4.819$, $p = 0.032$).

Table 6.
ANOVA comparison by groups for strength of lower limbs (mean difference= post- pre-measurement).

		Sum of Squares	df	Mean Square	F	Sig.
Standing Long Jump (mean diff= post- pre) cm	Between Groups	411.354	1	411.354	8.553	0.005
	Within Groups	2741.447	57	48.096		
	Total	3152.801	58			
Standing High JumpCMJ (mean diff= post- pre) cm	Between Groups	116.102	1	116.102	4.245	0.044
	Within Groups	1558.909	57	27.349		
	Total	1675.010	58			
Standing High Jump move (mean diff= post- pre) seconds	Between Groups	88.890	1	88.890	4.819	0.032
	Within Groups	1051.403	57	18.446		
	Total	1140.293	58			

4. Discussion

The purpose of the study was to assess the effect of 12-week training program in motor skills parameters and health parameters of young boys 12-14 years old. It was hypothesis that training program will improve the motor skills parameters and health parameters in experimental group in young boys. Based on the results of our study, the hypothesis was supported.

The analysis revealed no statistically significant differences in body height, body weight, and BMI between the groups ($p > 0.05$). However, a significant difference was observed in waist circumference ($p = 0.024$). Final results for motor parameter show significant differences between groups in favour of intervention groups for agility (10x5 m and T test) and sprint performance (20 m sprint test), except for the 10m sprint test. Also, the analysis revealed statistically significant improvements in all three tests assessing lower-body strength and power (standing long jump test, standing high jump CMJ test and standing high jump on the move test.

The findings Alonso Álvarez and Pazos Couto [15] research reported the importance of motor skills learning in the classroom. The performance of standing long jump test was significantly improved after the rope skipping training [16]. This improvement happened because the stretch-shorten cycle method is crucial to increase the jumping capacity. The study of Turgut, et al. [17] demonstrated the improvement of agility, explosive power and endurance through rope skipping training in female teenage volleyball players. This is similar to the results of our study even though the 12-week training program was implemented in boys and was focused on motor skills.

According to Guthold, et al. [18] lack of physical activity brings serious health problem around the world. Motor skills are important for development, growth and opportunities through being active [19]. Motor skills are depending by many factors such as maturation, gender, genetics, environment, experiences, opportunities, social factors and demographics [20]. The performance of sit and reach test was increased in the study of Rodríguez, et al. [8] after performing 5 minutes of hamstring stretching during the 32 weeks two times per week. The improvement of the study above was 7.22 cm in the experimental group. Standing long jump is closely linked with both upper and lower muscular strength in youth [21]. The high level of muscle strength helps in improving metabolic risk factor and mortality [22]. The study Merino-Marban, et al. [23] reported a significant improvement in explosive strength of lower extremities through dynamic-bouncing stretch as a final part of warm-up. This improvement is similar to the results of our study.

5. Limitation

A limitation of the current study is that more cities in Albania should be included to improve the accuracy and dependability of the results and conclusion. Future research could cover other cities and nations, as well as additional motor skills. As a result, they can do multigroup analyses.

6. Conclusion

These findings suggest that 12 weeks' intervention training program effectively improved agility and sprint performance (20m), also training program was effective in improving lower limb strength and jump performance, which are crucial for football players' athletic performance.

Despite this, the overall findings indicate that while the training program had a notable impact on motor performance and strength in children 12-14 years old (boys). it did not significantly alter general anthropometric characteristics over the 12-week period.

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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