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Effects of plyometric and strength trainings on selected physical fitness variables in Ethiopia youth sport academy female soccer players

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ABSTRACT: Plyometric is an exercise in which muscles exert force in short intervals of time. Back then, it was only employed in track and field events and was known as “jump training.” The purpose of this study was to investigate the effects of plyometric and strength trainings on selected physical fitness variables in Ethiopia Youth Sport Academy female soccer players. The study used quasi-experimental design. Random sampling technique was used to group the participants into plyometric and strength training groups. Both groups performed selected exercises for consecutive twelve weeks, implemented two days per week and two hours in each session. Paired sample t-test and independent t-test were conducted to analyze the change scores from pre and posttest for all subjects and from separated groups. The paired sample t-test results revealed that players in the plyometric group significantly improved their agility ($p < 0.05$) and explosive power performance ($p < 0.05$) from baseline to the end of the intervention. Whereas, female soccer players in the strength group only improved their explosive power ($p < 0.05$) following twelve-week of strength training intervention. As the independent sample t-test result identified no significant performance difference in agility ($p > 0.05$) and explosive power ($p > 0.05$) performances between the groups. In general, following twelve-week of continuous plyometric and strength trainings the study identified that both training interventions improved the agility and explosive power ability of female soccer players and no significant performance differences had been identified between the two groups.

Keywords/phrases: agility, explosive power, plyometric, strength

INTRODUCTION

Soccer is one of the most popular ball games which is widely played and followed by a high number of supporters all over the world at a professional level (Acar *et al.*, 2008). In modern soccer, physical fitness is one of the most important factors in indicating success for soccer players. Out of physical fitness variables, explosive power and agility are the performance indicators for soccer players during trainings and matches. Plyometric is a training technique used by athletes in all types of sports to increase strength and explosiveness. It consists of physical exercises in which muscles exert maximum force at short intervals of time to increase dynamic performances. Out of those performances, agility is one of the basic performance indicators in soccer which can be developed by plyometric training.

According to Bangsbo *et al.* (2006), during a 90-minute soccer match, professional soccer players make numerous explosive bursts, such as

kicking, tackling, jumping, turning, sprinting, and changing pace. Plyometric exercise consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric (shortening action) of the same muscle (Baechle, 1994). According to different scholars, plyometric trainings in soccer have a significant effect on players' power, especially explosive power of players in training and game situations (Chu, 1998).

Hoff (2004) suggests that strength training using high loads, few repetitions and maximal mobilization of force in the concentric mode have proved to be effective in the development of strength and related parameters. Strength (resistance) training is a training technique that improves muscle strength or size. But Herman, *et al.* (2008), studied that strength training alone does not alter knee and hip kinematics in female recreational athletes and that further research is needed to determine the effects of strength training in combination with other intervention methods on lower extremity biomechanics and performance improvement. Those two studies

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brought different results, making them controversial. Nowadays, many coaches, researchers and players are looking for ways to improve the performance of players in soccer. For instance, Ethiopia Youth Sport Academy has been delivering trainings for talented soccer players from all over Ethiopia for the last five years. However, the effectiveness of plyometric and strength trainings with reference to soccer related physical fitness variables hasn't been investigated yet. Therefore, the main aims of this study were to answer for the following questions¹. Does twelve-week of plyometric training has an effect on the agility of Ethiopia Youth Sport Academy female soccer players? 2. Does twelve-week of plyometric training has an effect on the explosive power of Ethiopia Youth Sport Academy female soccer players? 3. Does twelve-week of strength training has an effect on the agility of Ethiopia Youth Sport Academy female soccer players? 4. Does twelve-week of strength training has an effect on the explosive power of Ethiopia Youth Sport Academy female soccer players? 5. Which type of training does significantly bring change on the explosive power and agility of female soccer players?

MATERIALS AND METHODS

This study used quasi-experimental research design. The sample population of the study was 20. Using the baseline fitness tests, players were assigned into two equal groups (plyometric group= 10 players and strength group =10 players). Participants in the plyometric and strength training groups were performing their task immediately after the warming-up.

The interventions or treatments were performed for twelve weeks, two days per week and two hours per session. Participants continued their regular soccer training routines that were identical for every participant, except the two days of plyometric and strength training program.

The experiment consisted of two test sessions (pre and post exercise test) and two interventions (plyometric and strength). Pre-tests were performed three days before the beginning of training and it contained field tests (Illinois agility test and counter movement jump test) to evaluate agility and power respectively. Then, those programs were followed by post-tests, three days after the last training session. All testing sessions began with a dynamic stretching

of all muscles with warming up and at the end, cooling down.

Test Procedures

The vertical jump test and Illinois agility test were used to know the explosive power and agility level of players respectively. Before the tests, the subjects had performed warming-up exercises for 15 minutes along with dynamic stretching. Then, the researcher demonstrated how they could perform the test. During the Illinois agility test, an assistant score recorder commanded them to "Go!" simultaneously starting his stop watch which went on until the athletes finished the obstacle. In each trial the time to cover each Illinois agility test was recorded in seconds. The players were given two chances and took full recover between the first and second trials. As for the vertical jump test, the players' standing height with extended hand was measured and recorded. Then, the athletes jumped vertically as high as they could and touched the wall with their fingertips. In the end, the final result was recorded as the difference between the first standing height and the jumping height. The vertical jump tests were taken at baseline (pre-test) and end of the twelve weeks (post-test).

Dependent and Independent Variables

In this study, plyometric and strength trainings were used as independent variables of the study. On the other hand, the dependent variables were agility and explosive power performances/results of the participants respectively.

Validity and Reliability of Test Instrument

To ensure the validity and reliability of the tests, the study used standardized and internationally accepted testing tools, procedures and protocols. Valid tests were applied to both dependent variables of the experiment (explosive power and agility). Those were countermovement jump test and Illinois agility test.

Inclusion criteria were: Free from any physical health problems, willing to stay in the academy for more than three months, player in

the under 17 years old football team, willing to eat, sleep and train in the academy during the experiment weeks and do not take any medication.

Data Analysis

The data gathered through pre-test and post-tests were coded and arranged for analysis. The pre and post-test results were presented as mean (SD). The coded and arranged data were analyzed by using paired t-test to see performance changes in both groups from baseline (pre-test) to post-test and independent t-test to identify performance differences between the groups. The researchers also used SPSS version 20.0 software to describe, compare, summarize and analyze the changes in the dependent variables. The level of significance was set at $p \leq 0.05\%$.

RESULTS

Table 1: Demographic Characteristic of the Players.

Description	N	Descriptive Statistics	
		Mean	SD
Age (Years)	20	15.9	1.07
Training experience (years)	20	2.7	.73
BMI (kg/m ²)	20	18.9	.67

As shown in the table, the participants were 20 female EYSA soccer players. The average age of participants was 15.9 years (SD = 1.07). The age of participants ranged from 14 to 18 years ($M = 15.90$, $SD = 1.07$). The average training age of the players was 2.7 years which indicated that the athletes started their regular training after entering the academy. The above table also shows that the average body mass index of the players was 18.9.

Table 2. Descriptive Statistics of the pre- and post-test results of the dependent variable (Illinois Agility test).

Variables	Experimental Group	N	Mean	SD
Illinois Agility Pre- test (sec.)	Plyometric training group	10	18.4	0.87
	Strength training group	10	18.5	0.52
Illinois Agility Post-test (Sec.)	plyometric training group	10	17.8	0.78
	Strength training group	10	18.0	0.40

Test results in table 2 reveals the pre- and post-test assessment results of the two groups' Illinois agility tests. As indicated in the table, the mean (SD) values of the pre-test results of the Illinois agility tests results of players in the plyometric and strength groups were 18.4(0.87) Sec. and 18.5(0.52) Sec. respectively. The post-test mean (SD) values of 17.8(0.78) and 18.0(0.40) cm were scored by players in the plyometric and strength training groups at the end of the 12th week.

Table 3. Descriptive Statistics of the pre and post-test results of the dependent variables (Counter Movement Jump test).

Test	Experimental groups	N	Mean	SD
Pre-test score on CMJ(cm)	Plyometric training group	10	31.40	9.10
	Strength training group	10	25.70	8.07
Post-test score on CMJ(cm)	Plyometric training group	10	35.20	7.11
	Strength training group	10	35.80	7.23

The data in the above table (Table 3) reveals the descriptive analysis results of the pre- and post-test CMJ assessment results of the two groups. As indicated in the table, the mean (SD) values of the pre-test results of the CMJ of players in the plyometric and strength groups were 31.40(9.10) cm and 25.7(8.07) cm respectively. The post-test mean (SD) values of 35.20(7.11) and 35.80(7.23) cm were scored by players in the plyometric and strength training groups after 12 weeks of study weeks.

Table 4. Paired sample t-test results of the Pre to post-test dependent variables (Plyometric on agility).

Variables	Groups	Sig.
Pre- to post-test Illinois Agility Test(sec.)	Plyometric training group	0.000
	Strength training group	0.113

To see the effects of 12 weeks of plyometric training on the agility performance of the female soccer players, paired sample t-test was conducted. Based on the result of the analysis

(table 4), statistically, significant change ($p < 0.05$) had been identified among players in the plyometric training group. In the contrary, the plyometric group no meaningful change had been reported for players who didn't receive plyometric training (strength group).

Table 5: Paired sample t-test results of the Pre- to post-test dependent variables (strength on explosive power).

Variables	Groups	Sig.
Pre to post-test Counter Movement Jump Test (cm)	Plyometric training group	0.036
	Strength training group	0.02

During the 12 weeks of the study time, the female soccer players received plyometric (plyometric group) and strength (strength group) trainings. At baseline (pre-test) and at the end of the strength training interventions, the effect of the training on the explosive power ability of the female soccer players was tested and the results were analyzed using paired sample t-test. The data in table 5 reveals in comparison to the pre-test players in the plyometric group (who didn't receive strength training) and strength group (who received strength trainings) significantly improved their explosive power ($p < 0.05$).

Table 6: Independent sample t-test results of the post-test differences in the Illinois agility and counter movement jump tests.

Test variables	Pre-test	Sig.	Post-test	Sig.
	Mean Difference		Mean Difference	
Between groups Post-test performance difference in Illinois agility test	0.165	0.019	0.202	0.483
Between groups Post-test performances difference in counter movement jump test	-5.700	0.156	0.600	0.854

The study applied two types of interventions - plyometric and strength trainings. After 12 weeks of the training interventions, the study aimed at identifying the performance differences between the groups in their agility and explosive power abilities. Based on the results from independent sample t-test, the study reported no significant difference between the two study groups due to the designed plyometric ($p = 0.483$) nor the strength ($p = 0.854$) training interventions. Although the analysis results revealed no significant performance differences between the two study groups, the paired sample t-test analysis results had reported positive changes in the pre to post- training interventions in agility performance in the plyometric group ($p = 0.000$); in the explosive power performance, both in the plyometric ($p = 0.036$) and strength training groups ($p = 0.02$), even though no performance (pre- to post-test) change was reported in the strength training group ($p = 0.113$).

DISCUSSION

Some previous studies agreed with this finding. Thomas *et al.* (2009) study the effect of six weeks

of plyometric training and reported increases in vertical jump height and change in agility. The study concluded that both depth jump and CMJ plyometric were worthwhile training activities for improving power and agility in young male soccer players. In this study, the participants were female and the result was a similar improvement on the athletes' agility and explosive power performance.

Taking a look at other literatures, Rubley *et al.* (2011), studied the effect of plyometric training on power and kicking distance in adolescent female soccer players. From the study, the plyometric group had a significantly higher vertical jump after fourteen weeks. In addition, Adams and O'Shea, (1992), indicated that both strength and plyometric trainings were necessary for improving hip and thigh power production for vertical jumping ability. Based on these findings, the researcher observed increased vertical jump and agility.

Herman *et al.* (2008) studied that strength training alone does not alter knee and hip kinematics in female recreational athletes. Further research is needed to determine the effect of strength training in combination with

other intervention methods on lower extremity biomechanics and performance improvement.

According to Mirzaei and Norasteh, (2014), effects of six weeks of depth jump vs. countermovement jump training on sand on muscle soreness and performance, there was a significant effect of jumping trainings or plyometric trainings on the agility level of players. This study backed up one of the findings of the current study: plyometric trainings improve the agility level of the athletes. However, the training environment was different and it may have affected the results.

Also, according to Chu (1998), plyometric is a training technique used by athletes in all types of sports to increase strength and explosiveness. Different studies (Parsons *et al.*, 1998; Yap *et al.*, 2000; Miller *et al.*, 2001; Young *et al.*, 2001; Craig, 2004) also supported the discussed tables, i.e. plyometric trainings have a significant change in the agility of soccer players. In this study, the researchers also showed plyometric trainings bringing significant change on the agility performance of the players within the allotted time.

CONCLUSION

Following twelve-week of continuous plyometric and strength trainings, the study identified that both training interventions improved the agility and explosive power ability of female soccer players and no significant performance differences had been identified between the two groups due to the selected two interventions.

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APPENDEXS

Training protocols/ interventions / for plyometric and strength groups/ for twelve week

Table 1:- Plyometric trainings protocol for first, second and third weeks.

No.	Plyometric Trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Box step front jump /40"/	6-8	3	4'	Medium	1:20' include warming up and cooling down
2	Calf exercise /40"/	6-8 x 3	3	4'	Medium	
3	Plyo push ups	6-8	3	4'	Medium	
4	Cross leg movement	6-8	3	4'	Medium	
5	Tuck jump	6-8	3	4'	Medium	
6	Box step side jump	6-8	3	4'	Medium	
7	Burpees	6-8	3	4'	Medium	

Table 2:- Plyometric trainings protocol for fourth, fifth and sixth weeks.

No.	Plyometric Trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Box step front jump	6-8	3	3'	Medium/high	1:20' include warming up and cooling down
2	Calf exercise	6-8 x 3	3	3'	Medium/high	
3	Plyo push ups	6-8	3	3'	Medium/high	
4	Cross leg movement	6-8	3	3'	Medium/high	
5	Tuck jump	6-8	3	3'	Medium/high	
6	Box step side jump	6-8	3	3'	Medium/high	
7	Burpees	6-8	3	3'	Medium/high	

Table 3:- Plyometric trainings protocol for seventh, eighth and ninth weeks.

No.	Plyometric trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Box step front jump	6-8	3	2'	high	1:20' include warming up and cooling down
2	Calf exercise	6-8 x 3	3	2'	high	
3	Plyo push ups	6-8	3	2'	high	
4	Cross leg movement	6-8	3	2'	high	
5	Tuck jump	6-8	3	2'	high	
6	Box step side jump	6-8	3	2'	high	
7	Burpees	6-8	3	2'	high	

Table 4:- Plyometric trainings protocol for ten, eleven and twelfth weeks.

No.	Plyometric Trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Box step front jump	6-8	4	2'	high	1:20' include warming up and cooling down
2	Calf exercise	6-8 x 3	4	2'	high	
3	Plyo push ups	6-8	4	2'	high	
4	Cross leg movement	6-8	4	2'	high	
5	Tuck jump	6-8	4	2'	high	
6	Box step side jump	6-8	4	2'	high	
7	Burpees	6-8	4	2'	high	

Table 5:- Strength trainings protocol for first, second and third weeks.

No.	Strength trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Squat	8	3	4'	medium	1:20'
2	Bar bell good morning	8	3	4'	medium	include warming up and cooling down
3	Lunch	8	3	4'	medium	
4	Crunches	10	3	4'	medium	
5	Calf exercise	10	3	4'	medium	

Table 6:- Strength training protocol for fourth, fifth and sixth weeks.

No.	Strength Trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Squat	8	3	3'	Medium/high	
2	Bar bell good morning	8	3	3'	Medium/high	1:20'
3	Lunch	8	3	3'	Medium/high	include warming up and cooling down
4	Crunches	10	3	3'	Medium/high	
5	Calf exercise	10	3	3'	Medium/high	

Table 7:- Strength training protocol seventh, eighth and ninth weeks.

No.	Strength Trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Squat	10	3	2'	high	
2	Bar bell good morning	10	3	2'	high	1:20'
3	Lunch	10	3	2'	high	include
4	Crunches	12	3	2'	high	warming up
5	Calf exercise	12	3	2'	high	and cooling down

Table 8:- Strength training protocol ten, eleven and twelfth weeks.

No.	Strength Trainings	Reps	Set	Active Rest b/n Set	Intensity	Duration
1	Squat	10	4	2'	high	
2	Bar bell good morning	10	4	2'	high	1:20'
3	Lunch	10	4	2'	high	include
4	Crunches	12	4	2'	high	warming up
5	Calf exercise	12	4	2'	high	and cooling down