The effect of six-week plyometric and core stability exercises on performance of male athlete, 11-14 years old

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ABSTRACT

Background and objective: Core stability and plyometric exercises are training methods that athletes use to improve their performance. Main purpose of the study is examining the effect of six-week plyometric and core stability exercises on the performance of male athletes (11-14 years old). Methodology: 36 male athletes participated in the semi-experimental study. They randomly divided in three group (first group (12 subject); core stability exercise, second group (12 subject); plyometric exercise and third group (12 subject); control). The performance tests (Standing Broad Jump, Vertical Jump, 9.1 m Sprint, Shuttle Run, Flexibility and Seated Medicine Ball Toss tests) applied 1 day before starting core stability and plyometric exercises and then post test applied. ANOVA is used to comparison between the pretest and post test (p <0.05). Results: Core stability and plyometric exercise group showed significance increase in Performance tests (Standing Broad Jump, Vertical Jump, 9.1 m Sprint, Shuttle Run). Conclusion: based on the findings of this study, we recommend the core stability and plyometric exercises to improve general performance of athletes.

Key words: Core stability Exercise, Plyometric Exercise, Performance.

Introduction

Exercise is defined as some organized and regular activity that is done to enhance athletic performance [1] which is divided into different categories based on athletics’ performance necessities. Plyometric exercises and core stability exercises are among those various exercises which are used by athletes to improve their performance. Existing information shows that regular plyometric exercise can increase strength and power of adult persons [2,3]. In following 30 years, the method of exercises has been considered as one of the most common method of exercising in many east bloc countries. Coaches and athletes claim that plyometric exercises create relational bridge between strength and power and raise competitive performance of athletes directly. These exercises include a rapid stretching of muscles (eccentric contraction) that immediately followed by a concentric contraction and shortening of this muscle and connective tissues [4]. The stored elastic energy within the muscle produce more force than can be provided by a sole concentric action [5]. Recent researches show that plyometric exercises are effective and secure to progress of children and teens if these exercises be proportional to their age conditions [6-8]. For example in a survey by Matavulj et al (2001) conducted on 10-year-old basketball players, took to the conclusion that doing plyometric exercises by the player caused improvement of their jumping performance [7] and Kotzamanidis also stated that performing of plyometric exercises increase running speed and vertical jumping abilities of prepubertal boys [8].

On the other hand, core stability is a concept in the health and fitness professions which became popular in the early 1990s. Professionals such as physicians, physical therapists biomechanists and chiropractors use the concept to educate patients on the recovery from of prevention of injuries [9]. Researchers at description of core stability area
remark that the abdominals act as the front of the house, the paraspinals serve as the back the house, the diaphragm servers as the roof and the musculature of the hip girdle and pelvic floor create the 2 basements of the house [10]. For many strength and conditioning professionals, core stability is considered as a key component in training to improve sport performance [13-11]. it is believed that a strong core allows an athlete the full transfer of forces generated with the lower extremities through the torso, and to the upper extremities and sometimes an implement [15,14] and a weak core is believed to interrupt the transfer of energy, resulting in reduced sport performance and risk of injuries to a weak or underdeveloped muscle group. Therefore, training the core has become popular among strength coaches and personal trainers as a means to improve performance and reduce the chance for injury [16]. Although there are several discussions and notices about the importance and assessment methods of core stability area and exercising methods, the literature about the role of core stability in athletes performance is not rich. However, Nesser and Lee investigated the relation between core stability with performance of female soccer players, the participants of the study included 16 female soccer players and before ending of season they performed strength and performance tests. Acquired results of the study showed no significance relationship between core stability area and performance of female soccer players and based on these results it’s mentioned that in order to improve performance of players should not concentrate just on the core stability exercises [17]. Tse et al focused their research on rowers and to assess their core stability endurance used MacGill protocol and also assess subjects performance (vertical jump, broad jump, shuttle run, 40-m sprint, overhead medicine ball throw, 2,000-m maximal rowing ergometer test). After passing of eight-weeks of doing core stability exercises, significant difference observed in both right trunk flexion and left trunk flexion but result of the study didn’t show significant difference for any of the performance tests. According to previous findings there was not strong relationship between strength/stability of core stability area and athletic performance of male athletics [18]. On the other hand, Shinkle examined the impacts of core strength on the measure of power in the extremities and reported that core strength does have a significant effect on the ability of an athlete to create and transfer in the extremities [19]. Dendas investigated relationship between core stability and performance of male soccer athletes and discovered higher relation between trunk flexion (MacGill protocol), (the 60-s and 30-s maximum sit-up tests) with athletic performance [20]. Given inconsistencies and the lack of researches done in the past as well as the importance of this area, there is still the question of whether the core stability area has a direct impact on athletes’ performance or plays a secondary role in this regard? Whether is it possible to apply plyometric exercises as a method for improvement of performance in the growing ages? What kinds of exercises (core stability or plyometric) can affect performance of athletes and which one has priority over the other?

From this point of view, main aim of this study is to examine the effects of a periodical plyometric and core stability exercises on performance of 11 to 14 years old male athletes.

Methodology:

In the quasi-experimental study, 36 athletes (swimmer) participated voluntary that were divided randomly into three groups with 12 persons in per group, core stability group, plyometric group and control group. Before beginning of the research, necessary details about research method explained to the subjects of the study and then consent forms were filled and signed by the participants and their parents. Subjects who suffer from previous injuries in lumbar area and lower extremity and those with cardiovascular disease and any condition that may affect the process and results of the exercise were excluded from the study. The first and second groups performed their six-week training program and third group participated in this study as control group. Firstly three groups executed performance tests such as: vertical jump test, standing broad jump test, 9.1m (10yd) sprint test, agility shuttle run test, sit and reach test and seated medicine ball toss. To evaluate power, acceleration, speed and agility; vertical jump test, standing broad jump test, agility shuttle run test and seated medicine ball toss test were used that are common to assess athletes’ performance [21].

In vertical jump test, after scaling a wall by tape meter, asked subjects to stands side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height. The athlete then stands away from the wall, and leaps vertically as high as possible using both arms and legs to assist in projecting the body upwards. Their final score calculated by the difference in distance between the standing reach height and the jump height is the score. For doing the standing broad jump test, after scaling the ground, each subject carried out three jumps from behind of starting line and their best record considered as their final score. In 9.1 meters sprint test subjects stood behind starting line and started their test with their maximum power, by trainer’s command. Agility shuttle run test is done by subjects with determining of 9 meters distance and with drawing two lines in starting and finishing point. Two small pieces of wood placed on the one side of drawing lines and on the other side subjects had to stand. With coach order subjects should run towards the other side as fast as
they could and brought one piece of wood to the starting point and continue his task to transfer the second piece of wood to the starting line. The best of trails is recorded. In this test each subject should run a distance of nine meters four times as fast as he could. To measure flexibility of lower back and hamstring muscles, the person sitting on the floor so that his legs are fully extended. Feet (shoes off) are placed with the soles flat against the box, shoulder-width apart. Both knees are held flat against the floor by the tester, if required. With hands on top of each other and palms facing down, the subject reaches forward along the measuring line as far as possible. Score is measured based on centimeter.

Final test is seated medicine ball toss test (3 kg). In this case the person sit on the floor while leaning against the wall, threw the ball with all the power to the farthest point without separating his back and shoulders from the wall. It should be mentioned that prior to starting the test subjects warmed up their body for 15 minutes under coach observation. All of tests carried out three times and the best gained record by subjects considered their scores with accurate range of 0.5 cm or 0.01 second [23-21].

Core stability group participated in a 6 weeks exercising period that was designed to strengthen core stability area, the exercising program included 3 session exercising per a week in such a way that training intensity gradually increased from the first week to fifth weeks until last week that its intensity declined due to the participation of the subjects in performance tests. This exercising program concentrated on both groups of core stability muscles such as local muscles and global muscles [24] and plyometric group, also participated in a six weeks exercising period, two sessions per a week, with specific repetitions and sets. The quality of plyometric exercises improved from level one (the first and second weeks; 1-2 sets with 10 repetitions) level two (third and forth weeks; 1-2 sets with 8 repetition) and finally level three (fifth and sixth weeks; 1-2 sets with 6 repetitions). To create gradual stress by plyometric exercises, during first, third and fifth weeks subjects performed only one set of each exercise. Subjects executed 11 plyometric exercises during the first and second weeks and 12 exercises during third to sixth weeks. Subjects encouraged do their exercises as rapidly as they could. Level one included low intensity exercises such as double leg hop. In addition, performance of exercises of level one generated confidence among subjects and reassured them that they had ability of doing and continuing of exercises. Each exercise session included upper body plyometrics, lower body plyometrics and plyometric speed and agility drills which were specifically designed to enhance a subject’s ability to accelerate, decelerate, change direction, and then accelerate again. Enough time assigned for recovery of subjects and the rest of the research process fulfilled based on previous studies [25].

All subjects were under direct supervision during exercise and how to do the exercises were explained to them. Subjects in the both groups began their exercises after ten minutes of warm-up and ended it under trainer supervision by cool-down exercises. A day after the training session, the three groups performed the performance tests again.

To describe collected data mean and standard deviation and to examine normal distribution of scores Kolmogorov-Smirnov test, and to investigate amount of significance of exercise impact ANOVA were used.

Results:

Individual characteristics of subjects in three groups of plyometric training group, core stability group and control group are displayed in Table 1. According to ANOVA results there was no significant difference between variables of age, height and weight among subjects of the study which confirms the normal of the three groups in terms of individual characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>Plyometric</td>
<td>12.23</td>
<td>1.16</td>
<td>0.416</td>
<td>0.663</td>
</tr>
<tr>
<td></td>
<td>Core stability</td>
<td>12.53</td>
<td>1.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>12.61</td>
<td>1.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>Plyometric</td>
<td>144.53</td>
<td>4.70</td>
<td>0.361</td>
<td>0.669</td>
</tr>
<tr>
<td></td>
<td>Core stability</td>
<td>143.40</td>
<td>3.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>145.07</td>
<td>6.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>Plyometric</td>
<td>41.92</td>
<td>8.19</td>
<td>0.111</td>
<td>0.895</td>
</tr>
<tr>
<td></td>
<td>Core stability</td>
<td>40.50</td>
<td>8.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>41.76</td>
<td>8.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to descriptive features (mean and standard deviation) table 2 displays the performance tests, ANOVA results of pre-test and post-test in three groups: plyometric, core stability and control. As it can be seen in this table, there is only a significant difference (P<0.05) between the results of the pretest and posttest of vertical jump in plyometric group. Similarly, in standing broad jump test difference was significant only among core stability group subjects (P<0.05). The results of 9.1m sprint test and agility shuttle run test were difference so that this tests were difference in both plyometric and core stability groups. Accordingly, the results of pre-tests and post-tests of the flexibility (sit and reach test)
and throwing of medicine ball showed no significant differences among performance of three groups statistically (P>0.05).

Table 2: Descriptive features of performance tests and results of a ANOVA test of three groups: (plyometric, core stability and control) in the pre-test and post-test.

<table>
<thead>
<tr>
<th>Performance Test</th>
<th>Group</th>
<th>Mean and SD</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>24.2± 2.78</td>
<td>29.18± 4.09</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>26.05± 5.03</td>
<td>25.77± 4.35</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>24.38± 2.69</td>
<td>24.90± 2.66</td>
</tr>
<tr>
<td>Standing broad jump</td>
<td>plywood</td>
<td>plywood</td>
<td>1.55± 0.11</td>
<td>1.50± 0.08</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>1.32± 0.10</td>
<td>1.42± 0.13</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>1.45± 0.12</td>
<td>1.47± 0.09</td>
</tr>
<tr>
<td>9.1m sprint</td>
<td>plywood</td>
<td>plywood</td>
<td>2.86± 0.17</td>
<td>2.27± 0.20</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>6.68± 0.23</td>
<td>1.88± 0.17</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>2.79± 0.18</td>
<td>2.74± 0.21</td>
</tr>
<tr>
<td>Agility shuttle run</td>
<td>plywood</td>
<td>plywood</td>
<td>7.09± 0.42</td>
<td>5.98± 0.31</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>9.89± 0.54</td>
<td>6.54± 0.83</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>7.03± 0.42</td>
<td>6.80± 0.57</td>
</tr>
<tr>
<td>Sit and reach</td>
<td>plywood</td>
<td>plywood</td>
<td>14.01± 7.29</td>
<td>18.18± 7.89</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>19.71± 6.64</td>
<td>23.38± 3.25</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>13.27± 6.69</td>
<td>14.57± 7.03</td>
</tr>
<tr>
<td>Seated medicine ball</td>
<td>plywood</td>
<td>plywood</td>
<td>1.83± 0.41</td>
<td>2.02± 0.28</td>
</tr>
<tr>
<td>toss</td>
<td>plywood</td>
<td>plywood</td>
<td>1.63± 0.24</td>
<td>1.67± 0.41</td>
</tr>
<tr>
<td></td>
<td>plywood</td>
<td>plywood</td>
<td>1.90± 0.43</td>
<td>1.95± 0.26</td>
</tr>
</tbody>
</table>

Significant difference (P<0.05)

Discussion:

The aim of this study was to evaluate the impact of one period of exercising program based on plyometric and core stability methods during six weeks on performance of 11 to 14 years old male athletes. Findings of the study shows that six-week plyometric exercising can improve performance of male athletes numerically (except in the case of standing broad jump test) so that significant difference observed only in vertical jump, 9.1 m sprint test and agility test. However, it seems that exercises had a better impact on core stability group so that numerically gained results improved in all kinds of tests so that significant difference observed in standing broad jump, 9.1 m sprint test and agility shuttle run tests. Similarly, the control group showed improvement but not extent to the development of the post-test that was statistically significant.

With taking into consideration of review of literature the results of this study are confirmed. Accordingly, Chelly et al showed that plyometric trainings improve power, squat jump, sergeant jump and running speed of the young footballers [26]. Results of other researches that were done to investigate the impact of six-week plyometric exercises on some physical fitness factors, suggest a significant impact of these trainings on 60-meter sprint, muscular power in lower body and sergeant jump [27]. Almost similarly, Damon et al observed the same results in order that in a six-week research about effects of plyometric training showed a significant difference in squat and sergeant jump but in 50 yd sprint test special result did not observed [29]. Liao in a more and less different way examined the impact of longer exercising. He reported that the impact of 12-week plyometric exercises on standing broad jump test, sergeant jump and 50yd sprint test were significant but he did not find significant impact of those exercises on agility shuttle run test [30]. Another study took placed which focused merely on vertical jump, this study that extend twelve weeks showed a significance impact of plyometric exercises on sergeant vertical jump test [30] that was confirmed by other researchers [32-34].

Crowder et al by using both plyometric and isotonic with weight training methods, surveyed effects of dynamic push-up training on medicine ball toss test. Plyometric push-up training group showed more remarkable progression than the group who carried out isotonic exercises [35]. Also Vossen et al indeed, studied about influences of dynamic push-up training and plyometric push-up training on the 35 healthy females during six weeks and in 18 sessions. Based on their findings plyometric push-up training has a significant effect on medicine ball throwing test [36]. Conversely, Heiderschit et al found no significant difference in pre-and post-tests of medicine ball throwing test in an eight-week training period (twice a week) on the performance of female participants [37]. Results of recent study about medicine ball throwing test showed that plyometric trainings do not impact the results of the test. Perhaps, one of the possible reasons for the lack of influence on medicine ball throwing test is that training program of this research mainly focused on lower extremities, effectiveness of plyometric trainings on sprint and agility tests also can prove this result. Another reason that can be cited is that in the performance tests which took from subjects, individual skills play important role. In spite of this fact that the subjects who participated in this study were male athlete boys but they had never performed similar exercises like those designed in this study and based on gained information and researchers' observation only standing broad jump and vertical
jump test were similar to the previously done trainings by subjects. In a research conducted by Potdevin et al. on swimmers, researchers suggested that plyometric trainings influence dive and turn performance of the swimmers but has no significant effect on kicking propulsion performance that are conducted regularly by swimmers [38]. Since the common performance of swimmers includes upper and lower extremity performance, so it seems that more professional analysis are needed which solely focused on upper or lower extremities and subsequently measure specific performance of extremities as well as public performance extremities.

Core stability area and its importance in athletics performance newly attracted researchers' attention. Generally speaking, core stability is a concept in the health and fitness professions which became popular in the early 1990s [9]. Although, special information published about the importance of core stability area and its training and assessment methods, a few studies took placed about the role of core stability in athletics performance. Accordingly, the findings of present study showed that the highest impact of core stability trainings is on 9.1 m sprint test (0.00), agility shuttle run test (0.00) and standing broad jump test (0.04) and lowest impact on vertical sergeant jump test (0.69), medicine ball toss test (0.76) and flexibility test (1.08). With regard to the above information we can see that the difference between pre-test and post-test is only significant in 9.1 m sprint, agility shuttle run and standing broad jump tests which is not in concordance with review of literature. Accordingly, Nesser and Lee examined relation between core stability area and female soccer players' performance. Based on the findings of their study no significant relation existed between core stability area and performances of female player and in conclusion they stated that in order to improve players' performance one should not put extra attention on core stability area trainings [17]. Tse et al investigated power of core stability area and rower performance. They used MacGill protocol to assess endurance of core stability area and vertical jump, standing broad jump, agility shuttle run, 40 m sprint, medicine ball toss and 2,000-m maximal rowing ergometer tests to assess performance. After 8 weeks core stability exercises significant progress observed in both right and left lateral flexion but there was no significant relationship between trainings and performance of subjects. Dendas worked on the relation between core stability and performance of male soccer players and found closest relation between flexion trunk (MacGill protocol), 30 and 60 second sit-up test and performance of athletics. However, he did not observe a significant relationship between trunk extension, right and left flexion of athletics performance [20]. Nesser and Lee examined the relationship between endurance of core stability by performance tests such as bench press, squat, power clean, 20 m sprint, 40 m sprint, agility shuttle run and vertical sergeant jump and found that there is a week relationship between core stability and performance [16]. Sharrock et al found no relationship between power of core stability with medicine ball toss, 40 yards sprint, 4 ×9 m sprint, and sargent vertical jump [39].

According to the results of the previous research and current research as well, it should be mentioned that coaches and swimmers should accept the fact that among swimmers land base exercises do not attract trainers' attention like other sports. Likely, one of the main reasons for relative influence of land base exercises on general performance of swimmers because at primary stage of exercise, improvement is extremely high. Scibeck et al examined swimmers performance and core stability power among high school swimmers. On the other hand, in their research they investigated the impacts of therapy ball trainings on swimmers performance. It was reported that the therapy ball trainings cause the measure of core stability of swimmers improve but, has no effect on the swimming performance of the swimmers [40] and confirm the findings of current study. Regarding Scibeck et al it should be noted that evaluating these trainings by using special tests (Specific performance) is important and need further researchers attention.

It should also be noted that although exercise can improve status of core stability area, it seems the exercises play more important role in improving of balance and prevention of injuries than performance of athletics. In this case, investigating of relation between performance and balance with core stability area can reach to clear results. Several researches have been conducted about positive relation and influence of core stability exercises on improvement of balance but acquired results about relation of core stability and performance are contradictory that it can be due to the weakness in designing of the tests applied for measuring performance of core stability area, weakness in designing of trainings protocols related to the core stability area or lack of incongruity of selected performance tests. Lack of information in this area of study approves the necessity of further researches.

Conclusions:

The results of this study indicated that the core stability and plyometric exercises had a positive impact on athletic performance and can be included in athletes' training programs to improve their performance. Protocol of these programs should be designed and complemented based on needs and necessities of different sports. Therefore, more research and various training protocols are needed. On the other hand, considering the influence of both types of exercise, it seems a combination of these two types of training programs and their comparison
create remarkable results in athletes performance reaching to this goal needs further studies as well.

References


